Background: Standard puffing protocols are used to examine tobacco product emissions. Electronic cigarette (ECIG) emissions that do not use standard puffing protocols may differ from real-world emissions. This study compared JUUL particulate matter (PM) emissions using four unique 10-puff bout procedures.

Methods: We generated ECIG aerosol in a 0.5 m³ chamber using a JUUL ECIG device. For each experiment, 10 three-second puffs (30 second inter-puff interval) were generated. In Experiment 1, the JUUL pod was connected to the device for the duration of the bout. For Experiment 2, the JUUL pod was removed and reinserted after the first five puffs. For Experiment 3, the JUUL pod was removed and reinserted after every two puffs. For Experiment 4, the JUUL pod was removed and reinserted after each puff. PM 2.5 (μm in diameter and smaller (PM$_{2.5}$)) was measured using an aerosol sensor.

Results: Uncorrected mean real-time PM$_{2.5}$ concentration was 65.06 μg/m³ (SD=99.53, Median=16.01) for Experiment 1, 375.50 μg/m³ (SD=346.45, Median=265.47) for Experiment 2, 501.94 μg/m³ (SD=450.00, Median=374.71) for Experiment 3, 834.69 μg/m³ (SD=578.34, Median=725.34) for Experiment 4.

Conclusions: This study demonstrates that initial puffs after a JUUL is reinserted greatly increase PM$_{2.5}$ concentrations inside the chamber. A fully charged JUUL ECIG device was puffed using a diaphragm pump set to generate 3-second puffs at a flow rate of 1.5 L/min and an inter-puff interval of 30 seconds.

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Introduction

- Standard puffing procedures are used to measure tobacco product emissions by machine-puffing tobacco products in laboratory settings.
- Emissions from laboratory-generated procedures often underestimate emissions for cigarettes and may also underestimate ECIG emissions.
- This study examined particulate matter (PM) emissions from a JUUL ECIG device using four different 10-puff procedures.

Methods

- ECIG aerosol was generated into a 0.5 m³ chamber (Figure 1).
- A fully charged JUUL ECIG device was puffed using a diaphragm pump set to generate 3-second puffs at a flow rate of 1.5 L/min and an inter-puff interval of 30 seconds.
- New JUUL pods were used for each experiment after 5 “priming” puffs were taken from each pod.
- Real-time PM$_{2.5}$ concentrations inside the chamber were measured using a pDR-1500 sensor.

Results

- Uncorrected mean PM$_{2.5}$ concentrations were lowest in Experiment 1 (65.06 μg/m³; SD=99.53, Range=0-1222.00 μg/m³) and highest in Experiment 4 (Mean=834.69 μg/m³; SD=578.34, Range=0-2643.00 μg/m³).
- PM$_{2.5}$ concentrations generally increased after the JUUL pod was reinserted.

Discussion

- Using identical puffing procedures that only differed by the number of times a JUUL pod was removed and reinserted, aerosol generated from 10 puffs from a JUUL device in four experiments generated PM2.5 concentrations that differed greatly.
- Compared to when the JUUL pod was inserted and 10 puffs were generated without removing the pod, 10 puffs from a JUUL in which the pod was removed and reinserted after each puff resulted in mean PM2.5 concentrations inside of the exposure chamber that were 12.8 times higher.
- While increased nicotine emissions in the first puffs may increase the potential for JUUL to produce dependence, increased PM2.5 in the first puffs also likely increases user and bystander exposure to toxicants and the risk of negative health effects.

Conclusions

- Removing and reinserting a JUUL pod increases PM$_{2.5}$ emissions.
- Standard laboratory puffing protocols may underestimate JUUL or other ECIG product emissions.
- Laboratory puffing protocols should be developed to reflect real-world ECIG user behavior.