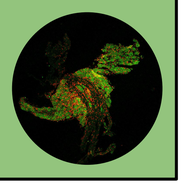
A Single Vape Exposure Restricts Ventilation in Adult Rats

Mila J. Fisher, Alicia M. Peters, and Jennifer A. Stokes, PhD

Department of Kinesiology, Southwestern University; 1001 E University Ave; Georgetown, Texas; 78626



Introduction

Electronic cigarette usage is an alternative to smoking, in which vape pens are used to heat and aerosolize liquids containing nicotine and other chemicals.

- Recent vaping research in humans shows increased airway resistance with acute (5 to 60 minutes) e-cigarette exposure. (1, review)
- There may be a slight decrease in lung function affecting lungs volumes such as tidal volume, inspiratory, and expiratory reserve volume. (1, review)

More research is needed to fully understand both the acute and chronic effects of vaping.

Current research in animal models suggests lung tissue changes with acute e-cigarette exposure (2).

- In rats, after only 15 minutes of exposure there was an increase in the inflammatory cytokines in the lungs (3)

This pilot study aimed to investigate the effects of a single e-cigarette vapor exposure in adult rats on lung function under normoxic and hypoxic conditions.

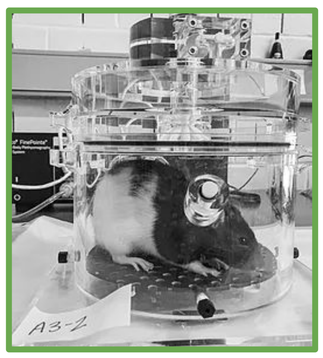
Since research has shown that e-cigarette exposure affects airway resistance and lung tissue, we hypothesize that acute e-cigarette exposure will affect breathing patterns under both normoxic and hypoxic conditions.

Methods

Study Timeline

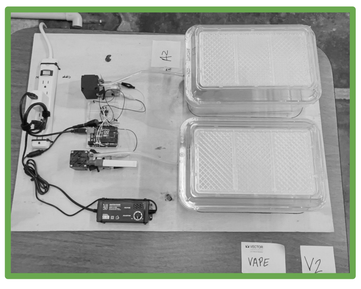
Baseline Ventilation Recordings → **Vape (JUUL) or Air Exposure (10 min)** → **Post-Vape Ventilation Recordings and Blood Collection**

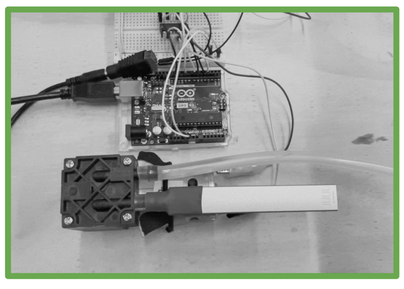
All animal protocols were approved by the SU IACUC (Protocol Stokes 0721)



Whole-Body Plethysmography: Ventilation was recorded in awake animals (adult Long Evans rats) using Data Sciences International Buxco whole-body plethysmography chambers and FinePoint software. Minute ventilation, tidal volume, and breathing frequency were assessed in normoxia (room air) and normobaric hypoxia (10% oxygen) both before and immediately after a single air or vape exposure.

Vape Exposure Chambers: Rats (n=18) were exposed to either air or JUUL 5% nicotine vapor using a whole-body exposure chamber (see pictures below) for 10 minutes. Rats in vape group (n=9) were individually placed into a vape chamber, while rats in air group (n=9) were placed in a chamber which only received room air. The vape system, a modified version of ref. 4, was turned on and ran on a continuous program of a 2 second draw of vape or air followed by 4 seconds off. After 4 minutes, the system pumps were turned off, and the rats remained in the chambers for an additional 6 minutes for 10 minutes of total vapor or air exposure.





References

1. Tsai, MuChun, et al. “Effects of e-Cigarettes and Vaping Devices on Cardiac and Pulmonary Physiology.” The Journal of Physiology, vol. 598, no. 22, 25 Sept. 2020, pp. 5039–5062., doi:10.1113/jp279754.
2. Masso-Silva, Jorge A., et al. “Acute and chronic effects of vaping electronic devices on lung physiology and inflammation.” Current Opinion in Physiology, vol. 22, 2021, 22:100447
3. Ahmad, Shama, et al. “Acute Pulmonary Effects of Aerosolized Nicotine.” American Journal of Physiology-Lung Cellular and Molecular Physiology, vol. 316, no. 1, 25 Oct. 2018, doi:10.1152/ajplung.00564.2017.
4. Frie, Jude A., et al. “OpenVape: An Open-Source E-Cigarette Vapor Exposure Device for Rodents.” Eneuro, vol. 7, no. 5, 18 Aug. 2020, doi:10.1523/eneuro.0279-20.2020.

Results and Conclusions

Single vape exposure decreases tidal volume and minute ventilation under normoxic (*figure 1)* and hypoxic (*figure 2)* conditions. Baseline ventilation data and post-exposure ventilation data in both normoxia and hypoxia were compared using two-way ANOVAs, with a Bonferroni post-hoc test. For normoxia (*fig. 1*), a significant difference between baseline and post-treatment for the vape condition was found in both tidal volume ($p = 0.0193$) and minute ventilation ($p = 0.0011$). For hypoxia (*fig. 2*), a significant difference was also found between baseline and post treatment for the vape condition in both tidal volume ($p < 0.0001$) and minute ventilation ($p = 0.0013$).

Figure 1 - Normoxia

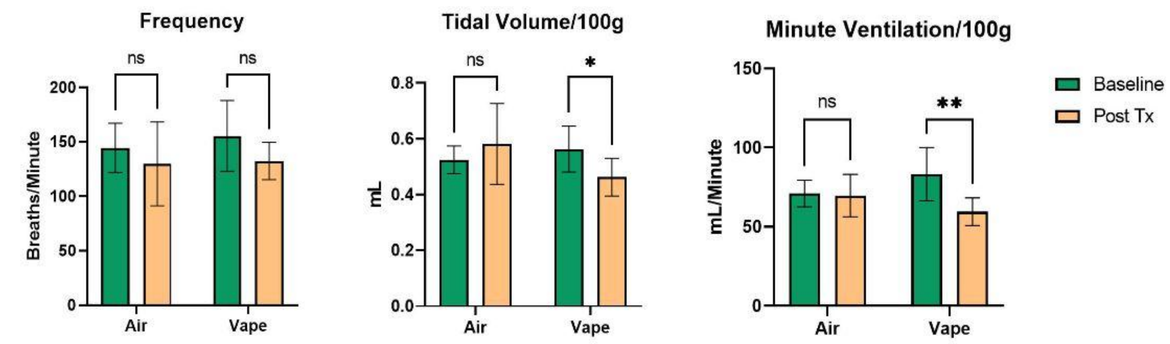
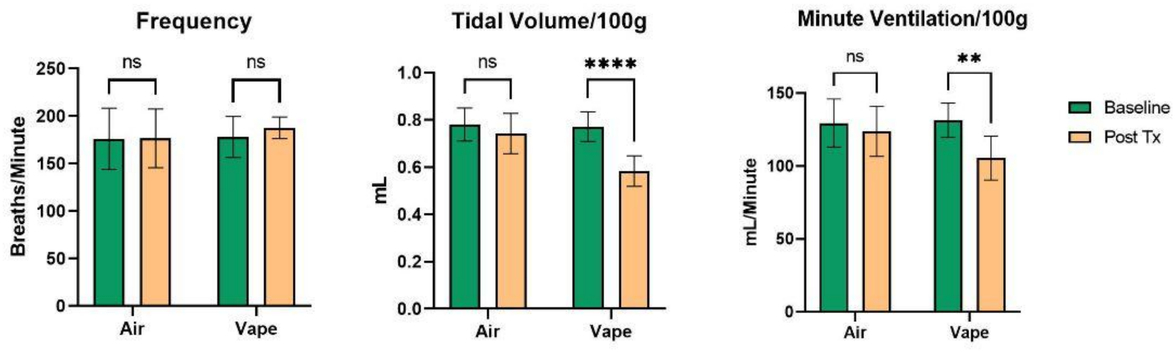


Figure 2 - Hypoxia



Conclusion: The data found in this study, supported by findings in other research, suggests that exposure to e-cigarette vapor increases breathing difficulty immediately after exposure. This difficulty is exacerbated by exposure to hypoxic conditions.

Limitations and Future Plans

- Limitations to this study include unplanned temperature variability (greater than 80°F for 5 consecutive days) in the week preceding this scheduled study, resulting in higher than normal frequency values. A repeat of this study is planned for when the temperature is more stable.
- Serum will be analyzed for cotinine (an indicator of nicotine exposure) and inflammatory cytokines.