A Single 10-Minute Vape Exposure Alters Ventilation in Adult Rats

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ABSTRACT

E-cigarettes, also known as electronic nicotine delivery systems (ENDS), are an alternative to the traditional cigarette. ENDS function using a heating device (e.g. "vape pen", such as JUUL) to heat liquids containing nicotine and other chemicals. Recent research in humans and animal models suggests that acute exposure (5 to 60 minutes) to e-cigarette vapor increases airway resistance and proinflammatory cytokine presence in lung tissue. These acute effects may lead to long term functional changes in the lung and tissue changes at the respiratory membrane. **PURPOSE**: The purpose of this study was to investigate the effects of an acute 10-minute e-cigarette vapor exposure on lung function and proinflammatory cytokine expression, specifically IL-1β in adult rats. **METHODS**: Adult male Long Evans rats (n=18) were randomly assigned to either the experimental vapor exposure group or the control air group. The vapor exposure group (n=9) was exposed once to 5% nicotine vapor for 10 minutes using whole-body exposure chambers. The air group (n=9) were placed in a chamber, but only exposed to room air. Ventilation recordings were completed the day before exposure (pre) and immediately after vapor or air exposure (post) using unrestrained whole-body plethysmography. Tidal volume/100g, breathing frequency, and minute ventilation/100g were assessed. Blood was collected at the end of the post-treatment day for all animals and processed to serum. Serum cotinine (a nicotine metabolite) and proinflammatory cytokine IL-1β were measured using enzyme linked immunosorbent assays (ELISA). **RESULTS**: The presence of cotinine was confirmed in the serum collected from the vapor exposed group (89.16 ± 31.16 ng/mL) compared to the air control group (0.054 ± 0.051 ng/mL). Baseline ventilation data (pre-) and post-treatment were compared between air and vapor exposed groups across three different parameters: tidal volume/100g, frequency, and minute ventilation/100g. These parameters were compared resulting in three distinct 2x2 (time x treatment) Mixed Model ANOVAs. A main effect of time (pre-treatment vs. post-treatment) on frequency ($p = 0.036$) and minute ventilation ($p = 0.006$) was observed. The main effect of time on breathing frequency was not due to the treatment group ($p = 0.906$). The minute ventilation for the vapor exposed group decreased from pre-treatment (83.2 ± 16.8 mL/min/100g) to post-treatment (59.5 ± 8.75 mL/min/100g; $p = 0.007$), while the minute ventilation of the air control group remained relatively constant pre-treatment (72.1 ± 8.6 mL/min/100g) to post-treatment (73.1 ± 15.1 mL/min/100g; $p = 0.76$). And while a main effect of time on tidal volume was not significant, there is a trend of a decrease in tidal volume for the vapor exposed group from pre- to post-treatment. There was no significant difference (unpaired student's t-test, $p = 0.44$) in circulating proinflammatory IL-1β cytokine levels in the serum between the vapor exposed group (4.96 ± 5.98 pg/mL) and air group (8.05 ± 9.98 pg/mL). **CONCLUSIONS**: After an acute 10-minute e-cigarette vapor exposure, respiratory function was altered in that minute ventilation and possibly tidal volume were decreased in rats exposed to vape. Circulating levels of proinflammatory cytokine IL-1β did not differ between exposure groups. Taken together these results suggest that even a single bout of e-cigarette vapor exposure results in functional changes in the adult lungs. Future studies will investigate the duration of this functional change and additional cytokine presence.