Electronic Cigarette Use and Respiratory Symptoms in Chinese Adolescents in Hong Kong

Electronic cigarettes (e-cigarettes) are increasingly used, but their health effects remain unclear. The primary ingredients of e-cigarette liquid, propylene glycol and flavoring chemicals (eg, diacetyl or diketone), are respiratory irritants and harmful to the lungs. Well-documented respiratory toxicants, such as particulate matters, volatile organic compounds, and metals, were found in e-cigarette aerosol, although in lower concentrations than conventional cigarettes.
Short-term adverse effects of airway resistance and inflammation have been observed in adults, but null associations were also reported. Children are particularly vulnerable to respiratory pollutants, yet, to our knowledge, no study has evaluated the respiratory effects of e-cigarettes in children. We assessed the association between e-cigarette use and respiratory symptoms in Chinese adolescents in Hong Kong.

**Methods** | During 2012-2013, we surveyed secondary 1 (US grade 7, typically aged 12 years) to secondary 6 students from 75 randomly selected schools using an anonymous questionnaire based on the Global Youth Tobacco Survey. An invitation letter was sent to parents, and student participation was voluntary. Ethics approval was granted by the institutional review board of the University of Hong Kong/Hospital Authority West Cluster. Parental passive oral consent was obtained. A total of 45 128 students (94.5% of all invited) were available for analysis after data cleaning. Smoking status was defined as never-smoking (smoked on ≥1 day in the past 30 days). Use of e-cigarettes in the past 30 days (yes or no), respiratory symptoms (cough or phlegm) for 3 consecutive months in the past 12 months (yes or no), sociodemographic characteristics (sex, age, and perceived family affluence), and secondhand smoke exposure were recorded. We weighted descriptive data by sex, age, and grade distribution of the corresponding general population. Adjusted odds ratios (AORs) of respiratory symptoms due to e-cigarette use were calculated using logistic regression (Stata version 13.0; StataCorp) for all students and by smoking status, adjusting for sociodemographic characteristics, secondhand tobacco smoke exposure, school clustering effects, and, where appropriate, smoking status.

**Results** | The mean (SD) age was 14.6 (1.9) years, and 51.1% were boys. Only 1.1% (95% CI, 1.0-1.2) of all students, 0.1% (0.1-0.2) of never-smokers, 5.8% (5.2-6.3) of ever-smokers, 2.0% (1.6-2.5) of experimenters, 9.6% (8.3-11.1) of ex-smokers, and 9.6% (8.2-11.2) of current smokers had used e-cigarettes in the past 30 days. Respiratory symptoms were reported by 18.8% of all students, 17.7% of never-smokers, 25.8% of ever-smokers, 21.7% of experimenters, 27.2% of ex-smokers, and 34.3% of current smokers. The Figure shows a higher prevalence of respiratory symptoms in e-cigarette users regardless of smoking status. Overall, e-cigarette use was significantly associated with respiratory symptoms (AOR, 1.28; 95% CI, 1.06-1.56) (Table). The corresponding AORs (95% CIs) were 2.06 (1.24-3.42) in never-smokers, 1.39 (1.14-1.70) in ever-smokers, and 1.40 (1.02-1.91) in ex-smokers. Positive but nonsignificant associations were observed in experimenters (AOR, 1.09; 95% CI, 0.66-1.80) and current smokers (AOR, 1.15; 95% CI, 0.81-1.62).

**Discussion** | To our knowledge, we present the first evidence of an association between e-cigarette use and respiratory symptoms in never- and ever-smoking adolescents, which is consistent with findings from other laboratory and adult studies on short-term adverse respiratory functions. Similar ORs between crude and adjusted models suggested the association was unlikely due to confounding effects, and e-cigarette use may independently predict respiratory symptoms. Respiratory symptoms are a simple and useful outcome to demonstrate the short-term health effects of e-cigarette use while...
long-term effects are being studied. Nicotine-containing e-cigarettes are banned in Hong Kong, but nicotine-free e-cigarettes are not regulated and are available from the Internet and retail stores. The strong association of respiratory symptoms with e-cigarettes observed in never-smokers (AOR, 2.06; 95% CI, 1.24-3.42) is comparable with that found in adolescent occasional smokers (AOR, 1.72; 95% CI, 1.01-2.93). This finding, together with the potential for e-cigarettes to become a gateway for conventional cigarettes, supported the World Health Organization's recommendation to regulate e-cigarette use, particularly in children.

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