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E-cigarette use and asthma in a multiethnic sample of adolescents

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ABSTRACT

There is minimal evidence from epidemiological studies on how e-cigarette use is related to health indices in adolescence. We hypothesized that e-cigarette use would be associated with asthma, controlling for demographics and cigarette smoking. The hypothesis was tested with cross-sectional data from a statewide sample of school students. Surveys were administered in classrooms in 2015 to adolescents in 33 high schools throughout the State of Hawaii. The sample (N = 6089) was 50% female and mean age was 15.8 years. Data were obtained on demographics; ever use and current (past 30 days) use of e-cigarettes, combustible cigarettes, and marijuana; ever being diagnosed with asthma; and currently having asthma. Multinomial regression examined the association between e-cigarette use and asthma controlling for cigarette smoking, marijuana use, and six demographic covariates. Current e-cigarette use was associated with currently having (vs. never having) asthma (adjusted odds ratio [aOR] = 1.48, CI 1.26–1.74) and with previously having (vs. never having) asthma (aOR = 1.22, CI 1.07–1.40). This was independent of cigarette smoking, marijuana use, and other covariates. Smoking and marijuana were nonsignificant in the multivariate analysis. Blacks, Native Hawaiians, other Pacific Islanders, and Filipinos had higher rates of asthma compared with Asian Americans and Caucasians. We conclude that e-cigarette use by adolescents is independently associated with asthma. This finding is consistent with recent laboratory research on pulmonary effects from e-cigarette vapor. Implications for public health should be considered.

1. Background

The use of electronic cigarettes (e-cigarettes) among adolescents has increased substantially over the past five years. Recent US data show prevalence estimates for current e-cigarette use (i.e., any use in the last 30 days) of 14%–16% in high school populations (Jamal et al., 2017; Miech et al., 2017a). Similar prevalence estimates have been noted in other countries (Dutra and Glantz, 2014; Goniewicz et al., 2014a, 2014b; White et al., 2015). However, there is little evidence available from human studies on how e-cigarettes are related to indices of health status. Researchers have noted that findings from laboratory studies of short-term e-cigarette effects on biological processes can be of uncertain relevance for human health, and there have been few epidemiological studies testing whether e-cigarette use is related to respiratory symptoms in human populations (Pisinger and Døssing, 2014).

Asthma has been prevalent among children and adolescents in the US and is linked to significant health, social, and financial morbidity (Akinbami et al., 2016; Kopel et al., 2014). Although levels of toxicants in e-cigarette vapor are lower than in smoke from combustible cigarettes (Goniewicz et al., 2014a, 2014b), health concerns have been raised because of the unregulated levels of nicotine itself and constituents that have no safe lower limit (Grana et al., 2014). E-cigarette vapor contains substantial levels of fine particles (Fuoco et al., 2014; Zhang et al., 2013), which have previously been implicated in pulmonary disease linked to cigarette smoke and air pollution (Brook et al., 2010). In addition, there is evidence that e-cigarette vapor can produce oxidative stress and inflammation in airways (Lerner et al., 2015; Wu et al., 2014), which presents a possible concern for pulmonary disease.

Two previous reports have examined the relation between e-cigarette use and asthma. An investigation from Korea (Cho and Paik, 2016) studied a large sample of high school students and found that e-cigarette use was related to higher likelihood of having been diagnosed with asthma and to more days absent from school because of asthma. An American investigation (Choi and Bernat, 2016) reported data from a 2012 survey of Florida high school students that showed a higher prevalence of current asthma among those who used e-cigarettes. Analogous results were found for self-reported respiratory symptoms (cough or phlegm persisting for 3 months) with Chinese secondary

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school students in Hong Kong (Wang et al., 2016) and with high school students in California (McConnell et al., 2017).

The previous studies on asthma are primarily from populations outside the US or based on data from an early stage of the e-cigarette phenomenon. In the present research we analyze data from a 2015 survey of adolescents in Hawaii, a population that has a substantial prevalence of e-cigarette use (Wills et al., 2015) and known risk factors for asthma (Min et al., 2014; Tam et al., 2016). The analyses controlled for demographics, cigarette smoking, and several covariates linked to asthma, such as overweight status. We hypothesized that e-cigarette use among adolescents would be associated with asthma independent of cigarette smoking. We used data from the 2015 Hawaii Youth Risk Behavior Survey (HYRBS) because the sample is multiethnic and the survey contains items on 30-day use of e-cigarettes and other substances and current asthma status, which are not included in some other surveys (e.g., national YRBS).

2. Methods

2.1. Procedure and participants

The HYRBS is administered every 2 years by the University of Hawaii to students in public middle and high schools throughout the state of Hawaii. The present research uses data from high school students (9th grade–12th grade) in the 2015 HYRBS. The 99-item survey was self-administered by students in classrooms, supervised by project staff, in 33 randomly selected high schools during the spring of 2015. Out of 43 high schools in Hawaii, participating schools were selected using a three-stage sample stratified by racial/ethnic concentration and metropolitan statistical area status to produce a representative sample of students in grades 9–12. Intact classes of a required subject or intact classes during a required period (e.g., second period) were selected randomly. All students in sampled classes were eligible to participate. Procedures involved passive consent from parents and affirmative assent from students. The overall response rate was 78% and surveys were obtained from 6089 participants. Procedures were approved by the Institutional Review Board for the University of Hawaii at Manoa.

The sample was 50% female and the mean age was 15.8 years (SD = 1.2). Grade level was 27% 9th grade, 25% 10th grade, 24% 11th grade, and 23% 12th grade. For primary ethnicity, 2% of the participants were American Indian or Alaska Native; 3% were Black or African American, 29% were Filipino, 39% were Native Hawaiian or Other Pacific Islander, 16% were Japanese or Other Asian, and 11% were Caucasian. For an item on intention for obtaining further education post-high school, responses were 12% definitely would not, 9% probably would not, 31% probably would, and 49% definitely would.

2.2. Measures

The YRBS measures have been previously tested for reliability and validity (Brener et al., 1995; Centers for Disease Control and Prevention, 2013). “Not sure” responses for the items on asthma and educational intentions were treated as missing.

2.2.1. Demographics

Participants responded first to items about their gender (dichotomous), age (7 categories, 12–18 years), and grade level (4 categories, 9th–12th grade). Race was assessed by the question “What is your race?” (8 categories, multiple responding allowed). Grades were assessed by “During the past 12 months, how would you describe your grades in school?” (5 categories, mostly A's to mostly F's). Body mass index (BMI) was assessed with write-in questions about height and weight. For multiple responses on ethnicity a coding procedure with override rules (Glanz et al., 2005; Kaholokula et al., 2006; Wills et al., 2013) was used to index primary ethnicity. (Results on asthma prevalence were similar for a subsample with monoethnicity.) Because educational attitudes and vocational track are correlates of e-cigarette use (Kinnunen et al., 2014; Wills et al., 2015) we included the item “How likely is it that you will complete a post high school program such as a vocational training program, military service, community college, or 4-year college?” (4 response options: definitely will not to definitely will).

2.2.2. Substance use items

Cigarette smoking was assessed by “Have you ever tried cigarette smoking, even a few puffs?” (No/Yes) and “During the past 30 days, on how many days did you smoke cigarettes?” (7 response options: 0 days to all 30 days). E-cigarette use had the lead-in instruction, “The next two questions ask about electronic vapor products, such as blu, NJOY, or Starbuzz. Electronic vapor products include e-cigarettes, e-cigars, vape pipes, e-hookahs, and hookah pens.” The items were “Have you ever used an electronic vapor product?” (No/Yes) and “During the past 30 days, on how many days did you use an electronic vapor product?” (7 response options, same as for cigarettes). Marijuana use was assessed with “How old were you when you tried marijuana for the first time?” (7 responses: Never tried to 17 years or older) and “During the past 30 days, how many times did you use marijuana?” (6 response options: 0 times to 40 or more times). The item on age of first marijuana use was recoded to never tried vs. tried at any age, providing an index for ever use of marijuana.

2.2.3. Asthma status items

Asthma status was assessed by the items “Has a doctor or nurse ever told you that you have asthma?” (no/yes/not sure) and “Do you still have asthma?” (4 response options: I have never had asthma (no/yes/not sure).

2.3. Analysis methods

Prevalence estimates for asthma and substance use were computed with weighted analyses using SAS Proc SURVEYFREQ, accounting for stratum and school clustering. Correlation analyses examined the intercorrelation of the asthma indices and the other study variables. A binary index for ever had asthma (vs. never) was derived from the first asthma item and two binary indices were derived from the second asthma item (previously had asthma vs. never and currently have asthma vs. never). For substance use variables we compared correlations using a scaled score (e.g., frequency of e-cigarette use in last 30 days) with correlations based on a binary variable (e.g., any e-cigarette use in last 30 days). The binary variables had somewhat larger correlations with asthma based on phi coefficients; hence binary variables were utilized for further analyses.

Multivariate analyses were performed in logistic and multinomial regression using Proc SURVEYLOGISTIC with an asthma index as the criterion and with binary codes for e-cigarette use, cigarette smoking, marijuana use, and the demographic variables entered simultaneously as predictors, with adjustment for stratum and school clustering. This controls for any correlation of e-cigarette use and cigarette smoking with the covariates and with each other. Variance inflation factors were < 2 for all analyses, indicating that multicollinearity was not an issue. To have comparable coefficients in the multivariate analysis (Stoolmiller et al., 2012; Wills et al., 2017) participant age, body mass index (age-sex percentile), and educational intentions were entered as binary variables (14–16 vs. 17–18, lowest terciles vs. upper tercile), and No/Little intention vs. Some/Much intention. For entering ethnicity we dropped one small group (Native Americans) and simplified the analytic model by constructing two binary indices, one that contrasted the two highest-rate asthma groups (Blacks and Native Hawaiians) and one that contrasted the two intermediate-rate groups (Filipinos and Pacific Islanders), each against the three lowest-rate groups (Japanese, Other Asians, and Whites) as the reference group. (Results were essentially identical with a procedure using 6 contrasts entered for all the ethnic