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RESEARCH ARTICLE

Frequency of Use and Smoking Status of U.S. Adolescent E-Cigarette Users in 2015

Konstantinos Farsalinos, MD,[1,2] Venera Tomaselli, PhD,[3] Riccardo Polosa, PhD[4]

Introduction: E-cigarette use by adolescents is an important issue for public health. This study analyzed the frequency of e-cigarette use and its association with smoking status among U.S. adolescents.

Methods: The National Youth Tobacco Survey 2015 was analyzed in 2017, focusing on frequency of past 30-day e-cigarette use according to smoking status of participants. Smoking status was classified as never smoker, ever/not a past 30-day smoker, and past 30-day smoker. Infrequent and frequent smoking and e-cigarette use was defined as use for <20 and ≥ 20 of the past 30 days, respectively.

Results: Past 30-day e-cigarette use was reported by 54.5% (95% CI=47.8%, 61.0%) of past 30-day smokers, 26.5% (95% CI=23.2%, 30.1%) of ever/not past 30-day smokers, and 4.6% (95% CI=4.0%, 5.2%) of never smokers ($p<0.001$). No past 30-day e-cigarette use was reported by 94.5% and frequent e-cigarette use by 0.3% of never smokers. Past 30-day e-cigarette use was reported by 50.4% (95% CI=43.6%, 57.3%) of infrequent and 64.7% (95% CI=54.4%, 73.8%) of frequent past 30-day smokers ($p<0.001$). E-cigarette use frequency correlated with both smoking status and tobacco cigarette consumption ($\rho=0.42$, $p<0.001$ and $\rho=0.40$, $p<0.001$, respectively). Past 30-day smokers were more likely to report past 30-day e-cigarette use (OR=11.42, 95% CI=9.06, 14.40) compared with adolescents reporting no past 30-day smoking.

Conclusions: E-cigarette use is more prevalent among ever and past 30-day smoking adolescents compared with never smoking adolescents. Frequent e-cigarette use is rare among never smoking adolescents.

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INTRODUCTION

Use of e-cigarettes by adolescents has been one of the most important public health discussion topics in the U.S. Recently, a report by the Surgeon General stated that e-cigarettes are now a major public health concern.[1] The report was based mainly on two large national surveys—Monitoring the Future (MTF)[2] and the National Youth Tobacco Survey (NYTS).[3] Both surveys found that the prevalence of e-cigarette use exceeded that of conventional cigarettes. A continuous increase in ever and past 30-day use has been observed in the NYTS survey since 2011,[3] while no significant difference in past 30-day use between 2014 and 2015 was observed in the MTF survey.[2]

The use of e-cigarettes by adolescents raises several public health concerns. E-cigarettes, although less harmful than smoking, are not risk free.[4] Therefore, the adoption of use by never smoking adolescents would expose them to a new health risk. The use of

From the [1]Department of Cardiology, Onassis Cardiac Surgery Center, Kallithea, Greece; [2]Department of Pharmacy, University of Patras, Patras, Greece; [3]Department of Political and Social Sciences, University of Catania, Catania, Italy; and [4]Department of Clinical and Experimental Medicine, University of Catania, Catania, Italy

Address correspondence to: Konstantinos Farsalinos, MD, Department of Cardiology, Onassis Cardiac Surgery Center, Sygrou 356, Kallithea 17674, Greece. E-mail: kfarsalinos@gmail.com.

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nicotine-containing e-cigarettes could result in dependence and have a gateway effect to smoking.[5,6] However, these issues are not relevant to those who already use tobacco cigarettes. A secondary analysis of the 2014 MTF survey found that frequency of e-cigarette use was directly related to the amount of ever smoking and was very low among never smokers.[7] Therefore, it is important to calculate the prevalence of e-cigarette use separately in smokers and never smokers. Additionally, it is reasonable to expect that frequency of e-cigarette use would be an important factor in evaluating potentially adverse public health effects. Traditionally, e-cigarette use has been reported as ever use and current use, with the latter defined as any use in the past 30 days. The value of these definitions in assessing the public health impact of tobacco or e-cigarettes has been questioned. Frequency and intensity of tobacco cigarette use in youth are important determinants of future regular smoking.[8,9] Focusing on past 30-day smoking was found to underestimate the decrease in youth smoking over time.[10] For e-cigarettes, a study in adults found that most past 30-day users were experimenters and had very low prevalence of frequent use.[11]

The 2015 NYTS found that the prevalence of past 30-day e-cigarette use was 16.0% in high school and 5.3% in middle school adolescents.[3] The purpose of this secondary analysis of the 2015 NYTS survey, performed in 2017, is to examine the frequency of e-cigarette use in U.S. adolescents and the association between patterns of tobacco cigarette and e-cigarette use.

METHODS

Study Sample

The 2015 NYTS employed a stratified, three-stage cluster sample design to produce a nationally representative sample of 17,711 middle school and high school students in the U.S. (sixth grade to 12th grade students). The majority of the study sample was aged 11 to 18 years. Smoking status was defined in the survey as ever or never use through a question: *Have you ever tried cigarette smoking, even one or two puffs?* There was a separate question about past 30-day use, which included information about the frequency of use: *During the past 30 days, on how many days did you smoke cigarettes?* Based on the responses to these questions, the smoking status was recoded as never smoker (never tried cigarette smoking), ever/not a past 30-day smoker (has tried cigarette smoking but smoked cigarettes on 0 days of the past 30 days), and past 30-day smoker (has tried cigarette smoking and has smoked in the past 30 days from 1 or 2 days to all 30 days). The ever/not a past 30-day smoker group included 178 subjects who reported they were ever smokers but had missing data on past 30-day smoking. Additionally, 59 respondents reported being never smokers and had missing data on past 30-day smoking; these respondents were considered as never smokers. Finally, five respondents had missing data on ever smoking but reported past 30-day smoking; these subjects were considered as past 30-day smokers. To facilitate the presentation of findings, the response options (*0 days*, *1–2 days*, *3–5 days*, *6–9 days*, *10–19 days*, *20–29 days,* and *all 30 days*) were recoded as infrequent smoker (smoking on 1–19 days of the past 30 days) and frequent smoker (smoking on 20–30 days of the past 30 days). Smoking consumption was assessed in the survey through a question: *During the past 30 days, on the days you smoked, about how many cigarettes did you smoke per day?* Response options were *I did not smoke in the past 30 days*, *less than 1 cigarette per day*, and *1, 2–5, 6–10, 11–20,* and *more than 20 cigarettes per day*.

Measures

E-cigarette use was defined as ever or never use through a question: *Have you ever used an electronic cigarette or e-cigarette, even once or twice?* Of note, in the 2015 NYTS, the e-cigarette questions were preceded by a paragraph describing the product and presenting relevant terminologies, to address the possibility that a proportion of users might use different terms to describe e-cigarettes. A separate question addressed past 30-day use: *During the past 30 days, on how many days did you use electronic cigarettes or e-cigarettes?* All responses (*0 days*, *1–2 days*, *3–5 days*, *6–9 days*, *10–19 days*, *20–29 days,* and *all 30 days*) are presented separately herein. Additionally, these responses were recoded to classify participants as infrequent e-cigarette users (using e-cigarettes for 1–19 days of the past 30 days) and frequent e-cigarette users (using e-cigarettes for 20–30 days of the past 30 days). The cut off was similar to that used for smoking frequency and was based on the classification of frequency of e-cigarette use by the Centers for Disease Control and Prevention (CDC).[12]

This study was not submitted for IRB approval because it utilized publicly available and anonymized data from a survey performed by the CDC.

Statistical Analysis

Statistical analyses were weighted by primary sampling unit and sampling stratum using Stata, version 13.0, with missing values treated like other values. Descriptive analysis was performed, with categorical data expressed as percent with 95% CI. Cross tabulations and chi-square tests were used to compare prevalence of e-cigarette use among different smoking status groups. The correlation between smoking status (never smoker, ever/not a past 30-day smoker, and past 30-day smoker) and frequency of past 30-day e-cigarette use, and between past 30-day tobacco cigarette consumption and past 30-day e-cigarette use frequency was assessed by Spearman rank correlation coefficient. Logistic regression analysis was performed to examine the association between past 30-day e-cigarette use and smoking status. Past 30-day use (no versus any past 30-day use) was the dependent variable, and separate models included ever smoking (no versus yes), past 30-day smoking (no versus yes), and past 30-day smoking frequency (no versus infrequent versus frequent) as independent variables. All models were adjusted for age and gender. No adjustment for race was performed because participants were allowed to select more than one response and there was substantial overlap between responses.