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The Prevalence of E-Cigarette Use in a Sample of U.S. Air Force Recruits

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Abstract

Introduction—The prevalence of electronic cigarette (e-cigarette) use is increasing markedly in the general population. Yet, remarkably little research exists to examine these ongoing trends in at-risk populations, and nothing is known about the prevalence of e-cigarette use among military personnel. The purpose of the current study is to provide recent (2013–2014) data on the prevalence of regular e-cigarette use in a population of recruits prior to their entry into the U.S. military.

Methods—The study utilized a cross-sectional assessment of e-cigarette and other tobacco and nicotine-containing product (TNCP) use in 2013–2014 among 10,043 U.S. Air Force (USAF) recruits in Technical Training. Chi-square tests, the Cochran–Armitage test for trend, and logistic regression models tested differences and trends across time for e-cigarette use.

Results—The rate of e-cigarette use among recruits was 5.2%, which doubled (3% to 6.5%, $p<0.0001$) across a 1-year period. E-cigarette use was associated with increased odds of all measured TNCPs, as well as dual and poly use (all $p<0.0001$).

Conclusions—Rates of e-cigarette use are slightly higher in young USAF recruits than in the general population, and e-cigarette users are likely to be using other TNCPs in tandem. Although additional work is needed to understand the reasons for this concomitant use, this is a necessary first step to understanding e-cigarette use prevalence in military populations. Historic trends suggest that, like general populations, e-cigarette use is on the rise for those entering the USAF and should be monitored to inform future prevention programming.

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Introduction

Over the past few years, the sales, marketing, and distribution of electronic cigarettes (e-cigarettes) have increased markedly. Following this trend, rates of e-cigarette use are increasing, with ever use of e-cigarettes among high school students in the U.S. doubling from 2011 (4.7%) to 2012 (10.0%)¹ and quadrupling among adults between 2009 (0.6%) to 2010 (2.7%).² These increases are considerable, yet remarkably little research exists examining these ongoing trends in at-risk populations. One such population at risk for high rates of tobacco use is the U.S. military.^{3,4} Given the rise of e-cigarette use among civilians, it seems likely that e-cigarette use may also be on the rise among military personnel.

In the general population, two widely disseminated beliefs about e-cigarettes are they are a safe alternative to cigarette smoking and they promote smoking cessation.^{5,6} Although the long-term safety of e-cigarette use is unknown, recent work suggests that the polycyclic aromatic hydrocarbons, tobacco-specific nitrosamines, and volatile organic and inorganic compounds acquired through regular e-cigarette use is comparable to those received in a typical day in a workplace environment,⁷ and are certainly fewer than those found in tobacco cigarettes,⁸ suggesting that e-cigarette use may indeed be a —safer|| substitute. Importantly, testing standard ingredients and their potential effects is difficult, as manufacturers are not required to disclose ingredients or meet the U.S. Food and Drug Administration (FDA)-mandated regulatory standards of the pharmaceutical industry for e-cigarette production. Therefore, content can vary widely across products and even over time within the same product.

Regarding the use of e-cigarettes as an alternative to smoking, research remains equivocal. In support of cessation benefits, two recent RCTs suggest that e-cigarettes may promote short-term cessation;^{9,10} however, no randomized evidence demonstrating long-term abstinence exists.^{9–12} Biener and Hargraves (2014)¹² reported that those “intensively” using e-cigarettes were six times more likely to have quit cigarette smoking after 2 years than those using e-cigarettes at lower rates, but low retention (51%) and potential confounding variables limit the reliability of these findings. Similarly, a number of other survey-based studies also suggest higher rates of cessation for e-cigarette users,^{13–16} but without randomization and comparison conditions, these results are not definitive. By contrast, other emerging research suggests that smokers who use e-cigarettes may not be more likely to quit,^{18,19} and some research suggests that e-cigarettes harm cessation rates.²⁰ However, these studies suffer from many of the same limitations as those in support of e-cigarette use for cessation, thereby not lending clarity to this issue.

More-stringent work is needed to evaluate the cessation benefits of e-cigarettes, but most concerning is the possibility that e-cigarettes users do so as an alternative to smoking in situations where smoking is not allowed, such as at work or school, but return to regular tobacco use when allowed. In this case, e-cigarettes are indeed satisfying the smoker's cravings, but are used as pacifiers until regular tobacco use can be resumed.^{2,20–26} The issue here is that little is known about the use of e-cigarettes in combination with other tobacco and nicotine-containing products (TNCs). If dual tobacco use (i.e., using two products) or

poly tobacco use (i.e., using three or more products) with e-cigarettes is prevalent, concern for net population harm with these products could be raised.

The Current Study

The purpose of the current study is to provide recent (2013–2014) data on the prevalence of regular e-cigarette use in a population of recruits prior to their entry into the U.S. military. This is a population of considerable interest, given that those entering the military typically represent the highest risk with regard to demographics and other factors that contribute to high rates of tobacco use. For instance, in addition to being primarily male,²⁷ the typical age group of military recruits (18–24 years) is known to be at highest risk for tobacco use.²⁸ Additionally, those who join the military often do so out of the appeal of experiencing excitement and adventure,²⁹ the same factors believed to underlie tobacco use.³⁰

Understanding prevalence of addictive behaviors prior to military entry allows for the development and maintenance of prevention programming for those entering the nation's largest workforce. The U.S. military employs approximately 1.4 million uniformed personnel currently serving in the four military branches.³²

In addition to establishing the prevalence of e-cigarette use, this study evaluates whether e-cigarettes are being used in isolation, or whether e-cigarettes are typically used in tandem with one or more TNCPs. Finally, historic trends in use are also reported to establish whether e-cigarette use in young military recruits is similar to that in the general population, and whether these trends appear to be changing over this critical time when e-cigarette use is on the rise in non-military individuals.

Methods

Study Sample

Participants in this study were all U.S. Air Force (USAF) recruits. All recruits first go to Lackland Air Force Base (AFB) for 8.5 weeks of Basic Military Training (BMT). During this period of time, recruits are required to be alcohol and tobacco/nicotine free, and heavy monitoring makes it impossible to violate this ban. After BMT, recruits are sent to Technical Training (TT) where they learn the skills for their designated job in the USAF. TT sites vary according to the skills being trained. During the first 2 weeks of TT, recruits are required to maintain the ban on alcohol and TNCPs, but may engage in legal use of these products after this period.

Participants in this study were 10,043 USAF recruits receiving TT from four advanced major TT bases: Lackland AFB, Fort Sam Houston, Keesler AFB, or Sheppard AFB. More than 75% of recruits attending TT at that time were trained at one of the three AFBs. Data were collected between fiscal years 2013 and 2014.

Across all sites, all recruits in TT participated in a universally implemented alcohol misconduct prevention program³³ and were asked afterward to participate in a brief, one-time survey regarding prior tobacco use. Owing to the universal nature of the prevention

program, all recruits in TT during the data collection period had the opportunity to participate in the survey.

Recruits were asked to report their tobacco and nicotine use prior to enlistment, as this was more representative of baseline use given the ban during BMT. Across all TT facilities, 71.8% of USAF recruits consented for the survey. This protocol was approved by the IRB at Wilford Hall Ambulatory Surgical Center.

Measures

The prevalence of tobacco use was assessed by asking participants how often they used the following products (prior to enlistment): cigarettes, smokeless tobacco, snus, cigars, cigarillos (little cigars), pipe, e-cigarettes, water pipe (hookah), and roll-your-own cigarettes. Responses were: *never*, *quit prior to BMT*, *less than monthly*, *monthly (not weekly but at least once a month)*, *weekly (not daily but at least once a week)*, and *daily*. Participants who reported never using any of the nine tobacco products were considered non-users. Regular use of a product was defined as at least monthly use of the product, as this is a common definition of regular TNCP use in young adults.^{34,35} For data analysis, participants were grouped into four categories of regular e-cigarette use: (1) non-users (never users, quit prior to BMT, and use less than monthly); (2) mono users (regularly using e-cigarettes); (3) dual users (regularly using e-cigarettes and one TNCP); and (4) poly users (regularly using e-cigarettes and two or more TNCPs).

Statistical Analysis

All analyses were performed with SAS, version 9.4. in 2014. Contingency tables along with chi-square tests were applied to generate descriptive statistics (proportions) for demographics and compare their equality by mono, dual, and poly use. To test the simple univariate trend over time, we used the Cochran–Armitage (CA) test for trend. To estimate the relative odds for trend between quarters, we ran logistic regression model with time as a covariate adjusting for age, gender, race, ethnicity, education, and marital status variability. To test the associations between e-cigarette use and TNCPs, we applied logistic regression models, adjusting for demographics.

Although participants were only assessed once, assessment periods were available to examine historic, cross-sectional trends in e-cigarette and tobacco use. These time periods were divided into four quarters: (Q1) April–June 2013 ($n=1,242$), (Q2) July–September 2013 ($n=2,339$), (Q3) October–December 2013 ($n=3,722$), and (Q4) January–March 2014 ($n=2,740$). All associations were considered significant at $\alpha=0.05$.

Results

In the final analytic sample ($N=10,043$), recruits were mostly male (77.0%), young (mean age, 20.5 years), and single (89.8%), with 16.4% self-describing as Hispanic and 28.4% as an ethnic minority. Our sample is comparable to the Active Duty Enlisted Workforce of the USAF ($N=248,613$), which is mostly male (81.3%), non-Hispanic (83.7%), and white (70.7%). Slightly more than 5% ($n=518$) of recruits reported regular e-cigarette use; the

prevalence of cigarette use was 11.5% ($n=1,096$) and that of smokeless tobacco was 9.1% ($n=864$).

Regular e-cigarette users were predominantly male, aged <20 years, Caucasian/non-Hispanic, less educated, and single (Table 1). Poly tobacco users were younger and less likely to be married compared with mono and dual users ($p<0.05$ for both). There were no other significant demographic differences among the mono, dual, and poly e-cigarette use categories.

Figure 2 presents the concomitant use of e-cigarettes with other TNCPs among non-users and regular e-cigarette users. E-cigarette use was associated with increased odds of all mentioned TNCPs, as well as dual and poly use (all $p<0.0001$). The AORs were 3.4 (95% CI=2.7, 4.2) for smokeless tobacco, 6.4 (95% CI=4.3, 9.5) for pipe, 6.7 (95% CI=5.2, 8.4) for cigars, 6.9 (95% CI=5.1, 9.5) for snus, 9.0 (95% CI=7.3, 11.0) for cigarillos, 9.7 (95% CI=8.0, 11.7) for hookah, and 14.8 (95% CI=12.2, 18.0) for cigarette use. Among the 518 recruits that reported using e-cigarettes, only 11.6% reported regularly using just e-cigarettes. By contrast, 23.9% of e-cigarette users were dual users and 64.5% of e-cigarette users were poly users. E-cigarette use was associated with 4.5 times higher odds of dual use, and 41.2 times higher odds of poly use compared to non-e-cigarette use ($p<0.0001$ for both).

Historic Trends

Across the four quarters, respondent demographics were fairly homogeneous, and consent rates were 61% for Q1, 71% for Q2, 77% for Q3, and 73% for Q4. The percentage of men ranged from 70% to 79%, whites from 67% to 69%, Hispanics 16% to 19%, some college 37% to 53%, and married from 9% to 12%. CA test for trend suggested a significant linear increase of e-cigarette prevalence across the four quarters, from 3% to 6.5% ($\chi^2=30.3$, $p<0.0001$) (Figure 1). Between Q1 and Q4, the prevalence of e-cigarettes among recruits doubled (AOR=2.1, 95% CI=1.5, 3.1, $p<0.0001$), with Q3 and Q4 having significantly higher prevalence and odds of e-cigarette use as compared with Q1 and Q2 (all $p<0.05$) (Figure 1). Compared with the overall prevalence of TNCP (27.2%), rates of e-cigarette use were much lower, at 5.2%. Although e-cigarette trends significantly increased over time, TNCP trends remained fairly constant (25.8%, 26.5%, 27.6%, and 27.9% over time, respectively) without a significant trend ($CA\chi^2=0.67$, $p=0.4127$).

Discussion

The current study demonstrates several important points about e-cigarette use in an elevated-risk sample of young recruits enlisting in the USAF. This is the first study to report that the majority of regular e-cigarette users are regularly using other TNCPs. In our sample, 88.3% of e-cigarette users are regularly using additional tobacco products. Although assessed cross-sectionally, this finding suggests that for a period of time, the majority of these young individuals are using e-cigarettes concomitantly with other TNCPs. This finding is consistent with the growing body of literature documenting concomitant use of e-cigarettes with cigarettes.^{2,20–26} Less is known about the concomitant use of e-cigarettes with other TNCPs, although the prevalence of dual and poly use in the current study is higher than rates found in previous studies of e-cigarette and tobacco users in general.^{2,36} It is also

considerably higher than previously reported dual and poly use in a military population.^{34,37–39} Because e-cigarette use appears to be associated with higher odds of dual and poly use, and given that the use of multiple forms of tobacco places the tobacco user at even greater risk for morbidity and mortality, e-cigarette users may be placing themselves at higher risk for tobacco-related health problems.^{40,41}

The results of the current study also indicate that the prevalence of regular e-cigarette use is markedly increasing in USAF recruits, with the prevalence doubling over 1-year's time. Our finding of the significant increase in e-cigarette prevalence in a military population is consistent with other published surveys of e-cigarette use in the civilian population. Although rates of ever use of e-cigarettes among high school students and adults have increased in recent years (5.3% and 2.1%, respectively),^{1,2} Q4 prevalence of 6.5% regular use is double the rate found in other national surveys of adult e-cigarette use.^{2,18} This difference may be partially due to the high risk for tobacco use in a military population. It is important to note the military is not creating these high rates of tobacco use—they appear to be inheriting them, with recruits already reporting high rates of nicotine and tobacco use when presenting for military service.

Implications

Findings from this study have numerous implications. Although no causal conclusions can be drawn from this cross-sectional sampling of use, the high rates of dual (or poly) use suggest that this group of individuals is choosing to use e-cigarettes while engaging in other tobacco/nicotine use. This behavior may be indicative of individuals attempting to reduce or quit smoking. Alternatively, individuals could be choosing e-cigarettes to satisfy cravings in environments where tobacco use is not allowed, only to return to tobacco use again when in a more accepting environment. Though both possibilities have important treatment implications, the latter possibility raises concerns. Specifically, that using e-cigarettes in tobacco-banned environments lessens the positive effects of the ban. Thus, these individuals may be more sensitive to reductions in nicotine levels, and may experience heavier withdrawal symptoms when and if they do decide to quit.

Another significant implication from the present work is the increasing trend in e-cigarette use over time. Marketing and general acceptance of e-cigarettes is on the rise, and these trends are clearly shown in this group. Given the efforts made by the U.S. military to assist individuals in living healthy lifestyles, awareness of increases in TNCPs, either in cessation efforts or nicotine level maintenance, can be of considerable importance for the development of prevention programming. If e-cigarettes are to be used by those who are attempting cessation, more attention may need to be directed toward proper use to reduce nicotine levels.

Limitations

This study is the first to evaluate the prevalence of e-cigarette use in a population presenting for military service in the USAF and to report the prevalence of other TNCPs among e-cigarette users while exploring characteristics of dual and poly users. However, although the U.S. military is at high risk for tobacco use³⁷ and is targeted by tobacco companies,⁴² the

military is not representative of the U.S. population in general. Additionally, only the USAF was assessed. Generalization to other service branches is unknown and should be studied in the future. However, because the USAF has the lowest rates of tobacco use in the military,⁴³ one suspects the prevalence of tobacco products, including e-cigarettes, to be higher in other service branches.

Another clear limitation is the cross-sectional nature of the assessment. This method did not allow us to follow individuals over time to examine whether e-cigarettes contributed to later cessation, or were simply another form of nicotine intake along with other TNCPs. Future work assessing this possibility in military populations would greatly enhance our understanding of the outcomes of e-cigarette use. In addition, we were unable to determine potentially important causal connections among TNCPs that may help inform research about who is starting e-cigarette use. For instance, some individuals may be utilizing e-cigarettes after already having tried traditional products, whereas for others, e-cigarettes may be a gateway to tobacco products. Such work would assist in the understanding of the products that prevention programs should target.

There are also limitations of assessment due to the nature of the sample. Working in military populations can be difficult, given that commanders are not required to allow access to recruits, and the offered time is often necessarily limited. As such, researchers must be judicious about what information is most necessary to obtain. In this study, we were able to gather information regarding prevalence of multiple TNCPs including e-cigarettes. However, a more detailed assessment of use could not be obtained. Future work might explore motives for e-cigarette use. E-cigarettes are now available on military bases; it would not be surprising to see trends in use following this availability.

Another limitation is the fact that recruits were sampled about their use prior to BMT, thereby introducing potential recall issues. Although it may be the case that some error is introduced after 10 weeks of BMT and a short time in TT, the likelihood that this leads to large errors in prevalence estimates is negligible. In any case, assessing use during BMT is quite unlikely, given considerable demands on young recruits' time during this period. The start of TT offers the first available opportunity to ask recruits about their behavior.

It is possible that, given the range in responses between quarters, non-respondents could have been more or less likely to smoke than respondents, potentially biasing the prevalence in either direction. Lastly, the educational attainment across the four quarters was somewhat variable (37%–53%). However, we controlled for that variability in our logistic regression model along with other demographics.

Conclusions

Results indicate slightly higher rates of e-cigarettes in young USAF recruits than in the general population, and e-cigarette users are likely to be using other TNCPs in tandem. Although additional work is needed to understand the reasons for this concomitant use, this is a necessary first step to understanding prevalence of e-cigarette use in military populations. In addition, historic trends suggest that, like general populations, e-cigarette use

is on the rise for those entering the USAF and should be monitored to inform future prevention programming.

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Figure 1. Prevalence of e-cigarette use among recruits from April 2013 to March 2014 (N=10,043)

Notes: The prevalence of regular e-cigarette use among recruits doubled between April 2013 (Q1) and March 2014 (Q4) (ORa=2.1; 95% CI=1.5-3.1; $p<0.0001$), indicating significant linear trend (CA $\chi^2=30.4$; $p<0.0001$). Proportions 95% CIs, trends, and odds were calculated using cross tabulations, χ^2 test, CA test for trend and logistic regression. Covariates included in the model were gender, age, ethnicity, race, education and marital status.

Figure 2. Tobacco product prevalence by e-cigarette use (N=10,043)

Notes: Regular e-cigarette use is associated with significantly higher odds of regular use of all TNCs, as well as dual and poly use compared to non e-cigarette users (all $p < 0.0001$). Associations were tested with logistic regression, adjusting for age, gender, race, ethnicity, education and marital status.

Table 1

Demographic Characteristics of E-Cigarette Users and Differences Between Mono, Dual, and Poly Users, *n* (%)

Variable	Mono users n=60	Dual users n=124	Poly users n=334	Total N=518
Gender				
Female	10 (17.0)	22 (17.7)	44 (13.2)	76 (14.7)
Male	49 (83.1)	102 (82.3)	290 (86.8)	441 (85.3)
Age				
<20-years-old	42 (70.0)	78 (62.9)	255 (76.4)	375 (72.4)
20-years-old	18 (30.0)	46 (37.1)	79 (23.7)	143 (27.6)
Race				
Caucasian	44 (73.3)	90 (73.2)	251 (75.4)	385 (74.6)
African American	3 (5.0)	5 (4.1)	19 (5.7)	27 (5.2)
Asian American	5 (8.3)	5 (4.1)	12 (3.6)	22 (4.3)
Other	6 (10.0)	12 (9.8)	27 (8.1)	45 (8.7)
More than one	2 (3.3)	11 (8.9)	24 (7.2)	37 (7.2)
Ethnicity				
Not Hispanic	52 (86.7)	97 (78.9)	285 (86.6)	434 (84.8)
Hispanic	8 (13.3)	26 (21.1)	44 (13.4)	78 (15.2)
Education				
High school graduate or GED	38 (63.3)	77 (62.6)	233 (70.6)	348 (67.8)
Some college	22 (36.7)	46 (37.4)	97 (29.4)	165 (32.2)
Marital status				
Single, separated, divorced, or widowed	51 (85.0)	106 (85.5)	310 (92.8)	467 (90.2)
Married or living together	9 (15.0)	18 (14.5)	24 (7.2)	51 (9.9)

Notes: Frequency and percent reported in the table. Differences in demographic characteristics across regular e-cigarette users calculated using χ^2 test. Boldface indicates statistical significance ($p < 0.05$).