**Review Article**

**Factors Associated with Electronic Cigarette Use in the Military Population**

**Mary Jane Willard, Ph.D., MBA, MA, RNP, CCRN, CNRN1#, Claudia P. Barone, DNP, Ed.D., CCNS-BC, APRN, LNC, CTTS****1, Brittany Beasley, Ph.D., RN, CNE1, Lana Brown, Ph.D., RN, NEA-BC2, Pamela deGraveles, Ph.D., RN, TTS1, James P. Selig, Ph.D.1**

1#University of Arkansas for Medical Sciences, Little Rock, Arkansas, USA

2Central Arkansas Veterans Healthcare System, Geriatric Research, Education, and Clinical Center, North Little Rock, Arkansas, USA

**#Corresponding author:** Mary Jane Willard, Ph.D., MBA, MA, RNP, CCRN, CNRN, Clinical Assistant Instructor, University of Arkansas for Medical Sciences, 4301 W. Markham St., Slot 529, Little Rock, Arkansas 72205, USA

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**Introduction**

Tobacco use is the leading cause of preventable deaths in all populations in the United States (U.S.) [1]. In 2017, tobacco cigarette use ranged from 8.8% to 24.8% in the U.S. population [2] This represents an estimated 34.3 million adults using tobacco cigarettes [3]. There has been a long history of tobacco use in the military [1]. The U.S. Marine Corps have the highest rate of tobacco cigarette use (30.8%), then the Army (26.7%),the Navy (24.4%), the Coast Guard (19.9%) and the U.S. Air Force (16.7%) [4,5]. There are no studies on the Space Force. In the Department of Defense (DoD) (2015) survey, 49.2% of active-duty service members reported using a nicotine product in the last 12 months and 62% (5.2 million) of the entire Veteran Administration enrollee population reported using tobacco cigarettes [6].

**Keywords:** Correlational study; Dual use; Electronic cigarette; Psychosocial factors; Tobacco use; United States Military

**Tobacco Cigarette Demographics**

The Healthy People 2020 Report identified several demographic characteristics such as race, gender, and educational attainment associated with increased tobacco use in the general population [7]. The male gender and individuals with low educational attainment are at an increased risk of smoking tobacco [8]. Adult men (15.8%) had a higher incident of smoking tobacco than adult women (12.2%) [3]. Based upon the literature, rates of tobacco use are highest among individuals with a high school diploma or less with lower rates of use among college educated individuals. Tobacco use was higher for the following military members among those under age 65; age 18-24 years (10.4%), ages 25-44 (16.1%), ages 45-64 (16.5%), and age 65 and older (8.2%) [3].

**Tobacco Cigarette Psychosocial Factors**

In the general and military populations, psychosocial factors have been associated with using tobacco cigarettes [1]. Certain behaviors such as depression, anxiety, aggression, and sleep problems are associated with an increase rate of smoking tobacco cigarettes [9-12]. The CDC (2018) determined that 35.2% of the general population with a mental health condition use tobacco cigarette.

Socio-environmental factors have been found to influence the intention to use tobacco [13,14]. Having a family member or friend who uses tobacco cigarettes can influence the likelihood of forming the same habit [15]. Other factors contributing to tobacco use include some military members use tobacco as a method of social interaction and networking [16]. The motivation for tobacco cigarette use or continue use is strongly influenced by the social environment and one study reported that 36% - 40% of the current military began tobacco cigarettes use after joining the military [13].

**Tobacco Cigarette Military Related Factors**

The prevalence of using tobacco cigarettes within a military unit has not been found to be directly associated with an increased use of tobacco cigarettes in military unit members [17]. However, unit culture may contribute in other ways to the increased use of tobacco cigarettes. Military members are more likely to begin using tobacco cigarettes if their leader also uses tobacco cigarettes [9,18]. The leadership of the unit has been associated with enhanced military member adjustment. This concept needs further exploration [19].

In military members with a history of deployment, 47.8% of them reported using tobacco cigarettes with 18% of them reporting heavy usage [17,18]. Deployment with combat experience predicts initiation of the use of tobacco cigarettes in younger and older military members, a higher rate of usage, and a higher relapse rate [14]. Deployment, major life stressors, and use of tobacco cigarettes were attributed to the older military members [14,18].

**Electronic Cigarettes**

Electronic Cigarettes (ECIGs) are battery-operated devices that generally contain cartridges with nicotine, flavors, and other chemicals [20]. In the United States (U.S.), ECIG use is increasing in all populations [4]. In 2018, 14.9% of American adults reported trying ECIGs and 4.5% reported using ECIGs daily [21,22]. However, 35.7% of military members reported trying ECIGs and 11.1% reported using ECIGs daily [23]. Electronic cigarettes are an emerging product in all populations and the prevalence data is conflicting [4]. There is a high prevalence of ECIG use in the military and it has increased in the last five years [15,24-27].

Despite this emerging trend in ECIGs, little is known about the factors associated with ECIG use. As the popularity of these devices increase, it is important to understand the factors associated with ECIGs use compared to tobacco use, dual use, and nonuse. The identification of these factors in military members using ECIGs will be guided by the Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB) (Figure 1) [28].

**ECIG Demographics**

The Center for Disease Control and Prevention has determined the prevalence of ECIG smoking in the general population in men is 17.5% and 13.5% in women [3]. The current ECIG use by gender in the military is 13.0% in men (11.6-14.4) and 9.2% (7.9-10.5) in women [6]. The age of military members ranged from 18 to 54 years in most studies [7,16,25-27]. The current ECIG use in the military categorized by age group is 22.8% for ages 17-24, 10.8% in ages 25-34, 5.4% for ages 35-44, and 2.5% for age 45 and older [6]. However, ECIG smoking in the general population ranged from, 13.1% for ages 18-24, 17.6% in ages 25-44, 18% in ages 45-64, and 8.8% for age 65 years and older [3].

Tobacco use has been associated with race. In the general population, Caucasians accounted for 16.6% of ECIG use and African Americans accounted for 16.5% of ECIG use [3]. The current ECIG use by race/ethnicity in the military is 12.4% (10.8-14) in Non-Hispanic Whites and 9.7% (6.4-13) in Non-Hispanic Blacks [6]. Race was examined in four other studies: 67% were African American [15], 32% were racial minority [27], 61.3% were Caucasian [27] and 54% Caucasian [16].

Education attainment has been associated with health behaviors [24,26]. For military members using ECIGs, educational attainment was identified as a potential factor for analysis; 62.1% high school [24]; 63.6% high school [27]; 43% high school [26]; 66% high school [25] and 43.1% some college [27]. Current military ECIG use by educational level is 23% for high school or less, 14.3% for some college, and 2.8% for a bachelor degree of more [6]. The prevalence of ECIG use in the general population was 24.1% less than high school; 40.6% with GED; 19.7% high school graduate; 18.9% for some college; 16.8% for associate degree; 7.7% for undergraduate degree, and 4.5% for graduate degree [29] according to the CDC [17].

Demographics differences in ECIGs as compared to tobacco cigarettes provide mixed results. The ECIG use in the military by pay grade is E1-E4 (lowest income level): 19.2% (16.6-21.8), E5-E6: 10.8% (9.1-12.5); E7-E9: 6.1% (4.7-7.5); W1-W5: 3.4% (2.1-4.6); O1-O3: 2.2% (1.5-2.8), and O4-10 (highest income level): 0.9% (0.4-1.4) [6]. Low-income military members reported that they were less likely to use ECIGs than high-income military members in another study (OR [<100% FPL vs. ≥200% FPL] = 0.48, 95% CI = 0.27 to 0.89) [30]. Additional studies should examine these factors to determine if income influences are associated with ECIG use in the military population.

**ECIG Psychosocial Factors**

Psychosocial factors and a mental health diagnosis has been associated with tobacco use and ECIG use [15,16]. Military members with mental health disorders are more likely to use ECIGs [15,16]. Hefner suggested about 39.7% of the military with a mental health diagnosis use ECIGs [16].

Military members with previous mental health disorders and deployment may place military members at risk for smoking initiation and relapse [14]. Additional psychosocial factors for military members using ECIGs may include coping strategies from mental health symptoms, boredom, and stress reduction [14]. Identifying which psychosocial factors contribute to ECIG use provides the author with a more comprehensive understanding of which military members are at risk for using ECIGs.

Peers can encourage tobacco smoking behaviors and having peers that smoke is a reliable risk factor for smoking initiation [31,32]. However, ECIG use and peer interaction in the literature is limited. The social environment is associated with a greater likelihood of susceptibility of using ECIGs [14].

**ECIG Military Related Factors**

The U.S. military has unique characteristics that make them vulnerable to harmful behaviors such as smoking. Military members that were current smokers, or ex-smokers are more likely to use ECIGs [24-26,40]. Deployment with combat experience demonstrated that younger, never smokers started using ECIGs at a higher rate than the older smokers (6.8 % vs 6.1%).14 Current tobacco users have a much higher rate of ECIG use in all states [2].

**Perception of Harm**

In the literature, the perception of harm was reviewed [37,38]. Military members under the age of 30 believed that ECIGs were less harmful than tobacco products [24]. A common misperception about ECIG’s is they release only water-based vapors [38]. Saying that ECIGs are safer than tobacco cigarettes does not mean they are risk free [37]. A positive attitude about ECIGs may explain the belief that they reduce harm and a negative attitude about ECIGs may explain the belief about the uncertainty of ECIG health effects which is congruent with our TRA and TPB framework [28].

**Significance of Study**

After more than a decade of ECIG use, there are many unanswered questions about the safety of ECIGs [33]. Electronic cigarettes are frequently marketed as a healthier alternative to tobacco cigarettes [33]. This marketing of ECIGs may mislead the public into thinking they are safe and acceptable to use but additional evidence is needed [33]. Studies have suggested through electronic liquid chemical analysis that ECIGs may contain carcinogens, metals, and other harmful compounds [34].

The influences and impact associated with ECIG use in the 2.1 million military members are unknown [33,35]. It is unclear if traditional risk factors for tobacco use are associated with ECIG use in the military population. Unlike the general population, there may be additional military-related factors associated with ECIG use in the military population that has not been explored in the literature.

Identifying demographic characteristics, psychosocial factors, and military related factors contributing to ECIG use behaviors as compared to tobacco use, dual use, and nonuse is a knowledge gap in the current literature. The purpose of this research study was to determine factors associated with military members ECIG use behaviors compared to tobacco use, dual use, and nonuse.

**Methods**

This was a cross-sectional, correlational study used convenience sampling to describe and examine the demographic characteristics, psychosocial factors, and military related factors in military members using ECIGs compared to tobacco use, dual use, and nonuse. The setting was all United States military members. According to the Department of Defense, there are 2.1 million military members in the United States [35].

The sample size was performed using G\* Power statistical analysis. For this study, 220 participants are needed for chi square test with a medium effect size of .30, a power of 0.95, two tailed test, an error probability of 0.05 [36].

The Research Electronic Data Capture (REDCap) 2019 web-based survey was used to conduct this study [40].

This secure, web-based software platform allows branching logic so only questions particular to the previously answered questions are asked. For example, if the person answers “yes” to using tobacco cigarettes, additional questions are asked about tobacco cigarettes such as how many “do you smoke.” However, if the person answers “no” to tobacco cigarettes than questions related to tobacco use are skipped. The 32 - 60 item survey used Behavioral Risk Factor Surveillance System (BRFSS) and military related questions [3]. The dependent variables were ECIG use, tobacco use, dual use, and nonuse. A few of the independent variable include the following: 1) demographics; gender, race, age, employment, income, housing, education, marital status, children, 2) psychosocial factors; general health, stress, depression, worry, anxiety, sleep, and friends, family, coworkers, or boss using ECIGs, tobacco or dual products, 3) military related factors; military branch, deployment, combat zone, tobacco use before and after joining the military, ECIG use before and after joining the military. We examined the relationships between the dependent variables and each of the independent variables (a) demographics, (b) psychosocial factors, and (c) military related factors in military members.

**Inclusion Criteria**

**Inclusion Criteria:** 1) U.S. military members; 2) ability to read English, 3) age > 18 years; 4) internet, computer, phone access.

**Exclusion Criteria**

**Exclusion Criteria:** 1) non-U.S. military members; 2) age < 18 years; 3) military members who have already completed the questionnaire.

**Instrument**

The Behavioral Risk Factor Surveillance System (BRFSS) is a national tool used for health-related risk behaviors [3]. The BRFSS is used to interview over 500,000 adults each year making it the largest health survey in the world [3]. Since 1984, the survey has been used examined the reliability and validity of the BRFSS [3]. Questions from the BRFSS and military related questions were used for this study [3]. Demographic characteristics, psychosocial factors, and military related factors were examined to determine if there were any associations being ECIG use, compared to tobacco use, dual use, and nonuse. This instrument has not been used exclusively in a military population study and has not been used in the web-based format making this study innovative.

**Results**

A total of 675 participants completed the survey. There were 241 surveys excluded based on not meeting the inclusion criteria or survey duplication leaving a remaining 434 completed surveys. The military members in this sample were predominately white (84%), married (52%) males (85%) ranging in age from 25 to 34 years (65%), with incomes in the $25,001 to $50,000 (50%) range with (43%) having no children under 18 years of age living in their home. Over 75% of participants owned their own home and 92% were employed for wages. Participants had at least a High School (HS) diploma (HS diploma, 19%; some college, 38%; college graduate, 19%; or graduate school or higher, 14%). The age range was from 20 to 71 with the mean age being 32.03. There were 364 (84%) Caucasians and 50 (12%) African Americans, and 20 (5%) other races (Table 1). In our sample, 37 (9%) participants had exclusive ECIG use with no other products, 67 (15%) of participants had exclusive tobacco cigarette use with no other products, 223 (51%) had dual use which includes ECIGs and tobacco cigarettes, and 107 (25%) had nonuse. Approximately 19% were Active-Duty Army, 30% were National Guard/Reserve, and 21% were veterans.

A general health questions allowed participants to rank their overall health as “excellent, very good, good, or fair.” A Pearson’s chi-square test of association was conducted between general health and ECIG use, tobacco use, dual use, and nonuse. This study showed a statistically significant association between general health and tobacco use; x2(4) = 21.02, *p* < .001, general health and dual use, x2(4) = 21.1, *p* < .001, and general health and nonuse, x2(4) = 15.61, *p* = .004. The associations were small in tobacco use, φc = .22, *p* < .001, dual use, φc = .22, *p* < .001, and nonuse, φc = .19, *p* = .004.

There was one question about how many days each month did participants feel worried or tense. A Pearson’s chi-square test of association was performed between self-reported worry/tense and ECIG use, tobacco use, dual use, and nonuse. A statistically significant association between worry/tense days and dual use, x2(3) = 12.23, *p* = .007, and worry/tense days and nonuse, x2(3) = 9.07, *p* = .028 was found. The associations were small using Cramer’s V in dual use, φc = .168, *p* = .007, and nonuse, φc = .145, *p* = .028.

There was one question about how many days each month did the participant get enough rest or sleep. A Pearson’s chi-square test of association was performed between self-reported rest or sleep each month and ECIG use, tobacco use, dual use, and nonuse. There was a statistically significant association between rest/sleep and dual use, x2(3) = 9.85, *p* = .02. The association was small using Cramer’s V in dual use, φc = .151, *p* = .02.

There were 174 (40%) participants in the tobacco use and nonuse group answer one question regarding if they “might start ECIG use in the future.” The categories were broken down into definitely yes, probably yes, probably no, definitely no, or missing. In the tobacco use group, 6 (10%) said definitely yes, 33 (57%) said probably yes, 12 (21%) said probably 7 (12%) said no definitely no, or nine missing values. In the nonuse group, 0 (0%) said definitely yes, 5 (5%) said probably yes, 26 (25%) said probably 73 (70%) said no definitely no, or three missing values. A Pearson’s chi-square test of association was performed between might start ECIG use in the future in the tobacco use and nonuse group. A statistically significant association between might start ECIG use in the future and tobacco use, x2(1) = 222.25, *p* < .001 and might start ECIG use in the future and the nonuse group, x2(1) = 316.07, *p* < .001. The association was large, using Cramer’s V in tobacco use, φc = .716, *p* < .001, and nonuse, φc = .853, *p* < .001 (Table 2).

This study had 260 (60%) ECIG use and dual use participants answered one question about if they were “trying to quit tobacco.” There were 13 (8%) participants in ECIG use, 5 (3%) in tobacco use, and 140 (88%) in dual use trying to quit tobacco. There was a statistically significant association between trying to quit tobacco and ECIG use x2(1) = 10.57, *p* = .001, and trying to quit and dual use, x2(1) = 6.79, *p* = .009. The association was small in ECIG use, φc = .201, *p* = .001 and dual use, φc = -.161, *p* = .009.

Out of 434 participants, 238 (55%) of them had been deployed at least one time. The number of deployments includes 193 (45%) with no deployments, 82 (19%) with one deployment, 68 (16%) with two deployments, 47 (11%) with three deployments, 24 (6%) with four deployments, 6 (1%) with five deployments, 3 (.7%) with six deployments, 8 (2%) with seven or more deployments. A Pearson’s chi-square test of association was conducted between the number of deployments and ECIG use, tobacco use, dual use, and nonuse. There was a statically significant association between deployments and ECIG use, x2(7) = 18.24, *p* = .011, and deployments and nonuse x2(7) = 15.12, *p* = .034. The associations were small using Cramer’s V in ECIG use, φc = .206, *p* = .011 and nonuse, φc = .187, *p* = .034.

There was one question about being in a combat zone and 432 participants completed that question. Our sample revealed that 239 (55%) military members had been in a combat zone. A Pearson’s chi-square test of association was performed between the combat zone experience and ECIG use, tobacco use, dual use, and nonuse. There was no statically significant association between combat zone experience and ECIG use, x2(1) = .28, *p* = .597, combat zone experience and tobacco use, x2(1) = .672, *p* = .412, combat zone experience and dual use, x2(1) = 1.27, *p* = .26, and deployments and nonuse x2(1) = 2.74, *p* = .098.

There was a statistically significant association between thinking ECIGs were less harmful than tobacco cigarettes in all groups; ECIG use, x2(2) = 40.16, p < .001, tobacco use, x2(2) 85.71, p < .001, dual use, x2(2) = 260.84, p < .001 and nonuse, x2(2) = 199.30. The association between thinking ECIGs were less harmful than tobacco cigarettes was moderate as assessed by Cramer’s V in ECIG use φc = .304, *p* < .001 and tobacco use φc = .444, *p* < .001, and strong in dual use φc = .775, *p* < .001 and nonuse φc = .678, *p* < .001.

There was a statistically significant association between the participant’s supervisor recommending ECIGs and tobacco use only, tobacco use, x2(1) = 6.55, p = .011. The association was small when assessed by Cramer’s V, φc = .161, *p* = .011. There was a statistically significant association between healthcare provider recommending ECIGs and dual use only, dual use, x2(1) = 6.03, p = .014. The association was small when assessed by Cramer’s V, φc = .155, *p* = .014.

There was a statistically significant association between “ECIGs cost less money than tobacco cigarettes,” ECIG use, x2(1) = 16.09, p < .001, dual use, x2(1) = 20.15, p < .001. The association between thinking ECIGs cost less than tobacco cigarettes was small as assessed by Cramer’s V in ECIG use φc = .251, *p* < .001 and in dual use φc = .281, *p* < .001.

**Discussion**

In the last decade, ECIG use has increased in the military and general populations [33]. While we have learned a great deal about ECIGs over the last decade, there are still many unknows about ECIGs in the military population. This knowledge gap requires a sense of urgency due to the increasing number of military members using both ECIGs and tobacco use (dual use) as identified in this study. All six services of the United States Armed Forces (Army, Air Force, Coast Guard, Marine Corps, Navy, and Space Force) were represented in this study. Additionally, 129 (30%) members in the National Guard/Reserve as well as 90 (21%) veterans participated in this study.

This study compared ECIG use to tobacco use, dual use, and nonuse. The focus of this study was ECIG use, however, we cannot disregard the number of dual users in this study was 223 (51%). Our study found that 327 (75%) participants used some form or ECIGs, tobacco, or dual use, demonstrating the need for additional research. There are several psychosocial factors that may contribute to dual use. Helping with concentration, stress, depression, decrease anxiety, reducing appetite were all identified as reasons for using ECIGs or dual use. These findings suggest that military members may be self-medicating with nicotine instead of seeking healthcare resources for these problems.

Our results by gender were slightly different than the current literature. In our study, men accounted for 6% of ECIG use and women accounted for 23% of ECIG use, however, 54% of dual use was in men and 31% of dual use was in women. In our study the only demographic data that was not associated with ECIG use, tobacco use, dual use, or nonuse was housing.

Psychosocial factors such as mental health disorders are associated with ECIG use. Our sample identified associations between worry/tense and dual use. In our study, dual use was associated with seven different psychosocial factors including general health, stress/depression, sleep, worry, tense, peers using ECIGs, peers using tobacco, and trying to quit tobacco. This study sought to identify factors associated with ECIG use in the military.

Our study examined family and peer characteristics which could provide valuable information about additional factors associated with ECIG use. However, in this study, there was not an association between families, friends, and coworkers using tobacco in the ECIG use group. ECIG use, tobacco use, dual use, and nonuse was statistically significant in family, friends, and coworkers using ECIGs.

Deployments had a statistically significant association with ECIG use but did not have a statistically significance in tobacco use or dual use. Surprisingly, there was not a significant association in ECIG use, tobacco use, dual use, or nonuse and being in a combat zone.

**Conclusion**

In conclusion, this study identified, measured, and evaluated associations between ECIG use compared to tobacco use, dual use, and nonuse in military members by demographic characteristics, psychosocial factors, and military related factors.

While there has been a long history of tobacco use in the U.S. military, the military has developed new strategies to reduce the use of ECIGs and tobacco products. The DoD and VA have several tobacco prevention programs These programs provide text messages, apps, podcasts, and classes to assist patients with smoking cessation.

Over 44% of participants started using ECIGs after joining the military. These results have implications for the DoD and VA. This study adds knowledge to the expanding research and provides insight into the limited and conflicting published research on demographic characteristics, psychosocial factors, and military related factors in the military population using ECIGs. This study provides insight into why some military members use ECIGs; however as new literature emerges; additional gaps should be addressed. Additionally, conducting research on dual use in military members is needed since the rates of dual use was much higher than reported in previous literature.

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