



Why do smokers use e-cigarettes? A study on reasons among dual users

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ABSTRACT

Objective: There is minimal research that has measured motivations behind e-cigarette use and the relationship to cigarette and e-cigarette use. The aim of this study was to (1) examine extent to which motivations to use e-cigarettes varies among dual users and (2) examine whether e-cigarette motivations are related to e-cigarette and cigarette consumption among dual users.

Methods: Adults residing in California were recruited through social media (n = 1762, 68.9 % males, 62.9 % White) to complete an online survey. Participants self-identified as using combustible cigarettes and e-cigarettes (dual users) and reported their motivations for using an e-cigarette device, nicotine consumption, and nicotine dependence with both combustible cigarettes and e-cigarettes.

Results: A greater proportion of people reported using e-cigarettes for enjoyment purposes than other motivations (34.2 %). Motivations to use e-cigarettes to quit were positively related to monthly cigarette consumption (IRR = 1.17, 95 % CI [1.08, 1.26]). Motivations to use e-cigarettes to quit smoking were also related to smoking the first cigarette within 30 min (IRR = 1.46, 95 % CI [1.05, 2.02]) and first e-cigarette within 30 min (b = 0.28, 95 % CI [0.19, 0.37]).

Conclusions: Compared to those who use e-cigarettes for enjoyment, smokers who are motivated to use e-cigarettes for cessation purposes are more likely to have greater nicotine dependence, cigarette consumption, and e-cigarette consumption. Future research needs to acknowledge that not all e-cigarette users are the same; motivations and use differ and are related to both consumption and dependence.

1. Introduction

The use of electronic cigarettes (e-cigarettes) is a continuing and rising public health concern (Centers for Disease Control and Prevention [CDC], 2021). In 2019, among all United States (U.S.) adults, 4.5 % reported being current e-cigarette users, of which 36.9 % reported concurrently smoking combustible cigarettes (i.e., were dual users; CDC, 2021). This high rate of dual use of e-cigarettes and combustible cigarettes is alarming given that data indicate that many initial e-cigarette users were not previous combustible cigarette smokers (CDC, 2021).

E-cigarette use is complicated by the fact that it is touted as a cessation aid (Benowitz, 2020; Hajek et al., 2019; United States Department of Health and Human Services [USDHHS], 2016); to date, it has not been approved as a cessation aid by the U.S. Food and Drug Administration (CDC, 2021). There is controversy among health

practitioners and researchers surrounding the effectiveness of e-cigarettes on smoking cessation and on public health more generally (CDC, 2021). There are also concerns that efforts to curb e-cigarette appeal to nonsmokers, including youth, might discourage adult cigarette smokers from switching to e-cigarettes (Friedman & Xu, 2020) or even encourage those who have converted to e-cigarettes to revert back to cigarette smoking (Harlow et al., 2021). Prior studies have found that e-cigarette use by cigarette smokers is most likely dual use of both products and that e-cigarettes may even discourage cigarette smokers from completely quitting (Kalkhoran & Glantz, 2015; Mejia et al., 2010), potentially prolonging nicotine addiction for these users (Glantz & Bareham, 2018).

Fewer studies have focused on understanding motivations for dual use of combustible cigarettes and e-cigarettes. Several factors may be influencing an individual's motivation to use e-cigarettes. Some may use e-cigarettes primarily to quit smoking (Nicksic et al., 2019), while others

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may use them to consume nicotine in public areas where cigarette smoking is not allowed (Simonavicius et al., 2017). Others use e-cigarettes because they enjoy the variety of flavors available, which combustible cigarettes do not offer, and some may use because they are simply curious (Kinouani et al., 2019). Very little research has examined the role these motivations may play in dual use of both combustible cigarettes and e-cigarettes.

Prior research has primarily suggested that e-cigarettes are used for cessation purposes (Berg et al., 2014; Rhoades et al., 2019). However, studies have found that most individuals using e-cigarettes to quit cigarette smoking were unsuccessful and instead used both products (Agaku et al., 2021; Caraballo et al., 2017). These findings are confirmed by a meta-analysis of 64 papers including 9 randomized control trials showing that daily e-cigarette use as observed in the adult population is not associated with quitting (Wang et al., 2021). A longitudinal study, focused on dual use, found that e-cigarettes did help with cigarette smoking cessation, but only in the short-term (Sweet et al., 2019). Findings indicated that although dual users were more likely to report abstinence from cigarette smoking after the first 6 months of e-cigarette use, these individuals also reverted to dual use of both products by 12 and/or 18 months term (Sweet et al., 2019). Another longitudinal study investigating dual use among cigarette smokers just beginning to use e-cigarettes, found that most cigarette smokers reported initial intentions to use e-cigarettes to assist in cigarette replacement or reduction (Berg et al., 2014). However, by week 8, participants began decreasing e-cigarette use and returning to (increasing) cigarette smoking (Berg et al., 2014).

When discussing dual use, it is important to consider the two types of cognitions at play: cigarette-related and e-cigarette-related cognitions. Dual users may hold specific beliefs, attitudes, and behaviors towards each type of tobacco product (i.e., cigarettes and e-cigarettes). For example, studies have demonstrated that smokers reported using e-cigarettes to reduce health risks, stress, and to quit and/or reduce cigarette smoking (Cooper et al., 2016; Finney Rutten et al., 2015; Simonavicius et al., 2017). Despite the existing literature on cigarette and e-cigarette cognitions, very little research has focused on dual use and the interplay between these two sets of cognitions and how this interplay might relate to behavior.

Guided by the Theory of Planned Behavior (Ajzen, 1991) and the Theory of Triadic Influence (Flay & Petraitis, 2009), cognitions (e.g., perceptions) are related to motivations, which lead to risk behaviors. Both theories posit that motives and intentions are related to behavior; individuals bring in their own attitudes and perceptions which form those motives and intentions. There can be misperceptions of risks as seen when investigating risks of e-cigarette use. Many perceive e-cigarettes to be less harmful than combustible cigarettes for various reasons (e.g., less nicotine, fewer chemicals) and safer to use around others (e.g., vapors are less harmful in terms of secondhand smoke; Rass et al., 2015). Specifically, dual users of both e-cigarettes and cigarettes may believe e-cigarettes are less harmful and are motivated to reduce the harm associated with their cigarette consumption, which is related to their subsequent behavior. Alternatively, some cigarette smokers may have been merely curious about e-cigarettes, thus motivating them to try using e-cigarettes. Despite these perceptions and motivations, e-cigarettes are not risk-free: e-cigarettes as typically used are not lower in nicotine (Cameron et al., 2013) and emerging research demonstrates potential negative health effects associated with e-cigarette usage (Wang et al., 2018) and secondhand e-cigarette exposure (Lerner et al., 2015).

Given the paucity and lack of clarity in the research regarding perceptions of dual use of cigarettes and e-cigarettes and subsequent behavior, the aim of the current study is to empirically examine how e-cigarette motivations might be related to cigarette and e-cigarette consumption. To better understand how motivations of e-cigarette use impact dual users the current study will: 1) examine the extent to which motivations to use e-cigarettes varies among dual users, and 2) examine whether e-cigarette motivations are related to e-cigarette and cigarette

consumption behaviors among dual users. Specifically, we examine the following cigarette and e-cigarette consumption behaviors: daily cigarette and e-cigarette consumption, number of times cigarettes and e-cigarettes are used in past 30 days, and how soon after waking do dual users use a cigarette and an e-cigarette.

2. Methods

2.1. Participants and design

We examined dual daily users of combustible cigarettes and daily users of e-cigarettes ($n = 1883$) who lived within an 11-county region in Central California. Participants were recruited online using targeted advertisements on social media in February 2020 and May 2020 as part of a larger study ($N = 3161$; Gonzalez et al., 2021). Participants were directed to a Qualtrics survey; there were a number of survey protection measures to account for automated responses including CAPTCHA and preventing multiple responses from the same IP address. As the current study examines the relationship between motivations, perceptions of use, and current e-cigarette and cigarette consumption, only participants who had used e-cigarettes and cigarettes in the previous month were included. This study was approved by the University of California, Merced Institutional Review Board.

3. Measures

3.1. Outcome variables

To measure e-cigarettes and (combustible) cigarette use, participants were asked about the number of days they smoked cigarettes in the last 30 days, the number of days they smoked e-cigarettes in the last 30 days, average number of cigarettes smoked per day, and the number of times they used an e-cigarette per day. Number of times used an e-cigarette per day was recoded to be dichotomous with $0 = \leq 10$ and $1 = 11 +$. Using the Fagerström Dependence scale (Heatherton et al., 1991), participants also reported when they smoked their first cigarette after waking and time to smoking first e-cigarette after waking (<5 min; $5-30$ min; $31-60$ min; > 60 min); both were dichotomized for analyses with $0 = >30$ min and $1 =$ within 30 min.

3.2. E-cigarette use motivations

Questions were adapted from the Population Assessment of Tobacco and Health study (USDHHS et al., 2021) in order to truncate the number of items to reduce response burden and also include an assessment of whether curiosity may be a motivation to use e-cigarettes. To measure motivations underlying e-cigarette use participants were asked, "What is your primary reason for using an e-cigarette device?" Participants could only select one option which included: to quit smoking combustible cigarettes, to reduce smoking, to use when I cannot or am not allowed to smoke, because I enjoy it (i.e., enjoyment), or curiosity. Indicator variable coding was used (0,1) for each of the e-cigarette motivations.

3.3. Harm perceptions

Questions were adapted from a previous study assessing harm perceptions as predictors of smoking (Song et al., 2009). Participants were asked about comparative e-cigarette harm with the question "Compared with cigarettes, how harmful are e-cigarettes to a person's health?" Response options followed a Likert scale format from 1 to 5 with 1 = much less harmful than cigarettes and 5 = much more harmful than cigarettes.

To measure perceptions of e-cigarette harm to health and others, participants were asked how likely on a five-point Likert type scale with 1 = very unlikely and 5 = very likely: (1) "If you continue to smoke e-cigarettes at your current rate, how likely is it that you will harm your

own health?” and (2) “If you continue to smoke e-cigarettes at your current rate, how likely is it that you will harm someone else’s health with second hand vape smoke?”.

Finally, perceptions of perceived e-cigarette addictiveness was measured by asking, “If you continue to smoke e-cigarettes at your current rate, how likely is it that you will become addicted?” Response options used a 5-point Likert scale format with 1 = very unlikely and 5 = very likely.

3.4. Demographics

Participants were asked basic demographic questions such as age, sex (male/female), race/ethnicity (Hispanic/Latino, non-Hispanic (NH) White, NH African American/Black, NH Asian, and NH Other), and socioeconomic status [SES]. SES was measured using annual household income (<\$50,000; \$51,000-\$75,000; \$76,000-\$100,000; > \$101,000) and education level (high school diploma/GED or lower; some college or Associates degree; Bachelor’s degree or higher). Household tobacco use was measured by whether the participant was the only user of tobacco in the house or if they lived with 1 person or more who used tobacco. Month of data collection (February 2020; May 2020) was also controlled for due to the U.S. being in a state of lockdown and wanting to delineate potential behavior changes due to this particular time period (Gonzalez et al., 2021).

3.5. Statistical analyses

Participant responses that did not fall within two standard deviations within the average survey completion time and people who obviously did not read the questions and answered randomly (under average time) or not paying attention to questions and took an exceeding amount of time (above average time) were excluded from analyses (n = 121; Gonzalez et al., 2021). The final sample of dual users was n = 1762. Initial analyses indicated some non-normally distributed data, particularly skewed to the right. Therefore, negative binomial regression models were run to quantify the relationship between e-cigarette motivations and the following outcome variables 1) monthly cigarette and e-cigarette use, 2) daily cigarette and e-cigarette use, and 3) cigarette nicotine dependence. This type of analysis returns an Incident Rate Ratio (IRR) which can be interpreted as percent change in the incident rate of the outcome variable for changes in the predictor (UCLA Statistical Consulting Group, n.d.). For example, an IRR above 1 can be interpreted as: For every level increase in the predictor variable, the outcome variable increases by (IRR-1)% [95 % CI]. In contrast, an IRR below 1 can be interpreted as: For every level increase in the predictor variable, the outcome variable decreases by (1-IRR)% [95 % CI]. A multivariable linear regression model was run to investigate e-cigarette motivations and e-cigarette nicotine dependence. For e-cigarette motivations, enjoyment was the reference category. For the “harm to own health,” “harm to others health via secondhand smoke,” and “perceived e-cigarette addictiveness variable,” the referent category is “very unlikely,” and for “comparative e-cigarette harm,” the referent category is “much less harmful than cigarettes.” Final models controlled for sex, race/ethnicity, SES, household tobacco use, and time of data collection. All analyses were conducted using STATA version 16.1.

3.6. Data availability

A de-identified version of this data is available upon request from the corresponding author. This study was not pre-registered.

4. Results

This sample of dual users was fairly young (M = 30.5 years, SD = 5.1 years; Table 1), predominately male (68.9 %), and most identified their race/ethnicity as NH White (63 %). More than half (52.5 %) reported

Table 1
Demographic and tobacco use characteristics of the sample of dual users.

Demographic characteristics: %, mean (95 % CI)	Overall (n = 1762)
<i>Demographic Characteristics</i>	
Age, mean (SD)	30.5 (5.1)
Gender: Female, %	31.1 %
Race/Ethnicity	
NH African American/Black	3.4 %
NH Asian	3.9 %
Hispanic/Latino	26.6 %
NH White	62.9 %
NH Other	3.3 %
Highest level of education completed, %	
High school/GED or less	17.9 %
Some college	23.4 %
Bachelor’s Degree	52.5 %
Professional Degree	6.3 %
Annual household income, %	
Up to \$50,000	27.7 %
\$51,000-\$75,000	34 %
\$76,000-\$100,000	22.5 %
\$101,000 or more	15.8 %
<i>Smoking Characteristics</i>	
E-cigarette use motivations	
Quit smoking combustible cigarettes	11 %
Reduce smoking combustible cigarettes	23.2 %
To use when I cannot or am not allowed to smoke	18.2 %
Enjoyment	34.2 %
Curiosity	13.2 %
Other reason	0.3 %
Comparative e-cigarette risk, mean (SD)	2.4 (1.1)
Risk of becoming addicted to e-cigarettes, mean (SD)	3.9 (0.9)
Perceived risk of harm to health by using e-cigarettes, mean (SD)	3.8 (0.9)
Perceived risk of harm to others via secondhand smoke using e-cigarettes, mean (SD)	3.8 (0.9)
Living with 1 or more people who use tobacco, %	57.4 %
How many days smoked cigarettes in last 30 days, mean (CI)	15.5 [15.1, 15.8]
How many days smoked e-cigarettes in last 30 days, mean (CI)	7.7 [7.5, 8.0]
No. cigarettes smoked per day, mean (CI)	12 [11.7, 12.3]
Smokes 10 + cigarettes per day, %	64.2 %
Number of times uses e-cigarette per day %	
Uses 10 or less times per day	67.4 %
Uses 11 + times per day	32.6 %
Time before smoking first cigarette upon waking	
Within 30 min	62.4 %
Longer than 30 min	37.6 %
Time before using first e-cigarette upon waking	
Within 30 min	54.2 %
Longer than 30 min	45.9 %

Note. SD = standard deviation; CI = confidence interval; NH = non-Hispanic.

having a college degree and living with at least one other person who used tobacco (57 %). Most dual users perceived e-cigarettes to be significantly less harmful than combustible cigarettes (65.3 %). Dual users were also aware of the increased risk of becoming addicted to e-cigarettes if they continued smoking at their current rate (69.6 %), as well as the risk of increased harm to self (68.5 %) and others via secondhand smoke (69.4 %). Among this sample, the most commonly reported reason for using an e-cigarette device was for enjoyment (34.2 %), followed by reducing combustible cigarette consumption (23.2 %), use when one cannot or is not allowed to smoke (18.2 %), curiosity (13.2 %), and cessation (11.0 %).

4.1. Daily use

Number of days cigarettes used in last 30 days. For each unit of increased perception of comparative e-cigarette harm, monthly cigarette consumption decreased by a factor of 0.98 (95 % CI [0.96, 1.00]; Table 2). For each unit of increased perception of e-cigarette harm to self, monthly cigarette consumption decreased by a factor of 0.96 (95 % CI [0.94, 0.99]). For each unit of increased perception that e-cigarettes

Table 2
Motivations impacting cigarette use and dependence¹

Variable	Daily Cigarette Use (n = 1179)	Number of Days Used Cigarettes in Last 30 Days (n = 1227)	Cigarette Use Upon Waking (n = 1219)
Incident Rate Ratio (95 % CI)			
E-cigarette use motivations			
Enjoyment (ref)	1.00	1.00	1.00
Need nicotine	0.90(0.89, 1.08)	1.10(1.03, 1.18)	1.22(0.90, 1.65)
Reduce Smoking	0.98(0.90, 1.06)	1.18(1.11, 1.26)	1.12(0.84, 1.50)
Curiosity	1.01(0.92, 1.10)	1.06(0.99, 1.14)	1.20(0.86, 1.67)
Quit smoking	1.08(0.97, 1.21)	1.17(1.08, 1.26)	1.46(1.05, 2.02)
Harm Perceptions			
Comparative e-cigarette harm	0.98 (0.96, 1.01)	0.98(0.96, 1.00)	0.91(0.83, 0.99)
E-cigarette harm to own health	0.98(0.94, 1.01)	0.96(0.94, 0.99)	1.00(0.90, 1.11)
E-cigarette harm to other's health	1.00(0.97, 1.04)	1.01(0.99, 1.03)	0.95(0.86, 1.05)
Perceived likelihood of becoming addicted to e-cigarettes	0.97(0.94, 1.00)	0.97(0.95, 0.99)	1.03(0.93, 1.13)
Race/ethnicity			
NH White (ref)	1.00	1.00	1.00
Hispanic/Latino	0.83(0.74, 0.92)	1.04(0.97, 1.12)	1.43(1.10, 1.86)
NH African American/Black	0.85(0.71, 1.00)	1.03(0.92, 1.16)	1.24(0.81, 1.89)
NH Asian	0.98(0.82, 1.17)	0.93(0.82, 1.06)	0.96(0.59, 1.56)
Age			
Female (ref: male)	1.00(0.99, 1.00)	1.00(1.00, 1.01)	1.02(1.00, 1.04)
Live with ≥ 1 person who uses tobacco	1.09(1.03, 1.16)	1.00(0.96, 1.05)	1.02(0.83, 1.25)
Education			
Bachelor's degree and higher	1.00	1.00	1.00
High school	1.05(0.96, 1.16)	0.93(0.87, 1.00)	0.71(0.51, 1.00)
Some college or Associate's degree	0.99(0.92, 1.06)	0.98(0.93, 1.03)	1.13(0.92, 1.39)
Annual Income			
\$101,000+	1.00	1.00	1.00
Up to \$50,000	1.21(1.08, 1.35)	1.09(1.01, 1.18)	1.05(0.77, 1.43)
\$51,000 - \$75,000	1.12(1.00, 1.24)	1.05(0.98, 1.13)	0.84(0.63, 1.13)
\$76,000 - \$100,000	1.04(0.94, 1.15)	1.17(1.09, 1.26)	0.98(0.75, 1.29)
Time of data collection (ref: Feb)			
	1.00(0.93, 1.07)	1.11(1.05, 1.16)	1.33(1.07, 1.63)

Note. ¹All variables are controlled for in overall model; CI = confidence interval; NH = non Hispanic. Bolded values are significant at $p < 0.05$.

were addictive, monthly cigarette consumption decreased by a factor of 0.97 (95 % CI [0.95, 0.99]). Participants reporting use of e-cigarettes because they were not allowed to smoke combustible cigarettes (IRR = 1.10, 95 % CI [1.03, 1.18]), those trying to reduce their cigarette smoking (IRR = 1.18, 95 % CI [1.11, 1.26]), and those trying to quit cigarette smoking (IRR = 1.17, 95 % CI [1.08, 1.26]) consumed combustible cigarettes on more days compared to those who use e-cigarettes for enjoyment. Compared to those with a bachelor's degree,

those with a high school education have decreased monthly cigarette consumption by a factor of 0.93 (95 % CI [0.87, 1.00]). Compared to those making more than \$101,000 per year, those making upward of \$50,000 annually reported increased monthly cigarette consumption by a factor of 1.09 (95 % CI [1.01, 1.18]), and those making \$76,000-\$100,000 annually have an increased monthly cigarette consumption by a factor of 1.17 (95 % CI [1.09, 1.26]). Compared to February 2020, respondents in May 2020 reported increased monthly cigarette consumption by a factor of 1.11 (95 % CI [1.05, 1.16]).

Number of days e-cigarettes used in last 30 days. For each unit of increased perception of comparative e-cigarette harm, monthly e-cigarette consumption decreased by a factor of 0.88 (95 % CI [0.85, 0.91]; Table 3). Those trying to reduce their cigarette smoking (IRR = 1.24, 95 % CI [1.11, 1.38]), and those trying to quit cigarette smoking (IRR = 1.49, 95 % CI [1.31, 1.71]) consumed e-cigarettes on more days than those who use e-cigarettes for enjoyment. Compared to NH White users, Hispanic/Latino dual users have increased monthly e-cigarette consumption by a factor of 1.57 (95 % CI [1.40, 1.76]). Compared to males, females reported decreased monthly e-cigarette consumption by a factor of 0.87 (95 % CI [0.81, 0.95]). Compared to those with a bachelor's degree, those with some college education have decreased monthly e-cigarette consumption by a factor of 0.91 (95 % CI [0.84, 1.00]). Compared to those making more than \$101,000 per year, those making \$76,000-\$100,000 annually have an increased monthly e-cigarette consumption by a factor of 1.43 (95 % CI [1.27, 1.60]). Compared to those who do not live with people who use a tobacco product, respondents who live with at least 1 other person who uses a tobacco product reported increased monthly e-cigarette consumption by a factor of 1.44 (95 % [1.32, 1.57]). Compared to February 2020, respondents in May 2020 reported increased monthly e-cigarette consumption by a factor of 1.15 (95 % CI [1.05, 1.25]).

Daily combustible cigarette use. For each unit of increased perceived e-cigarette addictiveness, daily cigarette consumption decreased by a factor of 0.97 (95 % CI [0.94, 1.00]; Table 2). Compared to NH White users, Hispanic/Latino dual users have decreased daily cigarette consumption by a factor of 0.83 (95 % CI [0.74, 0.92]), Compared to males, female respondents have increased daily cigarette consumption by a factor of 1.09 (95 % CI [1.03, 1.16]). Compared to those making more than \$101,000 per year, those making upwards of \$50,000 annually have increased daily cigarette consumption by a factor of 1.21 (95 % CI [1.08, 1.35]), and those making \$51,000-\$75,000 annually have an increased daily cigarette consumption by a factor of 1.12 (95 % CI [1.00, 1.24]). Compared to those who do not live with people who use a tobacco product, respondents who live with at least 1 other person who uses a tobacco product reported decreased daily cigarette consumption by a factor of 0.76 (95 % [0.71, 0.83]).

Daily e-cigarette use. Participants who were more likely to report perceptions of comparative e-cigarette harm to cigarettes reported lower daily e-cigarette use (IRR = 0.82, 95 % CI [0.73, 0.93]; Table 3). For each unit of increased perception of e-cigarette harm to others, daily e-cigarette consumption decreased by a factor of 0.88 (95 % CI [0.78, 0.99]). Additionally, for each unit of increased perceived e-cigarette addictiveness, daily e-cigarette consumption increased by a factor of 1.19 (95 % CI [1.06, 1.34]). Compared to NH White users, Hispanic/Latino dual users have increased daily e-cigarette consumption by a factor of 1.52 (95 % CI [1.11, 2.07]). For every unit increase in age, daily e-cigarette consumption increased by a factor of 1.04 (95 % CI [1.01, 1.06]). Compared to those with a bachelor's degree, those with a high school education have decreased daily e-cigarette consumption by a factor of 0.26 (95 % CI [0.13, 0.49]). Compared to those who do not live with people who use a tobacco product, respondents who live with at least 1 other person who uses a tobacco product reported increased daily e-cigarette consumption by a factor of 1.95 (95 % [1.50, 2.53]).

Table 3
Motivations impacting e-cigarette use and dependence¹

Variable	Daily E-cigarette Use (n = 1224)	Number of Days Used E-Cigarettes in Last 30 Days (n = 1216)	E-cigarette Use Upon Waking (n = 1211)
	Incident Rate Ratio (95 % CI)	Incident Rate Ratio (95 % CI)	Unstandardized b (95 % CI)
E-cigarette use motivations			
Enjoyment (ref)	1.00	1.00	1.00
Need nicotine	0.92(0.64, 1.33)	1.07(0.95, 1.21)	-0.01(-0.08, 0.07)
Reduce Smoking	1.12(0.80, 1.57)	1.24(1.11, 1.38)	0.02(-0.05, 0.09)
Curiosity	1.02(0.67, 1.53)	1.03(0.91, 1.18)	0.01(-0.07, 0.09)
Quit smoking	1.07(0.73, 1.57)	1.49(1.31, 1.71)	0.28(0.19, 0.37)
Harm Perceptions			
Comparative e-cigarette harm	0.82(0.73, 0.93)	0.88(0.85, 0.91)	-0.04(-0.06, -0.02)
E-cigarette harm to own health	0.94(0.83, 1.07)	0.98(0.94, 1.02)	-0.01(-0.03, 0.02)
E-cigarette harm to other's health	0.88(0.78, 0.99)	1.01(0.97, 1.05)	-0.00(-0.03, 0.02)
Perceived likelihood of becoming addicted to e-cigarettes	1.19(1.06, 1.34)	1.01(0.97, 1.05)	0.02(-0.01, 0.05)
Race/ethnicity			
NH White (ref)	1.00	1.00	1.00
Hispanic/Latino	1.52(1.11, 2.07)	1.57(1.40, 1.76)	0.22(0.14, 0.30)
NH African American/Black	1.29(0.79, 2.12)	1.14(0.94, 1.39)	0.30(0.16, 0.43)
NH Asian	0.63(0.32, 1.23)	1.08(0.88, 1.32)	0.10(-0.05, 0.24)
Age			
Female (ref: male)	0.69(0.52, 0.93)	0.87(0.81, 0.95)	-0.01(-0.06, 0.05)
Live with ≥ 1 person who uses tobacco	1.95(1.50, 2.53)	1.44(1.32, 1.57)	0.18(0.12, 0.24)
Education			
Bachelor's degree and higher	1.00	1.00	1.00
High school	0.26(0.13, 0.49)	0.66(0.57, 0.74)	-0.16(-0.24, -0.08)
Some college or Associate's degree	0.96(0.75, 1.22)	0.91(0.84, 1.00)	0.07(0.01, 0.13)
Annual Income			
\$101,000+	1.00	1.00	1.00
Up to \$50,000	0.91(0.62, 1.35)	1.12(0.98, 1.27)	-0.08(-0.17, 0.02)
\$51,000 - \$75,000	1.02(0.74, 1.42)	1.06(0.94, 1.20)	-0.14(-0.22, -0.05)
\$76,000 - \$100,000	1.20(0.89, 1.61)	1.43(1.27, 1.60)	-0.05(-0.13, 0.03)
Time of data collection (ref: Feb)	0.99(0.76, 1.29)	1.15(1.05, 1.25)	0.18(0.12, 0.24)

Note. ¹ All variables are controlled for in overall model; CI = confidence interval; NH = Non Hispanic. Bolded values are significant at $p < 0.05$.

4.2. Nicotine dependence

Measured time to first use of combustible cigarette after waking. Participants who were more likely to report perceptions of comparative e-cigarette harm to cigarettes reported smoking their first

cigarette later upon waking (IRR = 0.91, 95 % CI [0.83, 0.99]; Table 2). Those using e-cigarettes to quit smoking combustible cigarettes reported smoking their first cigarette sooner upon waking (IRR = 1.46, 95 % CI [1.05, 2.02]) compared to those using e-cigarettes for enjoyment. Compared to NH White users, Hispanic/Latino dual users reported smoking their first cigarette sooner upon waking by a factor of 1.43 (95 % CI [1.10, 1.86]). Compared to those with a bachelor's degree, those with a high school education reported smoking their first combustible cigarette later upon waking (IRR = 0.71, 95 % CI [0.51, 1.00]). Compared to those who do not live with people who use a tobacco product, respondents who live with at least 1 other person who uses a tobacco product reported smoking their first combustible cigarette sooner upon waking (IRR = 1.32, 95 % CI [1.06, 1.65]). Compared to February 2020, respondents in May 2020 reported smoking their first combustible cigarette sooner upon waking (IRR = 1.33, 95 % CI [1.07, 1.63]).

Measured time to first use of e-cigarette after waking. For dual users, the perception of increased comparative harm was associated with waiting a longer period of time after waking to use an e-cigarette ($b = -0.04, p < 0.05$; Table 3). Those using e-cigarettes for cessation purposes were likely to use their first e-cigarette sooner upon waking ($b = 0.28, p < 0.01$) compared to those who use e-cigarettes for enjoyment. Compared to NH White dual users, Hispanic/Latino dual users ($b = 0.22, p < 0.01$) and NH Black dual users ($b = 0.30, p < 0.01$) were likely to use their first e-cigarette sooner upon waking. For every unit increase in age, dual users were likely to use their first e-cigarette sooner upon waking ($b = 0.01, p < 0.05$). Compared to those with a bachelor's degree, those with a high school education were likely to use their first e-cigarette later upon waking ($b = -0.16, p < 0.01$), and those with some college education were likely to use their first e-cigarette sooner upon waking ($b = 0.07, p < 0.05$). Compared to those making more than \$101,000 annually, those making \$51,000 to \$75,000 annually were likely to use their first e-cigarette later upon waking ($b = -0.14, p < 0.05$). Compared to those who do not live with people who use a tobacco product, respondents who live with at least 1 other person who uses a tobacco product were likely to use their first e-cigarette sooner upon waking ($b = 0.18, p < 0.01$). Compared to February 2020, respondents in May 2020 were likely to use their first e-cigarette sooner upon waking ($b = 0.18, p < 0.01$).

5. Discussion

Among our sample, we found a greater proportion of dual users reported using e-cigarettes for enjoyment. Participants who used e-cigarettes for the purposes of reducing or quitting their cigarette smoking and need for nicotine reported higher monthly combustible cigarette use compared to those using e-cigarettes for enjoyment. Although previous studies have found that e-cigarettes do assist in reduction of cigarette smoking (Sweet et al., 2019), this was not fully reflected in this sample. Those using e-cigarettes for reduction or cessation purposes also reported a higher monthly e-cigarette use compared to those using e-cigarettes for enjoyment. These findings support previous work by Biener and Hargraves (2015) as well as Simonavicius et al. (2017).

Similar to the findings of monthly cigarette consumption, those who reported using e-cigarettes for cessation purposes reported using their first combustible cigarette upon waking much earlier than those who use e-cigarettes for enjoyment. These individuals are more likely to be addicted, making cessation efforts more difficult. These findings corroborate those found by Rass et al. (2015) who found dual users express preference for combustible cigarettes to e-cigarettes upon waking. Respondents using e-cigarettes for cessation purposes are also reporting using their e-cigarette device earlier upon waking than others, which is plausible given that they are trying to avoid using combustible cigarettes. Among this sample, a greater proportion reported smoking a combustible cigarette within 30 min of waking up, compared to an e-cigarette within 30 min of waking up.

6. Strengths and limitations

This study investigates a novel topic as dual use research has not focused on the relationship between motivations and consumption behavior of both products; rather, the focus has been primarily on attitudes of current dual users. Lastly, the aims of this study were to understand how motivations relate to consumption behavior, whereas existing nicotine research has focused primarily on demographic characteristics and the relationship to use.

Some limitations must be acknowledged. First, data were cross-sectional, therefore we cannot make causal inferences. Thus, we cannot conclude that using e-cigarettes for cessation purposes leads to greater cigarette consumption. However, previous longitudinal research has suggested that non-cigarette products increase dependency upon cigarettes (Petersen et al., 2018). Future research can take an experimental approach to help determine causal processes. Additionally, emerging research has suggested that the COVID-19 pandemic has impacted tobacco consumption such that some users reported smoking more due to stress (Gonzalez et al., 2021; Rigotti et al., 2021). Because of the cross-sectional nature of our data, we cannot determine if the emergence of COVID-19 changed behaviors or impacted reasons for e-cigarette use in our sample, though we have controlled for period of data collection in our analyses. Secondly, length of time using both products was not controlled for. Someone who has used combustible cigarettes for over a decade may have a more difficult time successfully using an e-cigarette device for cessation purposes compared to someone who has only been smoking cigarettes for two years. Future works should consider controlling for factors that may make cessation efforts considerably more difficult, including the nicotine dosing from e-cigarettes. Thirdly, we recruited via social networking which could have resulted in response bias, however, as outlined in the methods section, steps were taken to reduce this bias as much as possible. Finally, we did not consider other forms of cessation (e.g., nicotine gum, patches, etc.) although we did report motivations to quit smoking using e-cigarettes.

7. Conclusions

Among dual users there still seems to be a preference for combustible cigarettes. Whereas the argument tobacco and e-cigarette companies have used has been that e-cigarettes are helpful in cessation efforts (USDHHS, 2016), this is not reflected in this sample of adults since the most commonly reported use of e-cigarettes was for enjoyment purposes. Compared to people who use e-cigarettes for enjoyment, people motivated to use e-cigarettes to quit smoking combustible cigarettes are more likely to express addictive behaviors, greater combustible cigarette consumption, and greater e-cigarette consumption. The current study provides further insight on e-cigarette use motivations among dual users and the impact on combustible cigarette and e-cigarette consumption, and this may be important in developing cessation programs. As a field, this area of research is stalled because of a lack of consensus on whether e-cigarettes are beneficial for quitting cigarettes. Future research needs to acknowledge that not all e-cigarette users are the same, motivations and use differ, and these motivations are related to consumption as well as dependency.

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Methodology, Investigation, Resources, Writing – review & editing, Project administration, Funding acquisition. **Deanna M. Halliday:** Investigation, Data curation, Project administration, Writing – review & editing. **Mariaelena Gonzalez:** Conceptualization, Methodology, Data curation, Funding acquisition, Project administration, Resources, Writing – review & editing. **Anna E. Epperson:** Conceptualization, Methodology, Investigation, Data curation, Project administration, Resources, Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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