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## Correlates of e-cigarette use for smoking cessation among clients in residential substance use disorder treatment

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### ABSTRACT

Little is known about e-cigarette use among persons in substance use disorder (SUD) treatment, or their use of e-cigarettes for smoking cessation. Prevalence of e-cigarette use and correlates of e-cigarette use for smoking cessation were examined among clients in SUD treatment. Participants ( $n = 332$ ) were current cigarette smokers recruited from 20 residential SUD programs in California. We used multivariable logistic regression to identify correlates of using e-cigarettes for quitting smoking. Almost half (45.2%) of the sample had ever used e-cigarettes for smoking cessation, and 34% had used e-cigarettes in the past 30 days. Smokers who had used e-cigarettes for smoking cessation, compared to those who had not, were younger (adjusted odds ratio [AOR] = 0.94, 95% confidence interval [CI] = 0.91, 0.96), had more than a high school education (AOR = 1.69, 95% CI = 1.07, 2.68), sought treatment for both SUD and mental health disorder (AOR = 2.62, 95% CI = 1.38, 5.00), wanted help quitting smoking (AOR = 1.90, 95% CI = 1.03, 3.50) and perceived e-cigarettes as equally harmful (AOR = 3.03, 95% CI = 1.10, 8.33) or less harmful than tobacco cigarettes (AOR = 2.82, 95% CI = 1.02, 7.77). Black/African American and Hispanic/Latino participants were less likely to use e-cigarettes for smoking cessation than participants who identify as White. E-cigarettes were favorably perceived by clients in residential SUD treatment as a quit smoking aid. Treatment programs should consider how to advise clients with respect to the use of e-cigarettes for smoking cessation.

### 1. Introduction

E-cigarette use continues to grow among the U.S. adult population (Creamer et al., 2019). Among US adults in 2019, e-cigarettes were the most commonly used non-cigarette tobacco product (4.5%), with use of e-cigarettes highest among adults aged 18–24 years (9.3%) (Cornelius, Wang, Jamal, Loretan, & Neff, 2020). The convenience of newer pod-like devices, the use of nicotine salts to provide higher doses of nicotine with less throat irritation (Centers for Disease Control and Prevention, 2020), and marketing of e-cigarettes as smoking cessation aids all contribute to lower perceived harm (Collins, Glasser, Abudayyeh, Pearson, & Villanti, 2019) and may account for recent increases in use among adults (Stanton et al., 2020). Over a third of adult e-cigarette users (36.9%) also self-identify as current users of tobacco cigarettes

(Cornelius et al., 2020), and the most common reasons given for e-cigarette use are for cessation of tobacco cigarettes or health-related concerns (Patel et al., 2016; Sapru et al., 2020). While smokers may use e-cigarettes to reduce their exposure to the toxic chemicals found in tobacco cigarettes (National Academies of Sciences, 2020; Chun et al., 2017), there is insufficient evidence to conclude that e-cigarettes are effective smoking cessation aids (Centers for Disease Control and Prevention, 2020).

Little is known about e-cigarette use among vulnerable populations such as those with SUDs. Among SUD treatment clients high rates (78% to 85%) (Gubner et al., 2016; Baldassarri et al., 2019) of current cigarette smoking have been reported, however, with lower rates (18% to 31%) (Baldassarri et al., 2019; Gubner et al., 2016) of past 30-day e-cigarette use. Similar to the general population, the majority of current

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e-cigarette users receiving care in SUD treatment programs are also current users of tobacco cigarettes (Gubner et al., 2016; Baldassarri et al., 2019), and many report that they use e-cigarettes to either quit or reduce cigarette smoking (Gubner et al., 2016; Baldassarri et al., 2019; Stein et al., 2015; Peters et al., 2015). These findings highlight the importance of considering cigarette smoking status to understand e-cigarette use among clients in SUD treatment to inform the development of anti-vaping messages (Bhatnagar, Payne, & Robertson, 2019) to support smoking cessation in this population. Although the studies by Gubner et al. (Gubner, Andrews, Mohammad-Zadeh, Lisha, & Guydish, 2016) and Baldassarri et al. (Baldassarri et al., 2019) examined the correlates of current e-cigarette use among patients in SUD treatment, these studies did not focus on beliefs and attitudes for using e-cigarettes as a smoking cessation aid. Given the rapid evolution in e-cigarette products and messaging, there remains a need to inform how smoking cessation treatment can be tailored for SUD clients who use both e-cigarettes and tobacco cigarettes.

The high rates of tobacco use and tobacco-related mortality among individuals with SUDs, and the complex, emerging questions regarding the effectiveness of e-cigarettes as smoking cessation aids, highlights the need for up-to-date information about e-cigarette use in this population. The purpose of this study was to characterize e-cigarette use among clients in residential SUD treatment and to identify the correlates of e-cigarette use as a smoking cessation aid among current cigarette smokers.

## 2. Methods

We conducted a secondary data analysis of 562 participants in 20 residential SUD treatment programs in California who were recruited as part of three separate studies. A description of the full sample of 20 programs can be found in Guydish and colleagues (Guydish et al., 2020). Among the participating residential SUD treatment programs, some also offered behavioral health services for individuals who had recently been released from prison (who may not have identified that they had a SUD problem) or individuals who sought treatment for both SUD and mental health diagnoses. All three studies evaluated interventions designed to reduce continued tobacco use and/or use of nicotine containing products among clients in residential SUD programs. This report uses the baseline data collected during the calendar year of 2019.

### 2.1. Procedures

Research staff collected baseline data in the course of scheduled site-visits at the participating programs. Eligible clients were both smokers and non-smokers enrolled in the program on the day of the site visit. All participants provided informed consent and completed the survey using an iPad with a pre-populated unique participant research identification number. Respondents received a \$20 gift card for their time. The Institutional Review Board of the University of California, San Francisco approved all research procedures.

### 2.2. Measures

#### 2.2.1. Demographic characteristics and reason for treatment entry

Demographic characteristics collected for the survey included age, gender, race/ethnicity, and education. Race/ethnicity was categorized as Hispanic/Latino, African American/Black, White/Caucasian, and other (American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islanders, other race) or multiple races. We dichotomized education as less than or equal to high school or general equivalency diploma versus some college or more. In all three studies respondents were asked to report the reason they sought treatment. In two studies they were asked whether they sought treatment mainly for a substance use problem, for both substance use and mental health problems, or for some other problem. One study included the same item but with an

added response code for mental health problems. Self-reported reason for currently seeking treatment was coded into four categories: 1) SUD; 2) mental health disorder; 3) SUD and mental health disorder; or 4) other. Respondents were asked to report the primary drug for which they sought treatment: alcohol, amphetamines/methamphetamines, marijuana/cannabis, crack/cocaine, heroin, methadone, other opiates/analgesics, other drug, and not in treatment for any SUD. Primary drug was coded into these categories: alcohol, stimulants (amphetamine/methamphetamines, crack/cocaine), cannabis, opiates (heroin, methadone, and other opiates/analgesics), other drugs, and not in treatment for a SUD.

#### 2.2.2. E-cigarette use and perceptions of the harmfulness of e-cigarettes

Participants reported any lifetime use of e-cigarettes to help them quit smoking (yes/no), and how often they had used e-cigarettes in the past 30 days (daily, weekly, less than once a week, not at all). Perceptions of harmfulness of e-cigarettes relative to tobacco cigarettes were measured by asking participants whether they thought e-cigarettes were: a) not as harmful as tobacco cigarettes; b) equally as harmful as tobacco cigarettes; or c) more harmful than tobacco cigarettes.

#### 2.2.3. Current cigarette smoking, smoking behaviors, and attitudes toward quitting smoking

Current cigarette smokers were participants who reported having smoked at least 100 cigarettes during their lifetime and also reported being a current smoker at the time of the survey. Current smokers reported the number of days per week they smoked cigarettes, number of cigarettes they smoked per day (CPD), whether they had a serious quit attempt in the past year (lasting at least 24 h; yes/no), and whether they wanted help quitting smoking (yes/no). They were also asked about their attitudes toward quitting smoking by rating items on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5) about the extent to which they: a) had the required skills to quit smoking, b) were concerned about their smoking, and c) believed that counseling by a clinician would help them to quit smoking (Guydish, Tajima, Chan, Delucchi, & Ziedonis, 2011).

#### 2.2.4. Readiness to quit smoking

Readiness to quit smoking cigarettes was assessed by categorizing participants into one of three stages of change based on Prochaska & DiClemente (Prochaska & DiClemente, 1983): Precontemplation (no intention to quit smoking within the next 6 months), Contemplation (intention to quit smoking within the next 6 months), and Preparation (intention to quit within the next 30 days).

### 2.3. Data analysis

The sample for this analysis comprised 332 participants who reported current cigarette smoking. Bivariate analyses were used to compare those who had ever used e-cigarettes for smoking cessation to those who had never used e-cigarettes for smoking cessation, on demographic variables, substance use, smoking behaviors, readiness to quit smoking, and perceptions of the harms of e-cigarettes. For the questions that asked about attitudes toward quitting smoking, we combined the strongly agree and agree categories to describe percent agreement for each item. For the readiness to quit smoking variable, we collapsed the precontemplation and contemplation stages of change categories. We used the Student's *t*-test for continuous variables and the Pearson's chi-square test or Fisher's exact test for categorical variables. Next, we conducted a multivariable logistic regression analysis to examine independent associations between predictor variables and the dependent variable of ever use versus never use of e-cigarettes for smoking cessation. All variables were included in the model if they were significant at a  $p \leq 0.10$  in the bivariate comparisons (Hosmer & Lemeshow, 2000). The model accounted for nesting clients within treatment program. The generalized estimating equation (GEE) method

was applied for correlated data. SAS software was used to conduct all analyses (SAS version 9.4; Research Triangle Institute).

### 3. Results

#### 3.1. Demographic characteristics and reasons for treatment entry

Among 332 current smokers, the sample was predominantly male with an average age of 37.7 years (SD = 11.4), and a majority had at least a high school education (64.2%). Participants were racially/ethnically diverse [Hispanic/Latino (34.6%), Black/African American (16.9%), White/Caucasian (38%), and other/multiple race (10.5%)]. Participants reported that their primary drug for which they sought treatment was 15.1% alcohol, 46.8% stimulants, 21.8% opioids, 3.9% cannabis, and 2.1% other drugs. While approximately one in ten (10.3%) were not in treatment for SUD. The majority of respondents reported that they were seeking treatment for a SUD alone (62.2%). Demographic information is presented in Table 1 by lifetime ever use vs. never use of e-cigarettes for smoking cessation.

#### 3.2. E-cigarette use and perceptions of e-cigarettes

Almost half (45.2%) had ever used e-cigarettes to quit smoking, and over a third (34.0%) had used e-cigarettes in the past 30 days. Among participants reporting past 30-day use of e-cigarettes 11.6% used e-cigarettes daily, 10% used e-cigarettes weekly, and 12.5% less than once a week. Perceived harmfulness of e-cigarettes as compared with cigarettes for the sample was: 42.3% not as harmful as tobacco cigarettes, 42.9% equally as harmful as tobacco cigarettes, and 14.8% more harmful than tobacco cigarettes.

#### 3.3. Correlates of e-cigarette use as a smoking cessation aid

Bivariate comparisons between ever users of e-cigarettes for smoking cessation and never users are presented in Tables 1 and 2. Ever use of e-cigarettes for smoking cessation was significantly correlated with age ( $p < 0.0001$ ), race/ethnicity ( $p < 0.0001$ ), having more than a high school education ( $p = 0.034$ ), reason for currently seeking treatment ( $p = 0.003$ ), and perceived harmfulness of e-cigarettes ( $p = 0.003$ ). No significant differences between the two groups were found for gender, primary drug of choice, cigarettes per day, smoking days per week, past year quit attempts, readiness to quit smoking, wanting help with quitting smoking, and attitudes about quitting smoking.

#### 3.4. Independent predictors of using e-cigarette as a smoking cessation aid

Results for the multivariable logistic regression model are shown in Table 3. Smokers who had ever used e-cigarettes to quit smoking compared to those who had not were younger (AOR = 0.94, 95% CI: 0.91, 0.96,  $p = 0.0001$ ) and had more than a high school education (AOR = 1.69, 95% CI: 1.07, 2.68,  $p = 0.026$ ). Black/African American and Hispanic/Latino participants were less likely to use e-cigarettes for smoking cessation than White participants. Participants reporting that they sought treatment for both a SUD and mental health disorder were 2.62 times (95% CI: 1.38, 5.00,  $p = 0.003$ ) more likely to have ever used e-cigarettes as a smoking cessation aid as compared with those who sought treatment for an SUD alone. Those who reported wanting help to quit smoking were more likely to have ever used e-cigarettes for smoking cessation (AOR = 1.90, 95% CI: 1.03, 3.50,  $p = 0.040$ ). Participants who perceived that e-cigarettes were equally harmful as compared to tobacco cigarettes were 3.03 times (95% CI: 1.10, 8.33,  $p = 0.032$ ) more likely to have ever used e-cigarettes for quitting smoking. Similarly, participants who perceived that e-cigarettes are not as harmful as compared with tobacco cigarettes were 2.82 times (95% CI: 1.02, 7.77,  $p = 0.045$ ) as likely to have ever used e-cigarettes as a smoking cessation aid.

**Table 1**

Demographics and reason for treatment entry among current cigarette smokers in residential SUD treatment in California who report ever vs. never e-cigarette use for quitting smoking (N = 332).

	Mean (SD) or n (%)			$\lambda^2/t$ (df)	p value
	Total (N = 332)	Smokers reporting ever e-cigarette use for quitting (n = 150)	Smokers reporting never e-cigarette use for quitting (n = 182)		
<b>Demographics</b>					
Age	37.7 (11.4)	33.9 (9.1)	40.7 (12.1)	5.82 (327)	<0.0001
Gender					0.678 <sup>1</sup>
Male	243 (73.6%)	106 (71.6%)	137 (75.3%)		
Female	82 (24.9%)	39 (26.4%)	43 (23.6%)		
Race/ethnicity				21.89 (3)	<0.0001
Hispanic/Latino	115 (34.6%)	45 (30.0%)	70 (38.5%)		
Black/African American	56 (16.9%)	14 (9.3%)	42 (23.1%)		
White/Caucasian	126 (38.0%)	67 (44.7%)	59 (32.4%)		
Other/Multiple	35 (10.5%)	24 (16.0%)	11 (6.0%)		
Education				4.51 (1)	0.034
≤ HS/GED	213 (64.2%)	87 (58.0%)	126 (69.2%)		
> HS	119 (35.8%)	63 (42.0%)	56 (30.8%)		
<b>Primary drug for treatment entry</b>				11.01 (5)	0.051
Alcohol	50 (15.1%)	22 (14.7%)	28 (15.5%)		
Stimulants	155 (46.8%)	71 (47.3%)	84 (46.4%)		
Opioids	72 (21.8%)	39 (26.0%)	33 (18.2%)		
Cannabis	13 (3.9%)	5 (3.3%)	8 (4.4%)		
Other drugs	7 (2.1%)	5 (3.3%)	2 (1.1%)		
Not in treatment for SUD	34 (10.3%)	8 (5.3%)	26 (14.4%)		
<b>Currently in treatment for</b>					0.003 <sup>1</sup>
SUD	206 (62.2%)	87 (58.0%)	119 (65.8%)		
Mental health disorder	6 (1.8%)	3 (2.0%)	3 (1.7%)		
SUD and mental health disorder	92 (27.8%)	54 (36.0%)	38 (21.0%)		
Other	27 (8.2%)	6 (4.0%)	21 (11.6%)		

<sup>1</sup> By Fisher's exact test.

### 4. Discussion

In this study of clients in residential SUD treatment, almost half of current cigarette smokers (45.2%) had ever used e-cigarettes to quit smoking. Results of the multivariable logistic regression showed that smokers who sought treatment for both a SUD and mental health disorder were more than twice as likely to have ever used e-cigarettes as a

**Table 2**

Tobacco use characteristics among current cigarette smokers in residential SUD treatment in California who report ever vs. never e-cigarette use for quitting smoking (N = 332).

	Mean (SD) or n (%)			$\chi^2/t$ (df)	p value
	Total (N = 332)	Smokers reporting ever e- cigarette use for quitting (n = 150)	Smokers reporting never e- cigarette use for quitting (n = 182)		
<b>Cigarette smoking behaviors</b>					
Cigarettes per day (CPD)	9.8 (7.6)	9.9 (7.6)	9.7 (7.6)	0.25 (329)	0.803
Smoking days per week	6.4 (1.5)	6.5 (1.3)	6.3 (1.5)	1.04 (325)	0.299
Past year cigarette quit attempts	193 (58.1%)	88 (58.7%)	105 (57.7%)	0.03 (1)	0.858
Readiness to quit smoking cigarettes				1.75 (1)	0.185
Preparation	105 (31.7%)	42 (28.0%)	63 (34.8%)		
Pre-contemplation and contemplation	226 (68.3%)	108 (72.0%)	118 (65.2%)		
Want help with quitting	123 (37.2%)	63 (42.0%)	60 (33.2%)	2.75 (1)	0.097
<b>Attitudes toward smoking cessation (%Strongly agree)</b>					
Required skills to quit smoking	63 (19.0%)	31 (20.7%)	32 (17.7%)	0.47 (1)	0.491
Concerned about smoking	57 (17.2%)	26 (17.3%)	31 (17.1%)	0.002 (1)	0.961
Counseling by clinician would help quit smoking	40 (12.1%)	20 (13.3%)	20 (11.1%)	0.40 (1)	0.526
<b>Perceived harmfulness of E-cigarettes</b>				11.96 (2)	<b>0.003</b>
Not as harmful as tobacco cigarettes	140 (42.3%)	70 (47.0%)	70 (38.5%)		
Equally as harmful as tobacco cigarettes	142 (42.9%)	68 (45.6%)	74 (40.7%)		
More harmful than tobacco cigarettes	49 (14.8%)	11 (7.4%)	38 (20.9%)		

smoking cessation aid compared to those who sought treatment for an SUD alone. Our finding is consistent with other studies that have found higher rates of e-cigarette ever use among individuals with versus without a mental health disorder (Cummins et al., 2014; Spears et al., 2016). Current smokers who have a mental health disorder may perceive e-cigarettes as an alternate nicotine option compared to traditional tobacco cigarettes. For example, a national survey of US adults found that current smokers with as compared to those without a mental health disorder reported thinking more about the health benefits of using electronic nicotine delivery devices (Spears, Jones, Weaver, Pechacek, & Eriksen, 2018), and a study of chronic smokers with serious mental illness and history of failed treatment-facilitated quit attempts who were provided with e-cigarettes for 4 weeks found high ratings of enjoyment, satisfaction, and willingness to buy e-cigarettes (Pratt, Sargent, Daniels, Santos, & Brunette, 2016). It is also possible that individuals with mental health disorders may be using e-cigarettes to self-medicate psychiatric symptoms or to alleviate the side effects of psychiatric medications. A qualitative study of social media posts that examined the use of e-cigarettes among people with mental illness found that vapers used

**Table 3**

Factors associated with using e-cigarette as a smoking cessation aid among current cigarette smokers in residential SUD treatment in California who report ever vs. never e-cigarette use for quitting smoking (N = 294)<sup>2</sup>.

	Adjusted OR (95%CI)	p value <sup>1</sup>
Age	0.94 (0.91, 0.96)	<0.0001
<b>Race/ethnicity</b>		
White	1	
Hispanic/Latino	0.49 (0.25, 0.97)	<b>0.042</b>
Black or African American	0.33 (0.18, 0.61)	<0.001
Other/Multiple race	2.48 (0.99, 6.21)	<b>0.053</b>
<b>Education</b>		
≤ HS/GED	1	
>HS	1.69 (1.07, 2.68)	<b>0.026</b>
<b>Primary drug for treatment entry</b>		
Stimulant	1	
Alcohol	1.13 (0.53, 2.42)	0.745
Opiates	1.26 (0.62, 2.56)	0.517
Cannabis	0.57 (0.11, 3.03)	0.514
Other	1.03 (0.21, 5.16)	0.972
<b>Currently in treatment for SUD alone</b>		
Both SUD and mental health disorder	2.62 (1.38, 5.00)	<b>0.003</b>
<b>Want help with quitting</b>		
No	1	
Yes	1.90 (1.03, 3.50)	<b>0.040</b>
<b>Perceived harmfulness of e-cigarettes</b>		
More harmful than tobacco cigarettes	1	
Equally harmful than tobacco cigarettes	3.03 (1.10, 8.33)	<b>0.032</b>
Not as harmful than tobacco cigarettes	2.82 (1.02, 7.77)	<b>0.045</b>

<sup>1</sup> Logistic regression with clients nested within clinic.

<sup>2</sup> Four cases had missing values for covariates.

e-cigarettes to alleviate stress and psychiatric symptoms such as anxiety, depression, intrusive thoughts, and to offset the side effects of prescribed psychotropic medications (Sharma, Wigginton, Meurk, Ford, & Gartner, 2016).

Other noteworthy results included that current cigarette smokers who perceived that e-cigarettes were not as harmful or equally as harmful as tobacco cigarettes were more likely to have ever used e-cigarettes as a smoking cessation aid. The finding that some current smokers perceived e-cigarettes to be as harmful as tobacco cigarettes yet used them to quit smoking may appear counterintuitive. However, a possible explanation for this finding may be that beyond perceived risk, having more positive affect toward e-cigarettes may have motivated its use for quitting smoking. In a nationally representative sample of US adults who were aware of e-cigarettes, Popova and colleagues (Popova et al., 2018) found that images related to risk and disgust were frequently associated with cigarettes (35% and 23%, respectively), but were less common for e-cigarettes (11% and 14%). Moreover, they found that lower perceived risks of using e-cigarettes daily was associated with having more positive affect toward e-cigarettes, which in turn was associated with a higher likelihood of being a current e-cigarette user. Thus, in weighing the risks and benefits, a favorable attitude toward e-cigarettes may influence cigarette smokers' decision-making about whether to use e-cigarettes for quitting smoking.

Our finding that younger cigarette smokers were more likely to use e-cigarettes for smoking cessation is consistent with previous studies conducted with individuals receiving SUD treatment that have found younger age to be associated with ever using e-cigarettes (Gubner et al., 2016; Peters et al., 2015). Although our findings for education and race/ethnicity have wide confidence intervals, these findings are consistent with results of recent population studies demonstrating a greater reach of e-cigarette use among older adolescents and younger adults, those with higher education attainment, and people of White ethnicity (Pericot-Valverde et al., 2017; Harlow et al., 2019). Future research among patients in SUD treatment focusing specifically on e-cigarette users to examine the sociodemographic and substance use characteristics of those who have successfully quit smoking would be helpful in



monitoring potential disparities in smoking cessation outcomes (Hartwell, Thomas, Egan, Gilmore, & Petticrew, 2017).

Dual use of e-cigarettes and tobacco cigarettes was higher than what has been documented among some other samples of individuals with SUDs (Gubner et al., 2016; Baldassarri et al., 2019; Wang-Schweig et al., 2019). Dual use of e-cigarettes and tobacco cigarettes among vulnerable populations such as those with SUDs and mental illness has raised concerns about the potential of e-cigarettes to maintain nicotine dependence (Spears et al., 2018; Hefner et al., 2017). Dual users have higher exposure to nicotine and tobacco-related toxicants (Goniewicz et al., 2018), and an increased risk for the adverse health effects associated with the combined use of these products as compared with smoking alone (Osei et al., 2019). Moreover, users of nicotine delivery systems including e-cigarettes who also use other tobacco products are less likely to discontinue all tobacco use as compared with exclusive users of electronic nicotine delivery systems (Stanton et al., 2020). A recent randomized clinical trial that compared the effectiveness of e-cigarettes and nicotine replacement therapy (NRT), including product combinations for smoking cessation found that the 1-year abstinence rate was 18.0% in the e-cigarette group, as compared with 9.9% in the NRT group (Hajek et al., 2019). However, among participants with 1-year abstinence, those in the e-cigarette group were more likely than those in the NRT group to use their assigned product at the 1 year follow up (80% vs. 9%, respectively). Given the high prevalence of dual use of e-cigarettes and tobacco cigarettes among SUD treatment patients, it is critical for clinicians to ask patients not only about cigarette smoking but about all tobacco product use (Darville & Hahn, 2019). Counseling messages for patients in SUD treatment programs should also include information about the potential harms of the dual use e-cigarettes and tobacco cigarettes and use of other tobacco products, and evidence of the effectiveness of FDA-approved smoking cessation medications that have proven effective in helping individuals quit smoking, particularly when used in combination with behavioral counseling (Darville & Hahn, 2019).

Limitations of the study should be noted. The present study consisted mostly of men recruited from residential SUD treatment programs in a single state potentially limiting the generalizability of our findings to smokers living in other geographic regions of the country. However, our findings are similar to other studies of clients receiving SUD treatment (Gubner et al., 2016; Baldassarri et al., 2019; Campbell et al., 2019), increasing our confidence that use of e-cigarettes is common in this population, and is viewed by SUD clients as an acceptable method for quitting smoking. Our study examined self-reported mental health status, and did not examine differences in prevalence of e-cigarette use for smoking cessation across psychiatric diagnoses, because psychiatric diagnoses were not collected for all participants.

## 5. Conclusions

The use of e-cigarettes as a smoking cessation aid is common among individuals enrolled in residential SUD treatment programs, as is the concurrent use of e-cigarettes and tobacco cigarettes. Persons in SUD treatment with co-occurring mental health needs may be at higher risk of e-cigarette use. Future research should examine the characteristics of smokers who use e-cigarettes as a smoking cessation aid, their preferences for e-cigarette product types and specific attributes, and tobacco cigarette quit success in larger samples of clients enrolled in SUD treatment.

CM conceptualized the study and wrote the first draft of the paper. TH conducted all statistical analyses. SH contributed to data collection and management. KF and MS contributed to literature searches and provided input in editing the manuscript. NH contributed to the conceptualization of the analysis and provided feedback for all drafts. JG conceptualized, acquired funding, and supervised the study. All authors contributed to and have approved the final manuscript.

## 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.

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## References

- Baldassarri, S. R., Fiellin, D. A., Savage, M. E., Madden, L. M., Beitel, M., Dhingra, L. K., et al. (2019). Electronic cigarette and tobacco use in individuals entering methadone or buprenorphine treatment. *Drug and Alcohol Dependence*, *197*, 37–41. <https://doi.org/10.1016/j.drugalcdep.2018.12.012>.
- Bhatnagar, A., Payne, T. J., & Robertson, R. M. (2019). Is There A Role for Electronic Cigarettes in Tobacco Cessation? *Journal of American Heart Association*, *8*(12), Article e012742. <https://doi.org/10.1161/JAHA.119.012742>.
- Campbell, B. K., Le, T., Gubner, N. R., & Guydish, J. (2019). Health risk perceptions and reasons for use of tobacco products among clients in addictions treatment. *Addictive Behaviors*, *91*, 149–155. <https://doi.org/10.1016/j.addbeh.2018.08.037>.
- Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. Smoking Cessation. A Report of the Surgeon General. Published online 2020.
- Chun, L. F., Moazed, F., Calfee, C. S., Matthay, M. A., & Gotts, J. E. (2017). Pulmonary toxicity of e-cigarettes. *American Journal of Physiology. Lung Cellular and Molecular Physiology*, *313*(2), L193–L206. <https://doi.org/10.1152/ajplung.00071.2017>.
- Collins, L., Glasser, A. M., Abudayyeh, H., Pearson, J. L., & Villanti, A. C. (2019). E-cigarette marketing and communication: How E-Cigarette Companies Market E-Cigarettes and the Public Engages with E-cigarette Information. *Nicotine & Tobacco Research*, *21*(1), 14–24. <https://doi.org/10.1093/ntr/ntx284>.
- Cornelius, M. E., Wang, T. W., Jamal, A., Loretan, C. G., & Neff, L. J. (2020). Tobacco Product Use Among Adults - United States, 2019. *MMWR. Morbidity and Mortality Weekly Report*, *69*(46), 1736–1742. <https://doi.org/10.15585/mmwr.mm6946a4>.
- Creamer, M. R., Wang, T. W., Babb, S., Cullen, K. A., Day, H., Willis, G., et al. (2019). Tobacco product use and cessation indicators among Adults - United States, 2018. *MMWR. Morbidity and Mortality Weekly Report*, *68*(45), 1013–1019. <https://doi.org/10.15585/mmwr.mm6845a2>.
- Cummins, S. E., Zhu, S.-H., Tedeschi, G. J., Gamst, A. C., & Myers, M. G. (2014). Use of e-cigarettes by individuals with mental health conditions. *Tob Control*, *23*(suppl 3), iii48–iii53. <https://doi.org/10.1136/tobaccocontrol-2013-051511>.
- Darville, A., & Hahn, E. J. (2019). E-cigarettes and Atherosclerotic Cardiovascular Disease: What Clinicians and Researchers Need to Know. *Current Atheroscler Report*, *21*(5), 15. <https://doi.org/10.1007/s11883-019-0777-7>.
- Goniewicz, M. L., Smith, D. M., Edwards, K. C., Blount, B. C., Caldwell, K. L., Feng, J., et al. (2018). Comparison of Nicotine and Toxicant Exposure in Users of Electronic Cigarettes and Combustible Cigarettes. *JAMA Network Open*, *1*(8), e185937. <https://doi.org/10.1001/jamanetworkopen.2018.5937>.
- Gubner, N. R., Andrews, K. B., Mohammad-Zadeh, A., Lisha, N. E., & Guydish, J. (2016). Electronic-cigarette use by individuals in treatment for substance abuse: A survey of 24 treatment centers in the United States. *Addictive Behaviors*, *63*, 45–50. <https://doi.org/10.1016/j.addbeh.2016.06.025>.
- Guydish, J., Tajima, B., Chan, M., Delucchi, K. L., & Ziedonis, D. (2011). Measuring smoking knowledge, attitudes and services (S-KAS) among clients in addiction treatment. *Drug and Alcohol Dependence*, *114*(2–3), 237–241. <https://doi.org/10.1016/j.drugalcdep.2010.09.017>.
- Hajek, P., Phillips-Waller, A., Przulj, D., Pesola, F., Myers Smith, K., Bisal, N., et al. (2019). A Randomized Trial of E-Cigarettes versus Nicotine-Replacement Therapy. *New England Journal of Medicine*, *380*(7), 629–637. <https://doi.org/10.1056/NEJMoa1808779>.
- Harlow, A. F., Stokes, A., & Brooks, D. R. (2019). Socioeconomic and Racial/Ethnic Differences in E-Cigarette Uptake Among Cigarette Smokers: Longitudinal Analysis of the Population Assessment of Tobacco and Health (PATH) Study. *Nicotine Tob Res Off J Soc Res Nicotine Tob.*, *21*(10), 1385–1393. <https://doi.org/10.1093/ntr/nty141>.
- Hartwell, G., Thomas, S., Egan, M., Gilmore, A., & Petticrew, M. (2017). E-cigarettes and equity: A systematic review of differences in awareness and use between

- sociodemographic groups. *Tobacco Control*, 26(e2), e85–e91. <https://doi.org/10.1136/tobaccocontrol-2016-053222>.
- Hefner, K., Valentine, G., & Sofuoglu, M. (2017). Electronic cigarettes and mental illness: Reviewing the evidence for help and harm among those with psychiatric and substance use disorders. *American Journal on Addictions*, 26(4), 306–315. <https://doi.org/10.1111/ajad.v26.410.1111/ajad.12504>.
- Hosmer, D. W., & Lemeshow, S. (2000). *Applied Logistic Regression* (2nd ed.). Wiley.
- National Academies of Sciences, Engineering, and Medicine, Health and Medicine Division, Board on Population Health and Public Health Practice, Committee on the Review of the Health Effects of Electronic Nicotine Delivery Systems. Public Health Consequences of E-Cigarettes. (Eaton DL, Kwan LY, Stratton K, eds.) National Academies Press (US); 2016. Accessed May 4, 2020. <http://www.ncbi.nlm.nih.gov/books/NBK507171/>.
- Osei, A. D., Mirbolouk, M., Orimoloye, O. A., Dzaye, O., Uddin, S. M. I., Benjamin, E. J., et al. (2019). Association Between E-Cigarette Use and Cardiovascular Disease Among Never and Current Combustible-Cigarette Smokers. *American Journal of Medicine*, 132(8), 949–954.e2. <https://doi.org/10.1016/j.amjmed.2019.02.016>.
- Patel, D., Davis, K. C., Cox, S., Bradfield, B., King, B. A., Shafer, P., et al. (2016). Reasons for current E-cigarette use among U.S. adults. *Preventive Medicine*, 93, 14–20. <https://doi.org/10.1016/j.ypmed.2016.09.011>.
- Pericot-Valverde, I., Gaalema, D. E., Priest, J. S., & Higgins, S. T. (2017). E-cigarette awareness, perceived harmfulness, and ever use among U.S. adults. *Preventive Medicine*, 104, 92–99. <https://doi.org/10.1016/j.ypmed.2017.07.014>.
- Peters, E. N., Harrell, P. T., Hendricks, P. S., O'Grady, K. E., Pickworth, W. B., & Vocci, F. J. (2015). Electronic cigarettes in adults in outpatient substance use treatment: Awareness, perceptions, use, and reasons for use. *American Journal on Addictions*, 24(3), 233–239. <https://doi.org/10.1111/ajad.v24.310.1111/ajad.12206>.
- Popova, L., Owusu, D., Weaver, S. R., Kemp, C. B., Mertz, C. K., Pechacek, T. F., et al. (2018). Affect, risk perception, and the use of cigarettes and e-cigarettes: A population study of U.S. adults. *BMC Public Health*, 18(1). <https://doi.org/10.1186/s12889-018-5306-z>.
- Pratt, S. I., Sargent, J., Daniels, L., Santos, M. M., & Brunette, M. (2016). Appeal of electronic cigarettes in smokers with serious mental illness. *Addictive Behaviors*, 59, 30–34. <https://doi.org/10.1016/j.addbeh.2016.03.009>.
- Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change of smoking: Toward an integrative model of change. *Journal of Consulting and Clinical Psychology*, 51(3), 390–395. <https://doi.org/10.1037//0022-006x.51.3.390>.
- Sapru, S., Vardhan, M., Li, Q., Guo, Y., Li, X., & Saxena, D. (2020). E-cigarettes use in the United States: Reasons for use, perceptions, and effects on health. *BMC Public Health*, 20(1), 1518. <https://doi.org/10.1186/s12889-020-09572-x>.
- Sharma, R., Wigginton, B., Meurk, C., Ford, P., & Gartner, C. (2016). Motivations and Limitations Associated with Vaping among People with Mental Illness: A Qualitative Analysis of Reddit Discussions. *International Journal of Environmental Research and Public Health*, 14(1), 7. <https://doi.org/10.3390/ijerph14010007>.
- Spears CA, Jones DM, Weaver SR, Pechacek TF, Eriksen MP. Use of Electronic Nicotine Delivery Systems among Adults with Mental Health Conditions, 2015. *Int J Environ Res Public Health*. 2016;14(1). doi:10.3390/ijerph14010010.
- Spears, C. A., Jones, D. M., Weaver, S. R., Pechacek, T. F., & Eriksen, M. P. (2018). Motives and perceptions regarding electronic nicotine delivery systems (ENDS) use among adults with mental health conditions. *Addictive Behaviors*, 80, 102–109. <https://doi.org/10.1016/j.addbeh.2018.01.014>.
- Stanton, C. A., Sharma, E., Edwards, K. C., Halenar, M. J., Taylor, K. A., Kasza, K. A., et al. (2020). Longitudinal transitions of exclusive and polytobacco electronic nicotine delivery systems (ENDS) use among youth, young adults and adults in the USA: Findings from the PATH Study Waves 1–3 (2013–2016). *Tobacco Control*, 29 (Suppl 3), s147–s154. <https://doi.org/10.1136/tobaccocontrol-2019-055574>.
- Stein, M. D., Caviness, C. M., Grimone, K., Audet, D., Borges, A., & Anderson, B. J. (2015). E-cigarette knowledge, attitudes, and use in opioid dependent smokers. *Journal of Substance Abuse Treatment*, 52, 73–77. <https://doi.org/10.1016/j.jsat.2014.11.002>.
- Wang-Schweig, M., Jason, L. A., Stevens, E., & Chaparro, J. (2019). Tobacco Use among Recovery Home Residents: Vapers Less Confident to Quit. *American Journal of Health Behaviour*, 43(6), 1064–1074. <https://doi.org/10.5993/AJHB.43.6.5>.
- Guydish, Joseph, Kapiteni, Kwinoja, Le, Thao, Campbell, Barbara, Pinsker, Erika, & Delucchi, Kevin (2020). Tobacco use and tobacco services in California substance use treatment programs. *Drug and Alcohol Dependence*, 214, 1–7. <https://doi.org/10.1016/j.drugalcdep.2020.108173>.