

# Factors Associated with Regular Nicotine Salt Pod System Use Among Adult Smokers Abstaining from Combustible Cigarettes

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## Objectives

- Multiple studies<sup>1,2,3</sup> of adult smokers analyzing longitudinal data sources, including the U.S. National Institutes of Health (NIH) and Food and Drug Administration (FDA) Population Assessment of Tobacco and Health (PATH) Study, and population-level data from the U.S. Census Tobacco-Use Supplement, have found a positive association between regular use of Electronic Nicotine Delivery Systems (ENDS) and abstinence from combustible cigarettes among adult smokers who use ENDS
- Little is known about the characteristics of adult smokers who successfully switch entirely from cigarettes after initiating ENDS use and then use ENDS regularly as a nicotine alternative
- This study assessed factors associated with daily use of the Nicotine Salt Pod Systems (NSPS, JUUL Labs, Inc., San Francisco, CA), a type of ENDS, among adult smokers who abstained from smoking cigarettes 6 months after initiating NSPS use, compared to those who continued smoking cigarettes

## Methods

- Sample: Data from 18,834 current adult smokers aged  $\geq 21$ 
  - Smoked in past 30 days prior to NSPS purchase
  - Purchased an NSPS starter kit via retail or e-commerce between May - October 2018
  - Provided valid data on cigarette smoking and NSPS use at baseline and 180-day follow-up assessment
- At baseline, individual-level attributes shown to be associated with smoking status including, demographics, smoking history and characteristics, motivation for NSPS purchase, previous ENDS-use and other characteristics were assessed.
  - Survey questions closely reflected language from analogous surveys of tobacco product users by the FDA.
- Frequency and intensity of use of combustible cigarettes and NSPS products were reassessed at 180-days post baseline. Participants were defined as "complete switchers" at follow-up if they reported having smoked no cigarettes, not even a puff, in the last 30 days.
- The sample was stratified by switching status at 180 days; associations between baseline characteristics and daily/non-daily NSPS use at 180-days in each subgroup were assessed with logistic regression models.
- Each sample was randomly divided into independent training (67% of sample) and validation (33% of sample) data sets for logistic regression modeling. The training sample was used to derive the model, while the remaining data were used to evaluate the predictive ability of the final model.
- Survey approach was authorized by the ethical review committee of the Advarra Institutional Review Board (Columbia, MD, USA); all analyses were conducted in Python.

- Daily smoking at baseline (aOR = 1.8, CI = 1.3-2.4) was also a predictive feature in the switching subgroup.
- Smoking greater than 0-5 CPD at baseline also seemed predictive of daily NSPS use, although this association was attenuated and no longer significant among those smoking 15+ CPD.
- Logistic models from training samples performed well in validation samples, and accuracy scores averaged 0.68 (Figure 1).
- Among non-switchers, far fewer baseline variables were predictive of daily NSPS use in the logistic regression.
- Similar to the switchers subgroup, smoking 10-20 years at baseline (aOR = 1.6, CI = 1.0 - 2.6) was associated with daily NSPS use at 180-days in the non-switching subgroup as compared to those smoking <1 year at baseline, however this association was not significant for those smoking 20+ years.
- In contrast to the switching subgroup, risk perceptions were associated with NSPS use, which those citing that they purchased the NSPS because they believed it to be less harmful than cigarettes having increased odds of daily use (aOR = 1.4, CI = 1.1 - 1.8).
- Logistic models from training samples performed slightly less well in validation samples as compared to the switcher group (accuracy scores averaging 0.60) (Figure 1).

**Table 1.** Key univariate differences among baseline characteristics between daily/non-daily NSPS users who switched from smoking at 180 days as compared to those who continue to smoke in efficacy sample<sup>A</sup>

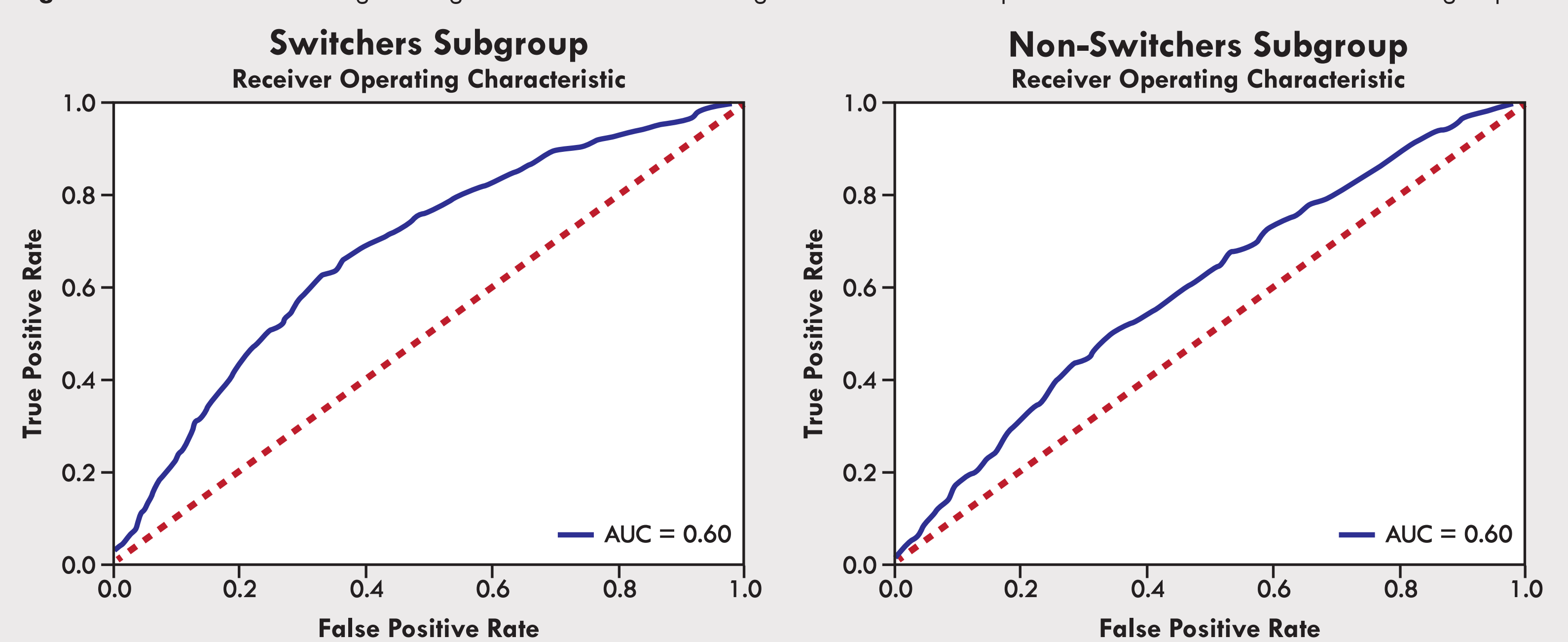
Covariate at Baseline	"Switchers" Smokers at Baseline Switching at 180 Days (55% of Baseline Smokers) N = 10,359			"Non-Switchers" Smokers at Baseline Still Smoking at 180 Days (45% of Baseline Smokers) N = 8,475		
	Daily NSPS Users at 180 days (%)	Non-Daily NSPS Users at 180 days (%)	Significant difference (p < 0.05)	Daily NSPS Users at 180 days (%)	Non-Daily NSPS Users at 180 days (%)	Significant difference (p < 0.05)
Age			*			*
21-24	31	51		25	31	
25-34	37	32		36	34	
35-44	19	11		22	20	
45-64	12	6		16	14	
65+	0.6	0.3		1.0	1.4	
Male	55	63	*	54	54	
White	83	81	*	83	83	
Baseline Cigarettes Per Day			*			*
0-5 CPD	38	61		26	33	
6-10 CPD	27	20		28	25	
11-15 CPD	14	7		17	16	
16-20 CPD	17	9		23	19	
20+ CPD	4	3		7	7	
Days Smoked Per Month			*			*
1-9 Days	17	38		9	14	
10-19 Days	12	17		8	12	
20-29 Days	21	21		20	20	
All 30 Days	49	25		63	54	
Years Smoked			*			*
<1 year	10	25		7	11	
1-5 years	25	35		18	22	
5-10 years	24	19		23	21	
10-20 years	20	11		22	18	
20+ years	21	10		30	27	
Menthol Smoker	25	21	*	29	29	
Previous ENDS User	60	55	*	70	67	
Overall Health Status			*			*
Good	41	44		34	34	
Fair	57	55		64	63	
Poor	2	2		3	3	
Motivation for Purchase						
To Quit Smoking (reference: No)	87	73	*	85	81	*
Believe to be less harmful than cigarettes to others around me (reference: No)	74	71	*	73	69	*
Believe to be less harmful than cigarettes to me (reference: No)	78	76	*	76	72	*
Comes in flavors I like (reference: No)	55	61	*	47	47	
More affordable than cigarettes (reference: No)	65	57	*	65	62	*
Has helped others I know quit smoking (reference: No)	66	57	*	65	60	*

<sup>A</sup>Note: Selected covariates only; descriptive statistics for full set of covariates available upon request

## Results

- Table 1** presents data from univariate comparisons of daily/non-daily NSPS users stratified by switching status at 180-day follow-up.
  - Overall, 55% of smokers who were assessed at baseline and 180 days had switched entirely from cigarettes for 30 or more days prior to the 180-day assessment.
  - Among switchers, daily NSPS users (vs. non-daily users) were more likely to be male, daily smokers, have a smoking history of >10 years, have tried another ENDS product previously, and cite desire to quit smoking cigarettes and affordability as reasons for their purchase of the NSPS product.
  - Among non-switchers, significantly less variability was seen among daily vs. non-daily NSPS users, in terms of gender, health status or previous ENDS product use. Daily users (vs. non-daily users) in this subgroup were also more likely to have been daily smokers who had smoked for >10 years and cite affordability and risk perceptions as reasons for NSPS product purchase.
- For switchers, baseline variables predictive of daily NSPS use in the logistic regression models included covariates such as cigarettes per day (CPD), number of days smoked in month prior to baseline, years smoked, age and overall health status (Table 2).
  - Smoking for >20 years (aOR = 2.7, CI = 1.5-4.9), smoking for 10-20 years (aOR = 1.8, CI = 1.2-2.8) and smoking for 5-10 years (aOR = 1.5, CI = 1.1-2.3) was associated with daily NSPS use, as compared to switchers who smoked for <1 year.

**Figure 1.** ROC Curve from Logistic Regression Models on Training and Validation Samples in Switcher and Non-Switcher Subgroups



**Table 2.** Results from Logistic Regression among Switchers on the Training Cohort: Parameter Estimates and Odds Ratios for Most Important Features

Parameter	Odds Ratio	95% CI for aOR	P value
Age			
21-24		Reference Category	
25-34	1.50	[1.15-1.96]	0.0028
35-44	1.35	[0.89-2.05]	0.1547
45-64	0.97	[0.56-1.69]	0.9185
65+	0.96	[0.18-5.21]	0.9619
Male	0.83	[0.68-1.02]	0.0736
White	1.02	[0.74-1.41]	0.9058
Baseline Cigarettes Per Day			
0-5 CPD		Reference Category	
6-10 CPD	1.32	[1.02-1.70]	0.0352
11-15 CPD	1.63	[1.14-2.33]	0.0074
16-20 CPD	1.05	[0.75-1.48]	0.7570
20+ CPD	0.90	[0.50-1.59]	0.7074
Days Smoked Per Month			
1-9 Days		Reference Category	
10-19 Days	1.21	[0.87-1.68]	0.2484
20-29 Days	1.17	[0.87-1.58]	0.2980
All 30 Days	1.77	[1.29-2.43]	0.0004
Years Smoked			
<1 year		Reference Category	
1-5 years	1.11	[0.80-1.54]	0.5387
5-10 years	1.55	[1.06-2.26]	0.0224
10-20 years	1.80	[1.15-2.83]	0.0102
20+ years	2.70	[1.50-4.86]	0.0009
Menthol Smoker	1.01	[0.83-1.22]	0.9377
Previous ENDS User	0.93	[0.76-1.13]	0.4478
Overall Health Status <sup>A</sup>	1.22	[1.01-1.48]	0.0358
Motivation for Purchase			
To Quit Smoking (reference: No)	0.76	[0.48-1.20]	0.2463
Believe to be less harmful than cigarettes to others around me (reference: No)	0.91	[0.68-1.21]	0.5069
Believe to be less harmful than cigarettes to me (reference: No)	1.10	[0.80-1.43]	0.6483
Comes in flavors I like (reference: No)	0.78	[0.60-1.02]	0.0645
More affordable than cigarettes (reference: No)	1.05	[0.84-1.32]	0.6810
Has helped others I know quit smoking (reference: No)	1.04	[0.83-1.30]	0.7329

**Table 3.** Results from Logistic Regression among Non-Switchers on the Training Cohort: Parameter Estimates and Odds Ratios for Most Important Features

Parameter	Odds Ratio	95% CI for aOR	P value
Age			
21-24		Reference Category	
25-34	1.05	[0.80-1.38]	0.7433
35-44	0.85	[0.57-1.26]	0.4186
45-64	1.08	[0.67-1.76]	0.7426
65+	0.81	[0.33-1.99]	0.6483
Male	0.98	[0.82-1.17]	0.8312
White	0.69	[0.51-0.94]	0.0164
Baseline Cigarettes Per Day			
0-5 CPD		Reference Category	
6-10 CPD	0.92	[0.71-1.19]	0.5226
11-15 CPD	0.92	[0.68-1.25]	0.5965
16-20 CPD	0.95	[0.69-1.29]	0.7263
20+ CPD	0.79	[0.53-1.20]	0.2710
Days Smoked Per Month			
1-9 Days		Reference Category	
10-19 Days	0.98	[0.66-1.46]	0.9243
20-29 Days	1.27	[0.88-1.83]	0.1962
All 30 Days	1.32	[0.92-1.91]	0.1352
Years Smoked			
<1 year		Reference Category	
1-5 years	1.07	[0.72-1.58]	0.7482
5-10 years	1.49	[0.98-2.27]	0.0631
10-20 years	1.61	[1.01-2.57]	0.0442
20+ years	1.43	[0.83-2.47]	0.1937
Menthol Smoker	0.97	[0.81-1.15]	0.7267
Previous ENDS User	1.06	[0.87-1.28]	0.5660
Overall Health Status <sup>A</sup>	1.10	[0.92-1.30]	0.2931
Motivation for Purchase			
To Quit Smoking (reference: No)	0.88	[0.58-1.35]	0.5716
Believe to be less harmful than cigarettes to others around me (reference: No)	0.97	[0.75-1.24]	0.7877
Believe to be less harmful than cigarettes to me (reference: No)	1.40	[1.1-1.79]	0.0066
Comes in flavors I like (reference: No)	1.05	[0.83-1.33]	0.6872
More affordable than cigarettes (reference: No)	0.95	[0.78-1.16]	0.6041
Has helped others I know quit smoking (reference: No)	1.03	[0.85-1.25]	0.7785

<sup>A</sup>Highlighted cells indicate statistically significant predictors of daily use

## Conclusion

- This study provides new longitudinal data on attributes associated with regular NSPS use among smokers who switch from combustible cigarettes as compared to those who do not.
- Baseline smoking history (i.e., number of years smoked) and smoking characteristics (number of days smoked in past 30-days) were significantly associated with daily NSPS use (vs. non-daily use) in both the switcher and non-switcher samples.
- Interestingly, motivation for purchasing NSPS was largely not predictive of use at 180 days.
- Identifying factors associated with NSPS use and switching behavior may inform and support the development of behavior change interventions and techniques designed to aid smokers in switching from the use of combustible cigarettes to alternative nicotine-delivery products, especially where other techniques they have tried have been unsuccessful.

<sup>1</sup>Russell, C., Haseen, F., & McKeganey, N. (2019). Factors associated with past 30-day abstinence from cigarette smoking in a non-probabilistic sample of 15,456 adult established current smokers in the United States who used JUUL vapor products for three months. Harm Reduction Journal.

<sup>2</sup>Kalkhoran, S., Chang, Y., & Rigotti, N. A. (2019). Electronic Cigarette Use and Cigarette Abstinence Over Two Years among US Smokers in the Population Assessment of Tobacco and Health Study. Nicotine & Tobacco Research.

<sup>3</sup>Zhu, S. H., Zhuang, Y. L., Wong, S., Cummins, S. E., & Tedeschi, G. J. (2017). E-cigarette use and associated changes in population smoking cessation: evidence from US current population surveys. British Medical Journal, 358, j3262.