# Factors Associated with Regular JL ENDS Use Among Adult Smokers Abstaining from Combustible Cigarettes

Prakash S, MSc, PhD; Goldenson N, PhD; Le GM, PhD, MHS; Vose JG, MD, MBA; Augustson E, PhD, MPH

JUUL Labs, Inc., San Francisco, CA, USA

## Objectives

- Multiple studies[1,2,3] of adult smokers analyzing longitudinal data sources, including the 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 JL ENDS (JUUL Labs, Inc., San Francisco, CA), a type of ENDS, among adult smokers who abstained from smoking cigarettes 6 months after initiating JL ENDS use, compared to those who continued smoking cigarettes.

## Methods

- Sample: Data from 18,834 current adult smokers aged ≥ 21.
  - Smoked in past 30 days prior to JL ENDS purchase.
  - Purchased an JL ENDS Starter Kit via retail or e-commerce between May - October 2018.
  - Provided valid data on cigarette smoking and JL ENDS use at baseline and 6 month follow-up assessment.
- At baseline, individual-level attributes shown to be associated with smoking status including demographics, smoking history and characteristics, motivation for JL ENDS 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 JL ENDS products were reassessed at 6 and 12 months 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 6 months; associations between baseline characteristics and daily/non-daily JL ENDS use at 6 months in each subgroup were assessed with logistic regression models. Analyses were repeated at 12 months.
- 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.

## Results

- **Table 1** presents data from univariate comparisons of daily/non-daily JL ENDS users stratified by switching status at 6 month follow-up.
  - Overall, 55% of smokers who were assessed at baseline and 6 months had switched entirely from cigarettes for 30 or more days prior to the 6 months assessment.
  - Among switchers, daily JL ENDS 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 JL ENDS product.
  - Among non-switchers, significantly less variability was seen among daily vs. non-daily JL ENDS 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 JL ENDS product purchase.
- For switchers, baseline variables predictive of daily JL ENDS 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 (Adjusted Odds Ratio (aOR) = 2.7, Confidence Interval (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 JL ENDS use, as compared to switchers who smoked for <1 year.
  - 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 was predictive of daily JL ENDS 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 JL ENDS 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 JL ENDS use at 6 months 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 JL ENDS use, with those citing that they purchased the JL ENDS because they believed it to be less harmful than cigarettes having increased odds of daily use (aOR = 1.4, CI = 1.1 – 1.8). Results were consistent when assessed using 12 month follow-up outcome rather than 6 month follow-up.
  - 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 JL ENDS who switched from smoking at 6 months as compared to those who continue to smoke in efficacy sample^

| | "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 | | |
|---|---|---|---|---|---|---|
| Covariate at Baseline | Daily JL ENDS Users at 6 Months (%) | Non-Daily JL ENDS Users at 6 Months (%) | Significant difference ($p < 0.05$) | Daily JL ENDS Users at 6 Months (%) | Non-Daily JL ENDS Users at 6 Months (%) | 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 | 87% | 73% | * | 85% | 81% | * |
| Believe to be less harmful than cigarettes to others around me | 74% | 71% | * | 73% | 69% | * |
| Believe to be less harmful than cigarettes to me | 78% | 76% | * | 76% | 72% | * |
| Comes in flavors I like | 55% | 61% | * | 47% | 47% | |
| More affordable than cigarettes | 65% | 57% | * | 65% | 62% | * |
| Has helped others I know quit smoking | 66% | 57% | * | 65% | 60% | * |

^Note: Selected covariates only; descriptive statistics for full set of covariates available upon request

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

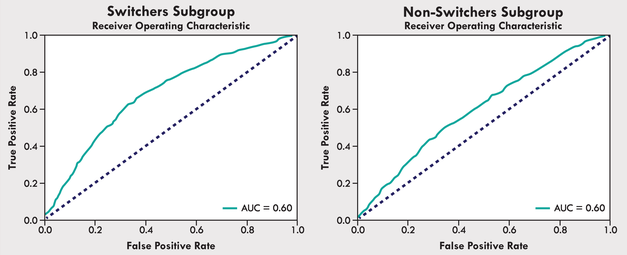
| Parameter | Odds Ratio | 95% CI for aOR | P value |
|---|---|---|---|
| **Age** | | | |
| 21-24 | | Reference Category | |
| 25-34 | 1.50 | [1.15-1.96] | 0.0028 |
| 35-44 | 1.35 | [0.89-2.05] | 0.1547 |
| 45-64 | 0.97 | [0.56-1.69] | 0.9185 |
| 65+ | 0.96 | [0.18-5.21] | 0.9619 |
| **Male** | 0.83 | [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^** | 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^** | 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 |

*Highlighted cells indicate statistically significant predictors of daily use

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




## Conclusions

- This study provides new longitudinal data on attributes associated with regular JL ENDS 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 JL ENDS use (vs. non-daily use) in both the switcher and non-switcher samples.
- Motivation for purchasing JL ENDS was largely not predictive of use at 6 months.

[1]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.
[2]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
[3]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.