# Differences in Rates of Adult Smokers Switching Away from Smoking using JUUL System Products, Across Jurisdictions with Different Maximum Nicotine Concentrations (North America and the United Kingdom)

Saul Shiffman,<sup>1</sup> Nicholas I. Goldenson,<sup>2</sup> Yu Ding,<sup>2</sup> Shivaani Prakash,<sup>2</sup> Cameron Hatcher,<sup>2</sup> Erik M. Augustson<sup>2</sup>

## Introduction

- Electronic nicotine delivery systems (ENDS), such as the JUUL System (JS; Juul Labs, Inc.), can potentially benefit public health by helping adult smokers switch away from combustible cigarettes
- Conceptually, switching should be facilitated when ENDS provide adequate nicotine delivery<sup>1-3</sup>
- The European Union's Revision of the Tobacco Products Directive (EU TPD) limits the maximum nicotine concentration for ENDS to  $20 \text{ mg/mL}^4$
- The primary aim of this study was to assess switching rates with JS in jurisdictions with such nicotine limits and jurisdictions without such limits, specifically:
- The United Kingdom (UK), limited to 20 mg/mL by EU TPD where JS is available in 18 mg/mL and 9 mg/mL nicotine concentrations; compared to
- North America (United States [US] and Canada) where JS is available in 59 mg/mL and 35 mg/mL nicotine concentrations

## Methods

### Study Design: Longitudinal study

- Baseline assessment, included detailed questions about smoking history, frequency, relative risk perceptions for smoking and ENDS products, and demographic characteristics
- Follow-up assessments at 1, 3, and 6 months to assess smoking status and JS use
- Data was collected beginning in March, 2019

### Study Sample:

- Adult established smokers (age  $\geq$ 21, smoked  $\geq$ 100 cigarettes in lifetime, smoking some days or every day) in the US, Canada (together 11,301) and UK (N=1,707)
- All respondents had newly purchased a JS Starter Kit or Device and consented to participate in this longitudinal study
- Analytic Approach:
- Baseline differences in demographic and smoking characteristics between North American and UK smokers were assessed
- Rates of complete switching (no smoking for  $\geq$ 30 days) at 1-, 3-, and 6-month follow-ups were compared in the UK vs North America:
- o Using unadjusted rates
- o Using propensity-score-matched samples, to account for differences in demographics and smoking characteristics at baseline among groups and create balanced samples across the UK and North America for comparison.

## Results

- In both jurisdictions, at each follow-up point, ≥82% of participants reported primarily using JS with the highest available nicotine concentration available in market (**Table 1**)
- There were significant differences in demographic and baseline smoking characteristics between adult JS purchasers in North America and UK at baseline.
- Notably, smoking quantity and frequency, duration of smoking, cigarette dependence, or perceived risks of JS were all lower in the UK than in North America (**Table 1**)
- Unadjusted switching rates showed differences between jurisdictions (Figure 1):
- At 1-month follow-up: not statistically different
- At 3-months follow-up: significantly higher in North America than the UK
- At 6-months follow-up: significantly higher in North America than the UK
- Propensity score matching adjusted the analytic sample based on the criterion derived from baseline characteristics, selecting North American respondents that were similar to UK respondents in terms of baseline demographics and smoking characteristics and excluding dissimilar North America respondents
- The matched samples consisted of 1,625 UK respondents and 1,386 North American respondents
- Logistic regression with propensity score matching on demographics and baseline smoking characteristics found that odds of switching were similarly significantly higher among those in North America as compared to the UK (**Figure 2**):
- At 1-month follow-up: significantly higher in North America than the UK
- At 3-months follow-up: significantly higher in North America than the UK
- At 6-months follow-up: significantly higher in North America than the UK

### References

- 1. Abrams DB, Glasser AM, Pearson JL, Villanti AC, Collins LK, Niaura RS. Harm minimization and tobacco control: reframing societal views of nicotine use to rapidly save lives. Annual review of public health. 2018;39:193-213.
- 2. Gottlieb S, Zeller M. A Nicotine-Focused Framework for Public Health. N Engl J Med. 2017;377(12):1111-1114.

3. Shihadeh A, Eissenberg T. Electronic cigarette effectiveness and abuse liability: predicting and regulating nicotine flux. Nicotine Tob Res. 2015;17(2):158-162.

4. European Union. Directive 2014/40/EU of the European Parliament and of the Council on the approximation of the laws, regulations and administrative provisions of the Member States concerning the manufacture, presentation and sale of tobacco and related products. Official Journal of the European Union. 2014/40;2014:127

#### <sup>1</sup>PinneyAssociates, Inc. <sup>2</sup>JUUL Labs, Inc.

 
 Table 1. Baseline Sociodemographic and Smoking Characteristics of Established Smokers in
North America and UK

Sociodemographic Characteristics	North America (N=11,301)	United Kingdom (N=1,707)	Difference (p-value)ª
Age, yr, <i>Mean(SD</i> )	38.35 (12.21)	33.51 (11.16)	<0.001
Sex			
Male	5972 (52.8)	1109 (65.0)	<0.001
Female	5285 (46.8)	593 (34.7)	
Transgender	44 (O.4)	5 (O.3)	
White Race (vs. non-white)	8734 (77.7)	1417 (83.6)	<0.001
Marital Status			
Married	4238 (37.7)	401 (24.0)	<0.001
Divorced, Separated or Widowed	2126 (18.9)	170 (10.2)	
Never Married	4886 (43.4)	1097 (65.8)	
Smoking Characteristics			
Daily Smoker (vs. Non -daily)	6791 (60.1)	838 (49.1)	<0.001
No. Cigarettes Smoked per Day, Mean ( <i>SD</i> )	13.42 (12.50)	11.20 (10.12)	<0.001
No. Days Smoked in Past 30 Days, Mean ( <i>SD</i> )	25.17 (8.52)	23.32 (9.63)	<0.001
Cigarette consumption, <sup>c</sup> Mean ( <i>SD</i> )	12.54 (12.58)	9.80 (10.26)	<0.001
Duration of regular smoking, yr, Mean (SD)	18.24 (12.38)	14.25 (11.09)	<0.001
Age started smoking regularly, yr, Mean ( SD)	18.21 (4.19)	17.98 (3.43)	0.009
Cigarette Dependence, <sup>b</sup> Mean ( <i>SD</i> )	3.10 (0.97)	2.95 (O.95)	<0.001
Felt Strong Craving to Smoke in Past 30 Days	10133 (89.7)	1489 (87.2)	<0.001
Smokes Within 5 Minutes of Waking Up	2167 (19.2)	194 (11.4)	<0.001
Relative Harm of JUUL vs. Cigarettes <sup>d</sup>			
Much less harmful	2353 (20.8)	533 (31.2)	<0.001
Less harmful	6475 (57.3)	989 (57.9)	
About the same level of harm	1433 (12.7)	92 (5.4)	
More harmful	75 (0.7)	6 (O.4)	
Much more harmful	48 (O.4)	6 (O.4)	
l don't know	917 (8.1)	81 (4.7)	
Nicotine Concentration at Each Follow-Up			
Use of highest nicotine concentration at 1 - month <sup>e</sup>	6159 (92.5)	833 (90.1)	0.01
Use of highest nicotine concentration at 3- month <sup>e</sup>	4871 (88.7)	612 (84.6)	0.001
Use of highest nicotine concentration at 6- month <sup>e</sup>	3823 (89.1)	414 (82.3)	<0.001

Note. Values represent N (%) unless noted otherwise. Denominators may be less than column heads due to missing data Differences between jurisdictions were tested with x2 for categorical variables and one-way analysis of variance for continuous variables.

bPROMIS e-cigarette (Range: 1-a5).

c(No. Cigarettes Smoked per Day × No. Days Smoked in Past 30 Days) / 30. d"In your opinion, is using the JUUL device likely to be less harmful, about the same, or more harmful to your health compared to smoking cigarettes?". eNorth America: 59 mg/mL (vs. 35 mg/mL); UK: 18 mg/mL (vs. 9 mg/mL).

**Figure 1.** Proportion of Smokers Reporting Complete Switching at 1-, 3- and 6-Month Follow-Up

Assessments in North America and the United Kingdom (±SE)



nited Kingdom: 1-Month, N=1078; 3-Month, N=863; 6-Month, N=640.

Figure 2. Proportion of Smokers in Propensity Matched Sample Reporting Complete Switching at 1-, 3- and 6-Month Follow-Up Assessments in North America and the United Kingdom (±SE)



### Conclusions

- These results suggest that regulatory environments such as those allowing the availability of ENDS with nicotine concentrations greater than 20 mg/mL may be associated with greater switching among adult smokers
- The associations of jurisdiction and switching rates at 3 months and 6 months were not explained by differences in key demographic and smoking characteristics; even after accounting for these factors in a balanced sample
- This is particularly of interest because the differences between smokers at baseline (shorter smoking history, lower cigarette consumption and dependence) would have suggested higher switching rates in the UK as these factors have previously been shown to be associated with higher likelihood of switching
- Limitations:

- Between-country differences are influenced by many factors, including social norms and other government policies not explicitly taken into account in these analyses.

- Future research should consider these factors and the extent to which jurisdiction or policy environments may explain differences in switching among adult smokers.

