Cigarette Smoking Slip and Relapse Behavior in Adult Former Smokers Who Use JL ENDS: A 12-month Longitudinal Study

Yining Z. Malloch, PhD; MPhil, Gem M. Le, PhD; MHS, Joshua G. Vose, MD, MBA; Erik M. Augustson, PhD, MPH.
JUUL Labs, Inc., San Francisco, CA, USA

Introduction

Use of electronic nicotine delivery systems (ENDS) has increased among adults. There is limited data on the patterns of smoking behavior among Former Established Smokers (FES) who are currently ENDS users. This study examined patterns in slip and relapse of combustible cigarette smoking over a 12-month period among FES who newly purchased an ENDS.

Methods

We analyzed longitudinal survey data of U.S. adults (age 21 or older) who recently purchased a JL ENDS Starter Kit—a package that includes a JL ENDS device, a USB charging dock, and one e-liquid pod in each of four flavors (1x Virginia Tobacco, 1x Mint, 1x Mango and 1x Creme) at 5.0% nicotine concentration. Participants were recruited through retail or online sales between October 2018 to October 2019. At baseline, participants were asked to report their smoking status and demographic characteristics. At 1-, 2-, 3-, 6-, 9- and 12-month follow-up surveys, they reported their past 30-day smoking status, JL ENDS use days and JL ENDS sessions per day. Among 6,086 FES at baseline, 1,599 (26.27%) completed follow-up assessments of past 30-day use of combustible cigarettes at 1-, 2-, 3-, 6-, 9- and 12-months.

Eligible participants:

1. Smoked more than 100 cigarettes in their lifetime and did not smoke at all in the past 30 days at baseline;
2. Have completed all follow-up assessments (i.e., 1-, 2-, 3-, 6-, 9-, and 12-month);
3. Were aged 21 years or older;
4. Reported English language fluency;
5. Had internet access;
6. Were permanent residents ofh the United States;
7. Responded to the survey within 7 days of purchasing, for the first time, a Starter Kit from a licensed retail store or online for personal use.

Stratification

1. Recent FES, i.e., FES who reported "within the past 12 months" to "When did you completely quit smoking cigarettes?"
2. Long-term FES, i.e., FES who reported "more than 12 months ago" to "When did you completely quit smoking cigarettes?"

A relapse was defined by at least two consecutive reports of past 30-day smoking during follow-up. A slip was defined as an isolated report of past 30-day smoking. Multinomial logistic regression models were used to examine factors (socio-demographics, smoking history, average JL ENDS use days and JL ENDS sessions per day in the past 30 days at follow-up assessments) associated with smoking abstinence (reference) vs. slip vs. relapse.

References

1. Babb S, Malarcher A, Schauer G, Asman K, Jamal A. Quitting Smoking Among Adults - United States, 2000-2015. MMWR Morb Mortal Wkly Rep. 2017 Jan 6;65(52):1457-1464. doi: 10.15585/mmw

Results

Among 1,599 FES, 44.18% were recent FES and 55.82% were long-term FES. Most FES were non-Hispanic white (79.31%) male (64.14%), never married (53.10%), had an annual household income below $49,999 (45.02%), and a mean age of 33.87 (SD = 10.99) (**Table 1**). FES smoked on average 12.61 cigarettes per day (SD = 9.28%) for 9.98 years (SD = 9.61) before quitting and had quit for about 3 years.

Recent FES tended to be younger, never married, minority race or ethnicity, lower education and income levels compared to long-term FES. Recent FES reported lower cigarettes per day before quitting, shorter years of smoking regularly and were more likely to smoke menthol cigarettes as their regular brands of cigarettes before quitting than long-term FES.

Table 1: Socio-demographic and Smoking History Characteristics of Recent and Long-Term Former Established Smokers, n = 1599

	Recent FES, n = 702	Long -Term FES, n = 887	Total, n = 1599	p
Age Mean (SD)	29.41 (9.63)	35.54 (11.20)	32.87 (10.99)	< 0.01
Age Groups				< 0.01
21 to 24	310 (44.16%)	133 (14.99%)	444 (27.77%)	
25 to 29	134 (19.09%)	179 (20.18%)	315 (19.70%)	
30 to 39	158 (22.51%)	311 (35.06%)	473 (29.58%)	
40 or older	100 (14.25%)	264 (29.76%)	367 (22.95%)	
Sex				0.03
Male	426 (61.12%)	586 (66.82%)	1016 (64.14%)	
Female	265 (38.02%)	288 (32.84%)	559 (35.29%)	
Transgender	6 (0.86%)	3 (0.34%)	9 (0.57%)	
Number Missing	5	10	15	
Race Ethnicity				< 0.01
Non-Hispanic White	480 (74.65%)	684 (82.81%)	1173 (79.31%)	
Non-Hispanic Black	24 (3.73%)	17 (2.06%)	41 (2.77%)	
Hispanics	67 (10.42%)	58 (7.02%)	126 (8.52%)	
Non-Hispanic Asian	34 (5.29%)	31 (3.75%)	65 (4.39%)	
Non-Hispanic Other	38 (5.91%)	36 (4.36%)	74 (5.00%)	
Number Missing	59	61	120	
Education				< 0.01
High School or Lower	186 (29.25%)	152 (18.12%)	340 (22.93%)	
Associate Degree or Some College	290 (45.60%)	369 (43.98%)	663 (44.71%)	
College Degree or Higher	160 (25.16%)	318 (37.90%)	480 (32.37%)	
Number Missing	66	48	116	
Marital Status				< 0.01
Married	178 (25.65%)	382 (43.51%)	564 (35.65%)	
Never Married	446 (64.27%)	389 (44.31%)	840 (53.10%)	
Divorced, Separated, or Widowed	70 (10.09%)	107 (12.19%)	178 (11.25%)	
Number Missing	8	9	17	
HouseholdIncome				< 0.01
≤ $49999	323 (55.59%)	282 (37.15%)	606 (45.02%)	
$50000-$99999	162 (27.88%)	259 (34.12%)	425 (31.58%)	
≥ $100000	96 (16.52%)	218 (28.72%)	315 (23.40%)	
Number Missing	121	128	253	
Number of Cigarettes Per Day before Quitting				< 0.01
Mean (SD)	11.59 (8.04)	13.42 (10.10)	12.61 (9.28)	
Number Missing	28	41	71	
Quit Days				< 0.01
Mean (SD)	141.14 (104.37)	1997.61 (2100.85)	1178.24 (1821.94)	
Number Missing	2	1	13	
Years Smoked Regularly				< 0.01
Mean (SD)	8.68 (8.87)	10.93 (10.05)	9.98 (9.61)	
Number Missing	65	26	94	
Age First Smoked Regularly				0.04
Mean (SD)	18.14 (3.11)	17.80 (3.13)	17.97 (3.14)	

On average, ~11% of FES smoked in the past 30 days at each of the follow-ups (**Table 2**). Recent FES showed higher rates of past 30-day smoking than long-term FES.

Table 2: Past 30-Day Cigarette Smoking of FES, Stratified by Recent and Long-Term FES at Follow-Up Assessments, n = 1599

	Recent FES, n = 702	Long Term FES, n = 887	Total, n = 1599
Ever Smoked in the Past 30 Days at Month 1	114 (16.24%)	57 (6.43%)	171 (10.69%)
Ever Smoked in the Past 30 Days at Month 2	108 (15.38%)	50 (5.64%)	158 (9.88%)
Ever Smoked in the Past 30 Days at Month 3	113 (16.10%)	59 (6.65%)	172 (10.76%)
Ever Smoked in the Past 30 Days at Month 6	102 (14.53%)	74 (8.34%)	176 (11.01%)
Ever Smoked in the Past 30 Days at Month 9	122 (17.38%)	71 (8.00%)	194 (12.13%)
Ever Smoked in the Past 30 Days at Month 12	118 (16.81%)	72 (8.12%)	191 (11.94%)

Across all follow-ups, 56.6% and 76.7% of Recent and Long-Term FES, respectively, remained abstinent from smoking (**Table 3**). Among those who did smoke during the study, smoking at only a single assessment was the most common pattern for both Recent (17.52%) and Long-Term FES (12.63%).

Table 3: Number of Past 30-Day Cigarette Smoking across Follow-Up assessments of FES, Stratified by Recent and Long-Term FES, n = 1599

Times Reported Ever Smoked Across Follow Ups	Recent FES, n = 702	Long -Term FES, n = 887	Total, n = 1599
Smoking Abstinence across All Follow-Ups	397 (56.55%)	680 (76.66%)	1086 (67.92%)
Past 30-Day Smoking at 1 Follow-Up	123 (17.52%)	112 (12.63%)	235 (14.70%)
Past 30-Day Smoking at 2 Follow-Ups	82 (11.68%)	44 (4.96%)	127 (7.94%)
Past 30-Day Smoking at 3 Follow-Ups	45 (6.41%)	31 (3.49%)	76 (4.75%)
Past 30-Day Smoking at 4 Follow-Ups	28 (3.99%)	14 (1.58%)	42 (2.63%)
Past 30-Day Smoking at 5 Follow-Ups	19 (2.71%)	2 (0.23%)	21 (1.31%)
Past 30-Day Smoking at 6 Follow-Ups	8 (1.14%)	4 (0.45%)	12 (0.75%)

Recent FES had the higher rate of relapse and slip than long-term FES (**Table 4**). Overall, 13.26% FES relapsed and 18.82% slipped.

Table 4: Smoking Abstinence vs. Slip vs. Relapse Rate of FES, Stratified by Recent and Long-Term FES, n = 1599

	Recent FES, n = 702	Long -Term FES, n = 887	Total, n = 1599
Abstinence	397 (56.55%)	680 (76.66%)	1086 (67.92%)
Slip	163 (23.22%)	138 (15.56%)	301 (18.82%)
Relapse	142 (20.23%)	69 (7.78%)	212 (13.26%)

Results of the multinomial logistic regression model (**Table 5**) showed that smoking status at baseline was the strongest predictor of slip and relapse. Specifically, long-term FES were significantly less likely than recent FES to have reported a slip (aOR = 0.55, 95% CI: 0.38 – 0.79) or relapse (aOR = 0.28; 95% CI: 0.18 – 0.44), after adjusting for sociodemographic factors, smoking history, and JL ENDS product use frequency and intensity. Average JL ENDS product use days in the past 30 days across follow-ups was negatively associated with odds of relapse (aOR = 0.97, 95% CI: 0.94 – 0.99). Sex and race/ethnicity were also significantly associated with slip and relapse outcomes.

Table 5: Multinomial Logistic Regression for Slip vs. Relapse Smoking Outcomes Relative to Abstinence Among Former Established Smokers, n = 982

	Slip			Relapse		
	aOR	95% CI		aOR	95% CI	
Intercept	1.42	0.33	6.13	1.25	0.23	6.75
Sex						
Male	-	-	-	-	-	-
Female	1.21	0.84	1.75	**1.67**	**1.09**	**2.55**
Transgender	1.92	0.25	14.80	1.51	0.13	18.00
Age	**0.95**	**0.91**	**0.99**	0.97	0.92	1.01
Race Ethnicity						
Non-Hispanic White	-	-	-	-	-	-
Non-Hispanic Black	1.57	0.56	4.41	**2.88**	**1.04**	**7.99**
Hispanics	0.98	0.53	1.82	1.42	0.72	2.80
Non-Hispanic Asian	2.21	1.00	4.89	2.30	0.93	5.69
Non-Hispanic Other	1.23	0.61	2.49	0.85	0.33	2.17
Education						
High school degree or lower	-	-	-	-	-	-
Associate Degree or Some College	1.57	1.00	2.47	1.52	0.91	2.54
College Degree or Higher	1.40	0.84	2.33	1.18	0.65	2.14
Marital Status						
Married	-	-	-	-	-	-
Never Married	1.37	0.89	2.11	1.33	0.80	2.20
Divorced, Separated, or Widowed	1.33	0.73	2.45	1.01	0.49	2.08
Cigarettes Per Day Before Quitting	0.98	0.96	1.00	0.98	0.96	1.01
Years Smoked Regularly Before Quitting	1.03	0.99	1.08	1.03	0.98	1.08
Age First Smoked Regularly	1.02	0.95	1.09	1.00	0.92	1.08
Time Since Last Quit						
Within the Past 12 Months (Recent FES)	-	-	-	-	-	-
More than 12 months ago (Long -Term FES)	**0.55**	**0.38**	**0.79**	**0.28**	**0.18**	**0.44**
Regular Brands of Cigarettes Smoked before Quitting were Menthol Cigarettes						
No	-	-	-	-	-	-
Yes	0.83	0.58	1.18	0.74	0.49	1.13
Average JL ENDS Sessions Per Day in the Past 30 Days Over 12 Months	1.01	0.99	1.03	0.99	0.97	1.02
Average JL ENDS Use Days in the Past 30 Days Over 12 Months	0.98	0.96	1.00	**0.97**	**0.94**	**0.99**

Note: **Bold** indicates statistically significant.

Conclusions

Among FES who purchased a JL ENDS, past 30-day smoking at follow-up assessments remained stable at 11.1%, and 67.9% of FES remained abstinent across the entire 12-month follow-up period. Significant differences were seen in rates of abstinence during the 12-months between recent FES (56.6%) and long-term FES (77%). Among those who did smoke during the study, smoking at only a single assessment was the most common pattern for both recent (17.5%) and long-term FES (12.6%). Slip and relapse rates among FES who purchased a JL ENDS varied by smoking history, where both rates were lower among long-term FES than recent FES.

Smoking history appeared to be the strongest predictor of slip vs. relapse. Average JL ENDS use days was negatively associated with relapse. Consistent with findings in literature, long time smokers are at a very high risk of relapsing back to smoking, with national surveys indicating a relapse rate generally in the range of 90%[1]. This would suggest that individuals who were at the highest risk for cigarette slip and relapse were those who were already at risk for continued smoking.

JLI Science