Web Material

E-cigarette use to aid long-term smoking cessation in the US: prospective evidence from the PATH cohort study

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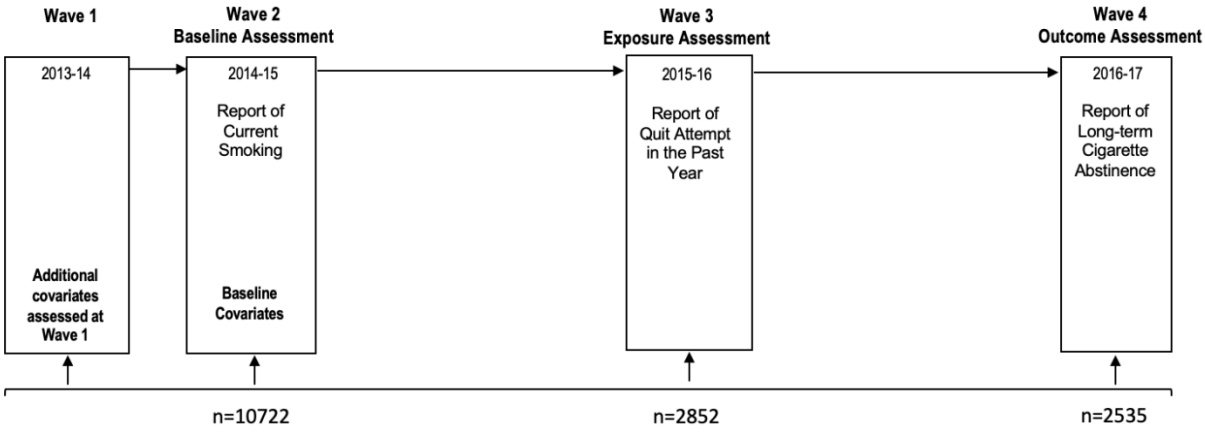


Web Figure 1. Data Collection Schema for E-cigarette Use to Aid Long-term Smoking Cessation in the US Analysis

Sample sizes (n) are unweighted.
Current smoking includes both daily and non-daily smoking.
Additional covariates assessed at Wave 1 include the assessments of smoking related diseases and daily e-cigarette use at Wave 1.

Web Appendix 1. Measurement Detail for Pre-identified Study Covariates (in PATH Study [with variable names])

Socio-demographics: Use standard derived variables for age, sex, ethnicity, race, education, and income (R02R_A_AGE, R02R_A_SEX, R02R_A_HISP, R02R_A_RACE, R01R_A_EDUC, R02_AM0030) Note the variable of education comes from PATH Wave 1 database, it's not available in Wave 2 database based on our knowledge.

Nicotine dependence scale: (R02_AN0025, R02_AN0030, R02_AN0065, R02_AN0035, R02_AN0045, R02_AN0085, R02_AN0090, R02_AN0060, R02_AN0095, R02_AN0100, R02_AN0055, R02_AN0050, R02_AN0070, R02_AN0075, R02_AN0080). Variables are combined to derive variable R02R_A_DPNDSCL_NOMISS by calculating the mean of the non-missing scores. Nicotine dependence items take the form of a series of statements on emotional and physical responses to nicotine products (e.g. "I frequently crave {product}", "I usually want to {use product} right after I wake up", "I [would] feel alone without my {product}"). Respondents are asked to rate their level of agreement with each statement on a 5-point scale, where 1="Not true of me at all" and 5="Extremely true of me". Respondents can also answer "don't know" or refuse to answer the question; these are treated as missing responses. Responses are rescaled to a 3-point scale, where 1 (not at all) = 0, 2 or 3 = 50 and 4 or 5 =100, summed and divided by the number of non-missing values.

Cigarette consumption: Average number of cigarettes smoked each day (R02R_A_PERDAY_EDY_CIGS). Responses could be reported as cigarettes or packs. For respondents with missingness in R02R_A_PERDAY_EDY_CIGS, we replaced their cigarette consumption by multiplying average number of cigarettes smoked per day among non-current 30-day smokers (R02R_A_PERDAY_P30D_CIGS) with the number of days smoked in the past 30 days (R02_AC1022), and divided by 30 days. Responses larger than 100 were considered errors and were replaced with 100 (the maximum value is 100).

Length of the QA Prior to Wave 2 (R02R_A_DURQUIT): Length of last quit attempt in the past 12 months. Derived with variables R02_AN0130_NN and R02_AN0130_UN.

Timing of the QA (R03R_A_ENDQUIT_CIGS): This was calculated as the date of W3 survey completed minus the end date of the most recent quit attempt reported in W3.

Smoke-free home (R02_AR1045): Statement that best describes rules about smoking a combustible tobacco product inside home. It's a 3-point scale from 1 (not allowed anywhere or anytime at all) to 3 (allowed anywhere or anytime at all).

Perceived harm of cigarettes (R02_AC9050): Respondents were asked "How harmful do you think cigarettes are to health?" and could reply on a 5-point scale from 1 (not at all harmful) to 5 (extremely harmful).

Relative perceived harm of e-cigarettes (R02_AE1099): Respondents were asked "Is using e-cigarettes less harmful, about the same, or more harmful than smoking cigarettes?" and could reply on a 3-point scale, where 1=Less harmful, 2=About the same and 3=More harmful.

Exposure to other smokers (R02_AX0068): "In the past 7 days, number of hours that you were in close contact with others when they were smoking."

Pack years of smoking: (R02R_A_PACKYEARS_CIGS): Calculated by multiplying the number of pack smoked per day by the number of years the respondent smoked regularly, when respondents answered "Yes" to either question "Smoked same number of cigarettes per day since started smoking fairly regularly (R02_AC9004)" or "Smoked same number of cigarettes per day since started smoking fairly regularly (Pack measure) (R02_AC9009)"

Age started smoking fairly regularly (R02R_A_AGEREG_CIGS) Calculated by variables R01_AC1007 and R02_AC1007NB.

Interest in quitting cigarettes (R02_AN0230): On a scale of 1-10 where 1=Not at all interested and 10=Extremely interested.

Self-efficacy about quitting (R02_AN0245): "If you did try to quit {product} altogether in the next 6 months, how likely do you think you would be to succeed?" on a 4-point scale from 1=Not at all likely and 4=Very likely.

Smoking related health diagnoses: Respondents were asked if they had ever been told by a doctor or health professional that they had any of the listed diseases.

Group A: Heart Disease: High blood pressure (R01_AX0111_01 and R02_AX0111_NB_01), High cholesterol (R01_AX0111_02 and R02_AX0111_NB_02) Congestive heart failure (R01_AX0111_03 and R02_AX0111_NB_03); a stroke (R01_AX0111_04 and R02_AX0111_NB_04); A heart attack (R01_AX0111_05 and R02_AX0111_NB_05); Some other heart condition (R01_AX0111_06 and R02_AX0111_NB_06)

Group B: Respiratory Disease: COPD (R01_AX0119_01 and R02_AX0119_NB_01); chronic bronchitis (R01_AX0119_02 and R02_AX0119_NB_02); emphysema (R01_AX0119_03 and R02_AX0119_NB_03); asthma (R01_AX0119_04 and R02_AX0119_NB_04); some other lung or respiratory condition (R01_AX0119_05 and R02_AX0119_NB_05)

Group C: Cancer: (R01_AX0144 and R02_AX0144 _NB)

Disorder symptoms for externalizing mental health problems(R02R_A_GAINEXTSCREEN_PY): Respondents were asked the last time they had experienced any of 7 externalizing (e.g., had a hard time paying attention or listening to instructions at school, work or home, bullied or started physical fights). The number of reports of experiencing such symptoms in the past month or the past 2-12 months was summed and coded into a 3-level severity indicator, with those reporting 0 or 1 symptom scored as Low, 2-3 symptoms scored as Moderate and 4 or more scored as High.

Disorder symptoms for internalizing mental health problems (R02R_A_GAININTSCREEN_PY): Respondents were asked the last time they experienced any of 4 internalizing disorder symptoms: feeling very trapped, lonely, sad, blue, depressed, or hopeless about the future, feeling very anxious, nervous, tense, scared, panicked, or like something bad was going to happen, had sleep problems. The number of reports of experiencing such symptoms in the past month or the past 2-12 months was summed and coded into a 3-level severity indicator, with those reporting 0 or 1 symptom scored as Low, 2-3 symptoms scored as Moderate and 4 or more scored as High.

Insurance coverage at Wave 2: (R02_AM0026_01 to R02_AM0026_08): Respondents who reported currently being covered by at least one type of health insurance, including insurance purchased directly or through an employer or union, Medicare, Medicaid, VA, TRICARE or other military health care and Indian Health Insurance, were scored as having insurance coverage. Missing data on all of these variables were coded to "did not have insurance".

Daily cigarettes use at Wave 2: Respondents' cigarettes used at Wave 2 (R02_AC1003), either smoked every day or smoked some days.

Daily e-cigarettes use at Wave 1 or Wave 2: Either daily e-cigarette use at Wave 1 (R01_AE1003) or daily e-cigarette use at Wave 2 (R02_AO1003C) were considered prior daily e-cigarette use.

Web Table 1. Univariate Distribution of Study Covariates by Cessation Aid Category

Wtd % is the population in row category who used the aid in the column header (for example, among those aged 18-34, 20.5% used e-cigs on the target quit attempt (QA), 79.5% did not use e-cigs, etc.). The columns in this table include comparison groups of our primary objective, used e-cigarettes on the QA and did not use e-cigarettes on the QA, which are also columns in Tables 1 of the main paper. The columns also include the unexposed group in our secondary objective, used pharmaceutical aid only on the QA. The last column includes summary of used no product on the QA.

Parameter (Variable name)		Used e-cigarettes on the QA (n=427)				Did not use e-cigarettes on the QA (n=2108)				Used pharmaceutical aid only on the QA (n=465)				Used no product on the QA (n=1643)			
		N	wtd %	95% CL		N	wtd %	95% CL		N	wtd %	95% CL		N	wtd %	95% CL	
Age	18-34	218	20.5	17.5	23.4	922	79.5	76.6	82.5	115	10.3	8.4	12.3	807	69.2	66.0	72.4
(R02R_A_AGE)	35-50	127	19.2	15.9	22.4	546	80.8	77.6	84.1	144	20.7	17.2	24.3	402	60.1	56.1	64.2
	50+	82	11.8	9.5	14.2	640	88.2	85.8	90.5	206	29.0	24.9	33.0	434	59.2	54.8	63.5
Sex	0 = Male	202	16.8	14.4	19.2	1012	83.2	15.4	21.3	191	17.6	15.1	20.1	821	65.7	62.7	68.6
(R02R_A_SEX)	1 = Female	225	18.1	15.3	20.9	1095	81.9	79.1	84.7	274	20.9	18.3	23.6	821	61.0	57.7	64.2
	Missingness	0	†	†	†	1	†	†	†	0	†	†	†	1	†	†	†
Education	Less than high school	89	13.2	10.1	16.4	593	86.8	83.6	89.9	113	17.1	13.9	20.3	480	69.7	65.1	74.2
(R02R_A_EDUC)	High school graduate	90	15.1	10.9	19.2	502	84.9	80.8	89.1	100	19.7	15.8	23.5	402	65.3	60.0	70.6
	Some college or higher	230	21.1	18.3	23.8	944	79.0	76.2	81.7	242	20.0	17.7	22.3	702	58.9	55.6	62.2
	Missingness	18	18.6	9.1	28.1	69	81.4	71.9	90.9	10	18.1	5.9	30.3	59	63.3	50.4	76.1
Ethnicity	Hispanic	37	8.7	5.9	11.6	334	91.3	88.4	94.1	40	9.6	6.7	12.6	294	81.6	78.1	85.2
(R02R_A_HISP)	Non-Hispanic	390	19.1	17.2	21.1	1732	80.9	78.9	82.8	413	20.5	18.6	22.4	1319	60.3	57.8	62.9
	Missingness	0	†	†	†	42	100	†	†	12	†	†	†	30	71.2	54.6	87.8
Race	White	354	20.8	18.5	23.0	1400	79.2	77.0	81.5	326	20.0	17.9	22.0	1074	59.3	56.5	62.1
(R02R_A_RACE)	Black	26	5.6	3.3	7.9	433	94.4	92.1	96.7	90	19.3	15.2	23.4	343	75.1	70.3	79.9
	Asian	4	†	†	†	33	88.7	80.6	96.8	5	†	†	†	28	76.2	63.2	89.3
	Other	39	18.1	12.0	24.2	190	81.9	75.8	88.0	36	14.0	9.7	18.4	154	67.8	61.0	74.6
	Missingness	4	†	†	†	52	94.3	89.4	99.3	8	†	†	†	44	80.8	69.0	92.6
Income	< 35,000	220	14.3	12.2	16.5	1341	85.7	83.5	87.8	268	17.5	15.1	19.9	1073	68.2	65.3	71.1
(R02_AM0030)	350,00-100,000	155	22.9	19.6	26.1	523	77.1	73.9	80.4	141	21.8	18.5	25.2	382	55.3	50.9	59.7
	>100,000	35	23.2	15.9	30.4	110	76.8	69.6	84.1	30	20.9	14.3	27.6	80	55.9	47.4	64.4

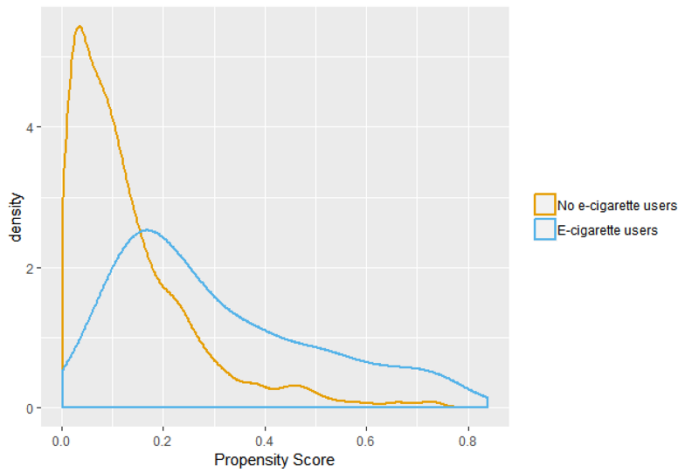
Parameter (Variable name)		Used e-cigarettes on the QA (n=427)				Did not use e-cigarettes on the QA (n=2108)				Used pharmaceutical aid only on the QA (n=465)				Used no product on the QA (n=1643)			
		N	wtd %	95% CL		N	wtd %	95% CL		N	wtd %	95% CL		N	wtd %	95% CL	
	Missingness	17	†	†	†	134	86.7	79.5	94.0	26	20.0	13.1	26.9	108	66.7	58.4	75.1
Health Insurance Status	No	70	15.6	10.6	20.5	414	84.4	79.5	89.4	50	10.0	7.1	13.0	364	74.4	69.2	79.6
(R02_AM0026_01-R02_AM0026_08)	Yes	357	17.9	16.2	19.7	1683	82.1	80.3	83.8	411	21.2	19.1	23.3	1272	60.9	58.4	63.4
	Missingness	0	†	†	†	11	†	†	†	4	†	†	†	7	†	†	†
Disorder symptoms for externalizing mental health problems	Low	184	13.2	11.3	15.2	1241	86.8	84.8	88.7	262	18.9	16.5	21.3	979	67.9	64.9	70.9
(R02R_A_GAINEXTSCREEN_PY)	Moderate	134	23.8	19.4	28.3	492	76.2	71.7	80.6	127	21.3	17.9	24.6	365	54.9	50.1	59.7
	High	109	22.5	18.5	26.5	375	77.5	73.5	81.5	76	17.2	12.8	21.6	299	60.3	55.2	65.4
Disorder symptoms for internalizing mental health problems	Low	153	13.8	11.7	16.0	1042	86.2	84.0	88.3	222	19.1	16.6	21.6	820	67.1	64.0	70.1
(R02R_A_GAININTSCREEN_PY)	Moderate	127	19.7	15.9	23.6	530	80.3	76.4	84.1	124	19.8	16.6	23.1	406	60.4	56.6	64.2
	High	147	22.4	18.9	25.9	536	77.6	74.1	81.1	119	18.5	14.7	22.3	417	59.1	54.1	64.2
Smoking-related diseases	1 = Marked	201	16.2	13.9	18.5	1069	83.8	81.5	86.1	308	24.8	21.8	27.9	761	58.9	55.7	62.2
Nicotine dependence	0-33.3	89	14.2	10.8	17.6	571	85.8	82.4	89.2	51	8.2	5.5	10.9	520	77.6	73.3	81.9
(R02R_A_DPNDSCL_NOMISS)	33.4-66.7	172	17.1	14.5	19.7	839	82.9	80.3	85.5	203	21.2	18.1	24.3	636	61.7	58.3	65.1
	66.8-100	165	21.6	18.4	24.8	648	78.4	75.2	81.6	207	27.0	23.7	30.3	441	51.4	47.4	55.4
	Missingness	1	†	†	†	50	97.8	92.9	100	4	†	†	†	46	89.8	79.9	99.6
Smoke-free home (R02_AR1045)	1 = Smoking is not allowed anywhere	246	17.5	15.3	19.7	1174	82.5	80.3	84.7	233	17.4	15.2	19.6	941	65.2	62.0	68.3
	Missingness	1	†	†	†	8	†	†	†	3	†	†	†	5	†	†	†
Perceived harm of cigarettes	Not to somewhat harmful	65	12.4	9.1	15.7	463	87.6	84.3	90.9	83	15.8	12.2	19.3	380	71.8	67.3	76.3
(R02_AC9050)	Very/extremely harmful	360	18.6	16.7	20.5	1641	81.4	79.5	83.3	380	20.0	18.0	22.0	1261	61.4	58.8	64.1
	Missingness	2	†	†	†	4	†	†	†	2	†	†	†	2	†	†	†
Relative perceived harm of e-cigarettes	1 = Less harmful	262	27.2	24.3	30.1	726	72.8	69.9	75.7	171	18.0	15.2	20.8	555	54.8	51.5	58.1
(R02_AE1099)	2 = About the same	142	12.5	10.3	14.7	1064	87.5	85.3	89.7	236	21.1	18.3	23.8	828	66.5	63.1	69.8
	3 = More harmful	16	†	†	†	242	94.3	90.8	97.8	36	13.3	8.7	17.8	206	81.0	75.0	87.0
	Missingness	7	†	†	†	76	91.1	83.7	98.4	22	23.8	14.2	33.4	54	67.3	55.0	79.5

Parameter (Variable name)		Used e-cigarettes on the QA (n=427)				Did not use e-cigarettes on the QA (n=2108)				Used pharmaceutical aid only on the QA (n=465)				Used no product on the QA (n=1643)			
		N	wtd %	95% CL		N	wtd %	95% CL		N	wtd %	95% CL		N	wtd %	95% CL	
Second-hand smoking hours in past 7 days (R02_AX0068)	<=10 hours	262	15.6	13.8	17.3	1479	84.4	82.7	86.2	331	19.8	17.5	22.1	1148	64.7	61.8	67.5
	>10 hours	161	22.1	18.6	25.6	597	77.9	74.4	81.4	130	18.0	14.9	21.2	467	59.9	55.7	64.0
	Missingness	4	†	†	†	32	86.1	71.8	100	4	†	†	†	28	74.2	56.4	92.0
Age began regular smoking (R02R_A_AGEREG_CIGS)	18+	160	17.2	14.4	20.0	874	82.8	80.0	85.6	204	19.3	16.6	22.1	670	63.5	59.8	67.2
	< 18	238	20.9	18.4	23.5	907	79.1	76.5	81.6	223	21.7	18.8	24.6	684	57.4	54.4	60.3
	Missingness	29	7.7	4.6	10.8	327	92.3	89.2	95.4	38	11.2	7.2	15.3	289	81.0	76.0	86.1
Cigarette consumption (R02R_A_PERDAY_EDY_CIGS)	1-9 CPD	194	15.3	13.2	17.5	1089	84.7	82.5	86.8	161	12.6	10.4	14.9	928	72.0	69.0	75.0
	10-19 CPD	131	20.3	16.4	24.3	533	79.7	75.7	83.6	150	23.6	20.0	27.2	383	56.1	51.4	60.8
	20+ CPD	93	19.4	15.6	23.2	436	80.6	76.8	84.4	147	29.8	25.1	34.5	289	50.8	46.2	55.4
	Missingness	9	†	†	†	50	87.7	79.1	96.3	7	†	†	†	43	74.8	62.2	87.5
Pack-years (R02R_A_PACKYEARS_CIGS)	<= 20	137	19.8	16.5	23.2	591	80.2	76.8	83.5	121	17.1	14.0	20.3	470	63.0	59.1	66.9
	21-35	29	19.7	12.3	27.1	117	80.3	72.9	87.7	41	31.7	23.0	40.4	76	48.6	40.0	57.2
	> 35	16	18.0	8.0	27.9	85	82.0	72.1	92.0	36	34.5	23.6	45.4	49	47.5	38.3	56.8
	Missingness	245	16.1	13.7	18.5	1315	83.9	81.5	86.3	267	17.7	15.5	20.0	1048	66.2	63.2	69.1
Interest in quitting cigarettes (R02_AN0230)	1-7	139	15.0	12.3	17.7	802	85.0	82.3	87.7	127	15.1	12.0	18.3	675	69.8	66.3	73.4
	8-9	86	18.5	13.9	23.2	379	81.5	76.8	86.1	93	19.6	15.9	23.2	286	61.9	56.0	67.8
	10 (extremely Interested)	164	19.0	16.3	21.7	736	81.0	78.3	83.7	205	23.6	20.5	26.7	531	57.4	54.0	60.8
	Missingness	38	18.0	11.4	24.7	191	82.0	75.3	88.6	40	16.6	11.3	22.0	151	65.3	57.5	73.2
Self-efficacy about quitting (R02_AN0245)	No intent to quit in next 6 mos	192	20.0	17.3	22.8	826	80.0	77.2	82.7	165	17.3	14.6	20.1	661	62.7	59.5	65.8
	Not at all or a little likely	28	19.3	12.4	26.3	117	80.7	73.7	87.6	34	22.7	15.2	30.3	83	57.9	49.1	66.8
	Somewhat likely	83	18.5	14.4	22.6	366	81.5	77.4	85.6	108	25.3	20.4	30.2	258	56.2	50.5	61.9
	Very likely	60	13.8	9.9	17.6	360	86.2	82.4	90.1	81	18.9	14.6	23.3	279	67.3	61.8	72.7
	Missingness	64	14.1	10.0	18.2	439	85.9	81.8	90.0	77	16.0	12.0	20.1	362	69.8	64.8	74.8
Length of the QA reported at W1 (R02R_A_DURQUIT)	<= 30 d	171	16.9	14.0	19.8	845	83.1	80.2	86.0	201	21.5	18.3	24.6	644	61.7	57.9	65.5
	30+ d	68	25.0	19.1	30.7	226	75.0	69.3	80.9	40	15.4	10.7	20.0	186	59.7	54.1	65.4

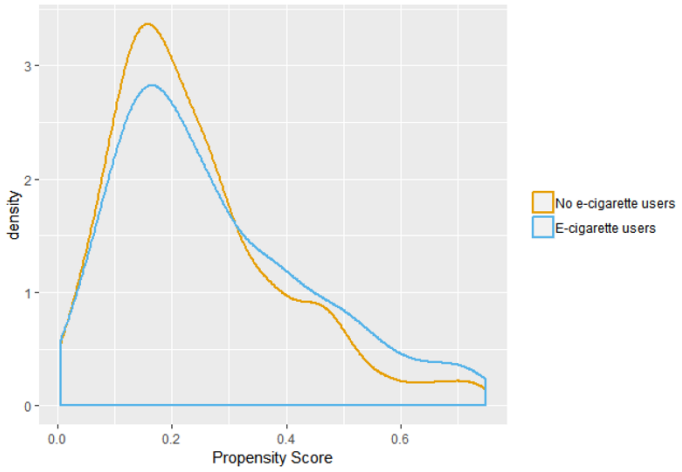
Parameter (Variable name)		Used e-cigarettes on the QA (n=427)				Did not use e-cigarettes on the QA (n=2108)				Used pharmaceutical aid only on the QA (n=465)				Used no product on the QA (n=1643)			
		N	wtd %	95% CL		N	wtd %	95% CL		N	wtd %	95% CL		N	wtd %	95% CL	
	No quit/no data	188	16.1	13.9	18.2	1037	83.9	81.38	86.1	224	18.1	15.7	20.6	813	65.8	62.5	69.1
Timing of the QA	<= 6 mo	205	15.7	13.6	17.8	1136	84.3	82.2	86.4	261	20.2	17.8	22.6	875	64.1	61.3	66.9
(R03R_A_ENDQUIT_CIGS)	6+ mo	98	19.3	15.6	23.0	461	80.7	77.0	84.4	99	17.9	14.5	21.4	362	62.8	58.1	67.5
	No quit/no data	124	19.3	16.2	22.5	511	80.7	77.5	83.8	105	18.0	14.6	21.5	406	62.6	58.5	66.7
Daily cigarettes use at W2 (R02_AC1003)	1=Marked	290	17.4	15.3	19.5	1455	82.6	80.5	84.7	383	23.4	21.0	25.8	1072	59.2	56.4	61.9
Daily e-cigarette use at W1 or W2	1=Marked	106	54.3	47.3	61.3	96	45.7	38.7	52.7	25	12.3	7.6	16.9	71	33.4	26.3	40.6

† Estimate was suppressed because it has low statistical precision. It is based on a denominator sample size of less than 20.

(A)



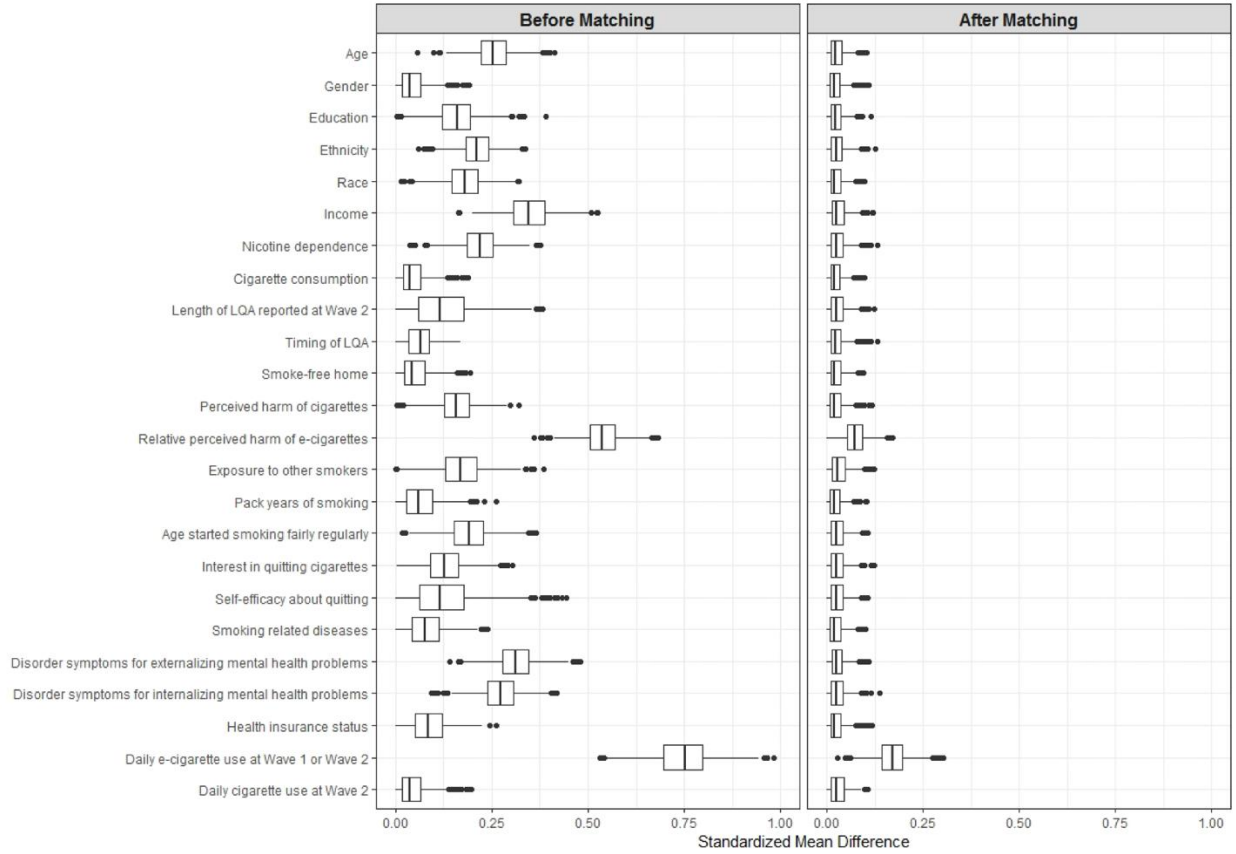
(B)



Web Figure 2. Improvement in Propensity Score and Covariate Balance with Propensity Score Matching, E-cigarettes on the QA vs No E-cigarettes on the QA: (A) Kernel Densities of Propensity Scores between Comparison Groups before Matching (Randomly Selected One Example from 1500 Bootstrap Runs); (B) Kernel Densities of Propensity Scores between Comparison Groups after Matching (Randomly Selected One Example from 1500 Bootstrap Runs.

(A) Sample size: 406 e-cigarettes use and 2129 no e-cigarettes use in randomly selected bootstrap sample.

(B) Sample size: 375 e-cigarettes use and 676 no e-cigarettes use after propensity score matching on the randomly selected bootstrap sample.



Web Figure 3. Standardized Differences in 24 Important Covariates between Smokers Who Used E-cigarettes to Quit in 2015-2016 and Those Who Did Not, before and after Matching.

Each boxplot presents the bootstrap distribution of the weighted standardized mean difference between smokers who used e-cigarettes to aid their most recent quit attempt (LQA), and those who did not, on the indicated variable. We consider an optimal match to be a covariate with a standardize mean difference of < |0.1|. Before matching, 16 of the 24 covariates had less than optimal comparability between study groups (standardize mean difference > |0.1|). After matching, 1 of the 24 covariates had less than optimal comparability between study groups; this variable was included in the final logistic regression model comparing the matched groups. 1500 bootstrap samples were used. For a given covariate, we define “a marked improvement in covariate balance from matching” as a decrease of at least 0.1 units in the median absolute difference of the standardized covariate between exposed and non-exposed subjects, comparing the bootstrap distribution before and after matching. These comparisons do not use the survey weights. For this comparison, the following 16 covariates below achieved a marked improvement in covariate balance from the matching procedure (ordered by size of the difference in medians: Daily e-cigarette use at W1 or W2, Relative perceived of harm of e-cigarettes, Income, Disorder symptoms for externalizing mental health problems, Disorder symptoms for internalizing mental health

problems, Age, Nicotine dependence, Ethnicity, Age started smoking fairly regularly, Race, Exposure to other smokers, Perceived harm of cigarettes, Education, Interest in quitting cigarettes, Self-efficacy about quitting, Length of the QA reported at W2.

Web Table 2. Prior E-cigarette Use (Never, Ever, Fairly regularly, Daily) among US Smokers Who Made A Quit Attempt in 2015-2016, by Use or No Use of E-cigarettes as A Cessation Aid

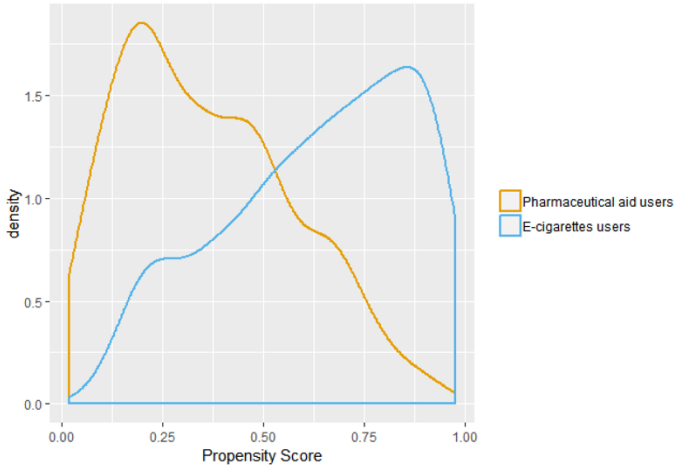
	E-Cigarettes used to quit (W3) N=294		E-cigarettes not used to quit (W3) N=1881	
Prior E-cigarette use	%	95% C.L.	%	95% C.L.
Never	15.4	10.6, 20.2	53.7	51.5, 55.9
Ever but not fairly regularly	42.3	37.7, 46.9	35.7	33.5, 38.0
Fairly regularly but not daily W1 or W2	21.5	16.7, 26.4	7.4	6.0, 8.7
Daily W1 or W2	20.8	15.6, 25.9	3.2	2.4, 4.1

Abbreviations: C.L., Wilson Confidence Limit; the QA, last quit attempt; W2, PATH Study Wave 2; W3, PATH Study Wave 3; W4, PATH Study Wave 4.

[a] Weighted U.S. population estimates.

We presented details of the covariate with the largest residual between-group difference after matching: previous daily use of e-cigarettes. That there was still a residual difference after 1:2 matching reflects the considerable difference in previous daily e-cigarette use between the two study groups. Among those who used e-cigarettes to help them on the QA, 20.8% were previous daily users and a further 21.5% had been fairly regular users. For those who did not use e-cigarettes on the quit attempt, only 3.2% had been previous daily users of e-cigarettes and a further 7.4% had used e-cigarettes fairly regularly.

(A)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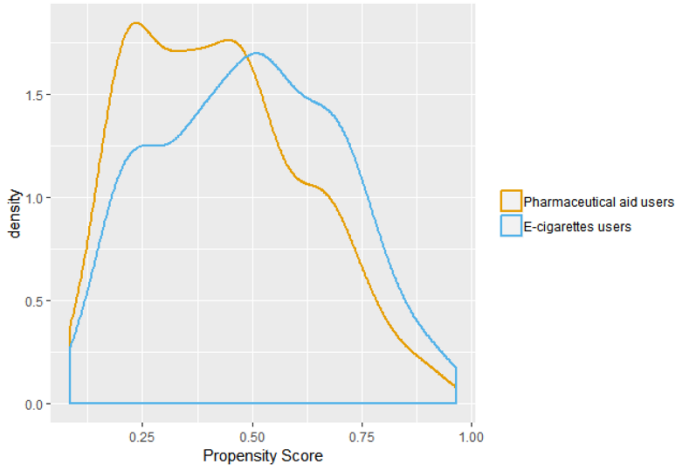
Propensity Score
Pharmaceutical aid users
E-cigarettes users

(B)


density
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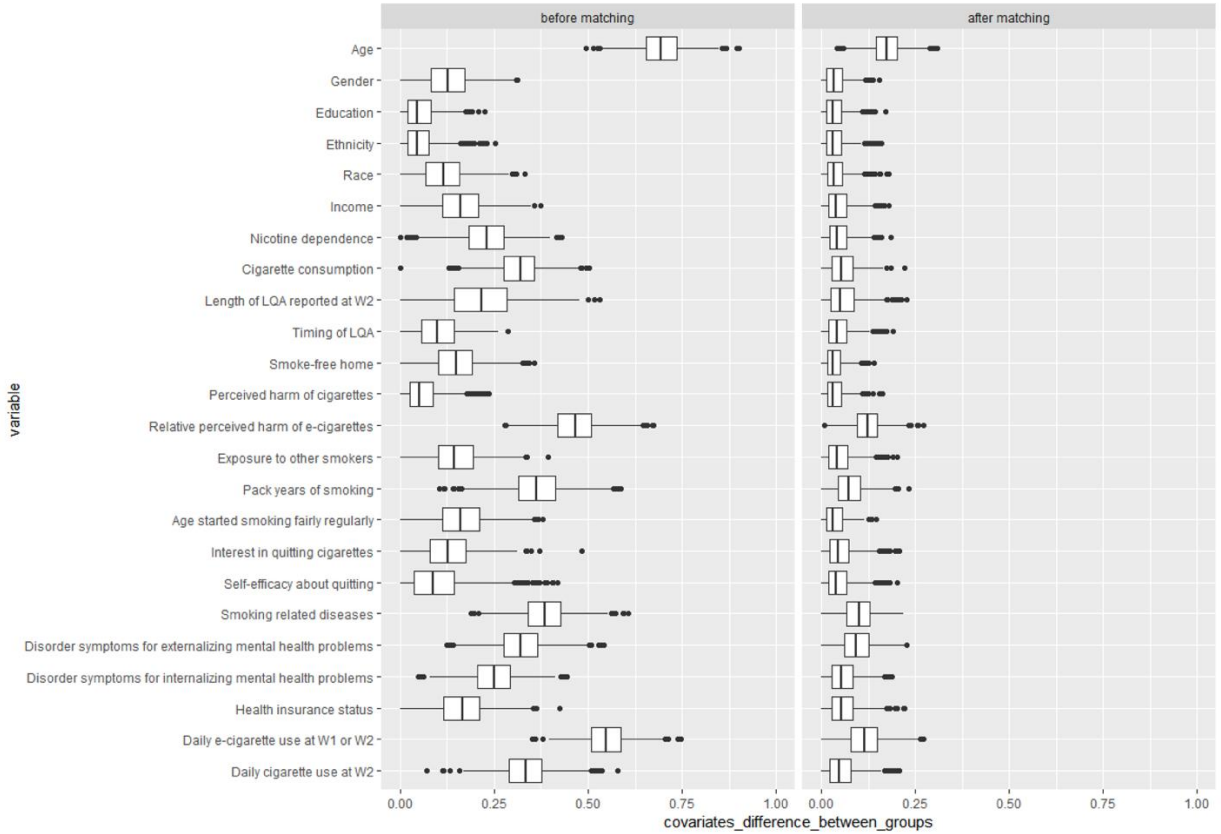
Propensity Score
Pharmaceutical aid users
E-cigarettes users

(C)

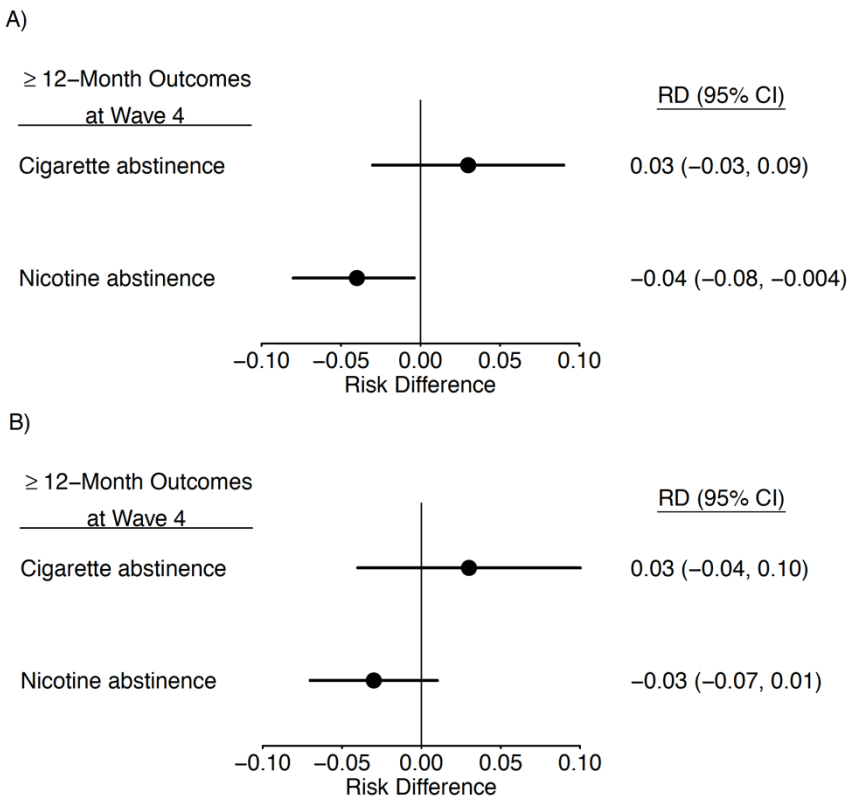


Web Figure 4. Improvement in Propensity Score and Covariate Balance with Propensity Score Matching, E-cigarettes on the QA vs Pharmaceutical Aid on the QA. (A) Kernel Densities of Propensity Scores between Comparison Groups before Matching (Randomly Selected One Example from 1500 Bootstrap Runs); (B) Kernel Densities of Propensity Scores between Comparison Groups after Matching (Randomly Selected One Example from 1500 Bootstrap Runs); (C) Covariate Balance between Comparison Groups before and after Matching.

(A) Sample size: 444 e-cigarettes use and 448 pharmaceutical aid use in randomly selected bootstrap sample.

(B) Sample size: 251 e-cigarettes use and 353 pharmaceutical aid use after propensity score matching on the randomly selected bootstrap sample.

(C) For a given covariate, we define “a marked improvement in covariate balance from matching” as a decrease of at least 0.1 units in the median difference of the standardized covariate between exposed and non-exposed subjects, comparing the bootstrap distribution before and after matching. These comparisons do not use the survey weights. For this comparison, the following 16 covariates below achieved a marked improvement in covariate balance from the matching procedure (ordered by size of the difference in medians): Age, Daily e-cigarette use at W1 or W2, Relative perceived of harm of e-cigarettes, Smoking related diseases, Daily cigarette use at W2, Pack years of smoking, Cigarette consumption, Disorder symptoms for externalizing mental health problems, Disorder symptoms for internalizing mental health problems, Nicotine dependence, Length of the QA reported at W2, Age started smoking fairly regularly, Health insurance status, Income, Exposure to other smokers, Gender.



Web Figure 5. Sensitivity Analyses of the Main PSM Analyses: The 1:2 Propensity Score Matching with Matched Pairs or Triples Adjusted as Random Effects. A) E-cigarettes Used for Cessation vs No E-cigarettes Used for Cessation; B) E-cigarettes Used for Cessation vs Pharmacotherapy but No E-cigarettes Used for Cessation.

Differences in long-term abstinence rates from smoking cigarettes, and from use of any nicotine containing product, comparing the type of aid used for smoking cessation: A) e-cigarettes used for cessation vs no e-cigarettes used for cessation; B) e-cigarettes used for cessation vs pharmacotherapy but no e-cigarettes used for cessation. Weighted differences in rates of 12+ months abstinence between e-cigarette users and a matched sample of non-e-cigarette users, matched on 26 smoking-related characteristics and further adjusted by logistic regression. Bars represent Bonferroni adjusted 95% bootstrap confidence intervals. Samples drawn from 2852 adult respondents to the Population Assessment of

Tobacco and Health Study who reported smoking at Wave 2 (2014-15), reported a quit attempt and cessation aids used at Wave 3 (2015-16) and reported abstinence outcomes at Wave 4 (2017-18). RD: Risk difference. CI: Confidence Interval.

Web Appendix 2. Sensitivity Analyses of the Main PSM Analyses: The 1:1 Propensity Score Matching with Matched Pairs or Triples Adjusted as Fixed Effects

Additionally, we conducted the sensitivity analysis to test the robustness of 1:2 propensity score matching by comparing estimated mean effects of each outcome of each comparison with those effects derived using 1:1 propensity score matching, in which we did not adjust any remaining covariate or overall propensity score due to the excellent covariates balance after matching. (data not shown) All estimates for each comparison and for each outcome were very similar to those estimates in our main propensity score matching analyses, which indicates 1:2 matching didn't introduce significant bias in our study compared to 1:1 matching.

Web Appendix 3. Sensitivity Analyses of Logistic Regression Models for PSM Models

We present sensitivity analyses for our primary comparison, use of e-cigarettes on the QA vs no use of e-cigarettes on the QA, related to both long-term (12+ months) cigarettes abstinence and nicotine abstinence; and our secondary comparison, use e-cigarettes on the QA vs use pharmaceutical aid on the QA with same endpoints. Overall, we used logistic regression analyses with longitudinal survey weights in parallel to PSM analyses in this section. Missing covariates were imputed with one simple imputation before logistic regression (seed was set to 1000 in R). Bonferroni correction was adjusted to primary comparison related 2 outcomes, and the secondary comparison related 2 outcomes respectively.

a. Primary comparison: use e-cigarettes on the QA vs did not use e-cigarettes on the QA

12+ months cigarette abstinence (Model 1, Web Table 3): Logistic regression of e-cigarette as a cessation aid compared to no e-cigarette on the QA, controlled for relevant propensity score covariates (age, gender, ethnicity, race, education level, income, nicotine dependence (ND), relative perceived harm of e-cigarettes and daily e-cigarettes use at Wave 1 or Wave 2), corrected for multiple (2) comparisons.

12+ months nicotine abstinence (Model 2, Web Table 3): Logistic regression of e-cigarette as a cessation aid compared to no e-cigarette on the the QA, controlled for relevant propensity score covariates (age, gender, ethnicity, race, education level, income, nicotine dependence (ND), relative perceived harm of e-cigarettes and daily e-cigarettes use at Wave 1 or Wave 2), corrected for multiple (2) comparisons.

Findings from the 4.a of sensitivity analyses of the primary comparison (use e-cigarettes on the QA vs did not use e-cigarettes on the QA)

Outcome 1. 12+ months cigarette abstinence: There was no difference in 12+ month cigarettes abstinence at W4 between those who used an e-cigarette to quit and those who did not. The confidence limits on odds ratio crossed 1.0.

Outcome 2. 12+ months nicotine abstinence: There was statistically significant difference in 12+ month nicotine abstinence at W4 between those who used an e-cigarette to quit and those who did not. The confidence limits on odds ratio didn’t cross 1.0. Using an e-cigarette to quit prior to W3 caused 5 percent decrease in 12+ month nicotine abstinenc at W4 compared to not using an e-cigarette to quit prior to W3.

b. Secondary comparison: use e-cigarettes on the QA vs use pharmaceutical aid on the QA

12+ months cigarette abstinence (Model 3, Web Table 3): Logistic regression of e-cigarette as a cessation aid compared to pharmaceutical aid on the the QA, controlled for relevant propensity score covariates (age, gender, ethnicity, race, education level, income, nicotine dependence (ND), relative perceived harm of e-cigarettes and daily e-cigarettes use at Wave 1 or Wave 2), corrected for multiple (2) comparisons.

12+ months nicotine abstinence (Model 4, Web Table 3): Logistic regression of e-cigarette as a cessation aid compared to pharmaceutical aid on the the QA, controlled for relevant propensity score covariates (age, gender, ethnicity, race, education level, income, nicotine dependence (ND), relative perceived harm of e-cigarettes and daily e-cigarettes use at Wave 1 or Wave 2), corrected for multiple (2) comparisons.

Findings from the 4.b of sensitivity analyses of the second secondary comparison (use e-cigarettes on the QA vs use pharmaceutical aid on the QA)

Outcome 1. 12+ months cigarette abstinence: There was no difference in 12+ month cigarettes abstinence at W4 between those who used an e-cigarette to quit and those who used pharmaceutical aid only to quit. The confidence limits on odds ratio crossed 1.0.

Outcome 2. 12+ months nicotine abstinence: There was no difference in 12+ month nicotine abstinence at W4 between those who used an e-cigarette to quit and those who used pharmaceutical aid only to quit. The confidence limits on odds ratio crossed 1.0.

Web Table 3. Sensitivity Analyses of Logistic Regression Models for PSM Models

Model	Comparison Groups	Outcome Assessment	Risk Difference	Risk Ratio	Odds Ratio	Adj 95% CI for OR
1	E-cigarette on the QA vs no e-cigarette on the QA	12+ months **cigarette abstinence** at W4	0.02	1.14	1.20	0.78, 1.85
2	E-cigarette on the QA vs no e-cigarette on the QA	12+ months **nicotine abstinence** at W4	-0.05	0.35	0.38	0.15, 0.99
3	E-cigarette on the QA vs pharmaceutical aid on the QA	12+ months **cigarette abstinence** at W4	0.04	1.42	1.36	0.64, 2.88
4	E-cigarette on the QA vs pharmaceutical aid on the QA	12+ months **nicotine abstinence** at W4	-0.03	0.50	0.42	0.11, 1.57

Logistic regression models adjusted for covariates age, gender, ethnicity, race, education level, income, nicotine dependence (ND), relative perceived harm of e-cigarettes and daily e-cigarettes use at Wave 1 or Wave 2; Model details and findings are included in Web Appendix 5.

Web Appendix 4. Sensitivity Analyses of Logistic Regression Models for Interactions between E-cigarette Use and Key Covariates on Cigarette Abstinence/ Nicotine Abstinence

We present sensitivity analyses for testing whether e-cigarette use on cigarette abstinence/ nicotine abstinence was different by study key covariates: baseline smoking status (daily vs non-daily cigarette smoking at Wave 2), nicotine dependence (nicotine dependence scale <50 vs >=50), age (<35 vs >=35), sex (male vs female), education level (at least some college or higher vs others) and race & ethnicity (non-Hispanic white vs others). Logistic regressions were conducted, and one of the key covariates listed above, the e-cigarette use and their interaction were included as predictors in each of the logistic regression models. Those with missing covariates were removed in the logistic regression models.

1 (Models 1.1 and 1.2 in Web Table 4). Interaction between e-cigarette use and baseline smoking status on cigarette abstinence/ nicotine abstinence

Logistic regression of e-cigarette use, baseline smoking status and their interaction

on cigarette abstinence/ nicotine abstinence

2 (Models 2.1 and 2.2 Web Table 4). Interaction between e-cigarette use and nicotine dependence on cigarette abstinence/ nicotine abstinence

Logistic regression of e-cigarette use, nicotine dependence and their interaction

on cigarette abstinence/ nicotine abstinence

3 (Models 3.1 and 3.2 Web Table 4). Interaction between e-cigarette use and age on cigarette abstinence/ nicotine abstinence

Logistic regression of e-cigarette use, age and their interaction

on cigarette abstinence/ nicotine abstinence

4 (Models 4.1 and 4.2 Web Table 4). Interaction between e-cigarette use and sex on cigarette abstinence/ nicotine abstinence

Logistic regression of e-cigarette use, sex and their interaction

on cigarette abstinence/ nicotine abstinence

5 (Models 5.1 and 5.2 Web Table 4). Interaction between e-cigarette use and education level on cigarette abstinence/ nicotine abstinence

Logistic regression of e-cigarette use, education level and their interaction

on cigarette abstinence/ nicotine abstinence

6 (Models 6.1 and 6.2 Web Table 4). Interaction between e-cigarette use and race & ethnicity on cigarette abstinence/ nicotine abstinence

Logistic regression of e-cigarette use, race & ethnicity and their interaction

on cigarette abstinence/ nicotine abstinence

Findings from outcome 1. 12+ months cigarette abstinence: None of the interactions between the key covariates and e-cigarette use were statistically significant, which indicates that there were no difference of e-cigarette use on cigarette abstinence among those with different baseline smoking status, nicotine dependence, age, sex, education level and race & ethnicity The confidence limits on odds ratio crossed 1.0.

The interaction between e-cigarette use and baseline smoking status on cigarette abstinence was nearly significant, and daily baseline cigarette users were more likely to be cigarette abstinence at Wave 4 if they used e-cigarette at Wave 3, compared to non-daily baseline cigarette users (OR for the interaction: 2.15, 95% CI: 0.99, 4.68). However, e-cigarette use was not significant to cigarette abstinence among either daily baseline cigarette users or non-daily users. In detail, among daily baseline cigarette users, the odds ratio for cigarette abstinence comparing those who used e-cigarette to quit and those who didn't use e-cigarette to quit was 1.52 (95% CI: 0.95, 2.42). Among non-daily baseline cigarette users, the odds ratio for cigarette abstinence comparing those who used e-cigarette to quit and those who didn't use e-cigarette to quit was 0.71 (95% CI: 0.38, 1.30).

Findings from outcome 2. 12+ months nicotine abstinence: None of the interactions between the key covariates and e-cigarette use were statistically significant, which indicates that there were no difference of e-cigarette use on nicotine abstinence among those with different baseline smoking status, nicotine dependence, age, sex, education level and race & ethnicity The confidence limits on odds ratio crossed 1.0.

The interaction between e-cigarette use and education level on nicotine abstinence was nearly significant, and those who were more educated were less likely to be nicotine abstinence at Wave 4 if they used e-cigarette at Wave 3, compared to non-daily baseline cigarette users (OR for the interaction: 0.21 95% CI: 0.04, 1.04). In detail, e-cigarette use was significant to nicotine abstinence among those who were more educated, the odds ratio for nicotine abstinence comparing those who used e-cigarette to quit and those who didn't use e-cigarette to quit was 0.13 (95% CI: 0.03, 0.48). E-cigarette use was not significant to nicotine abstinence among those who were less educated, and the odds ratio for nicotine abstinence comparing those who used e-cigarette to quit and those who didn't use e-cigarette to quit was 0.59 (95% CI: 0.24, 1.46).

Web Table 4. Sensitivity Analyses of Logistic Regression Models for Interactions between E-cigarette Use and Key Covariates on Cigarette Abstinence/ Nicotine Abstinence

Model	Interaction	Outcome Assessment	Odds Ratio	Adj 95% CI for OR
1.1	E-cigarette use and baseline smoking status	12+ months cigarette abstinence at W4	2.15	0.99, 4.68
1.2		12+ months nicotine abstinence at W4	3.05	0.37, 25.25
2.1	E-cigarette use and nicotine dependence	12+ months cigarette abstinence at W4	1.52	0.71, 3.25
2.2		12+ months nicotine abstinence at W4	6.17	0.78, 48.54
3.1	E-cigarette use and age	12+ months cigarette abstinence at W4	0.92	0.42, 2.05
3.2		12+ months nicotine abstinence at W4	0.91	0.17, 4.94
4.1	E-cigarette use and sex	12+ months cigarette abstinence at W4	0.50	0.22, 1.12
4.2		12+ months nicotine abstinence at W4	0.89	0.19, 4.20
5.1	E-cigarette use and education level	12+ months cigarette abstinence at W4	1.07	0.49, 2.34
5.2		12+ months nicotine abstinence at W4	0.21	0.04, 1.04
6.1	E-cigarette use and race & ethnicity	12+ months cigarette abstinence at W4	1.54	0.57, 4.17
6.2		12+ months nicotine abstinence at W4	0.89	0.17, 4.69

Logistic regressions were conducted, the e-cigarette use and their interaction were included as predictors in each of the logistic regression models along with covariates baseline smoking status (daily vs non-daily cigarette smoking at Wave 2), nicotine dependence (nicotine dependence scale <50 vs >=50), age (<35 vs >=35), sex (male vs female), education level (at least some college or higher vs others) and race & ethnicity (non-Hispanic white vs others). Those with missing covariates were removed in the logistic regression models. Model details and findings are included in Web Appendix 6.