Certara Tobacco User Population Dynamics Model

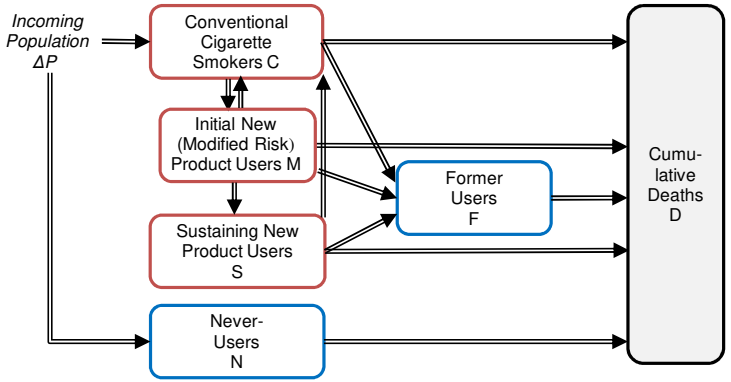
v. 2.15, 12/2018

This workbook uses Excel Visual Basic macros when you click on the buttons. You might need to enable them, using File, Options, Trust Center, Trust Center Settings, Macro Settings, Enable All Macros.

Model Purpose

To predict long-term cigarette and New Product use prevalence and effects on mortality in an evolving population with births and deaths. The New Product here is a Very Low Nicotine (VLN) cigarette.

Model Diagram



New Product users are assumed to use the new product for one year, then revert to conventional cigarettes (CC) or become sustaining users (reverting to CCs at a slower rate).
A specified proportion of New Product users reduce their cigarettes per day (CPD), which reduces relative risk of dying (with a one-year lag).
Former users are tracked by the number of years since quitting: 1, 2, ...,29, 30+. Relative risk of dying declines slowly with years since quitting toward never-smoker levels.
Cessation (quitting) is assumed permanent, or rather, is defined as permanent.
See separate documentation for more detail.

Excel Tips

- Sheets are generally independent, not linked to each other (exception: mortality difference relative to a conventional-cigarettes-only reference case on another sheet). Simply copy and edit sheets and plots to make comparisons.
- Copy a sheet by Control-dragging its tab (hold down the Ctrl key). Similarly, copy a plot by Ctrl-dragging it. If you have trouble, just right-click to get a menu (good general advice).
- Open and close Excel's outlining (which hides rows and columns) with the numbered boxes or + and - symbols. You may add and remove outlining with Alt-Shift-Right-Arrow and Alt-Shift-Left-Arrow.
- Using the Tornado sheet requires making a "multiple selection" with the Control key (click on selection area 1, Ctrl-click on selection area 2).
- Red triangles in the upper right of cells indicate cell comments; hover the pointer over these to read them.
- The model sheets are identical except for inputs; keep them that way (see group editing tip).
- To avoid accidentally changing calculations, you can use Format, Protect Sheet... (accept defaults). Then you can change only inputs (and macro outputs), and the Tab key will step through these.
- Advanced users can edit multiple model sheets at once (e.g., to change inputs consistently), using Excel's group editing feature (Ctrl-Select tabs; caution: remember to return to single-sheet editing!).
- Advanced users can review the button actions by opening the Visual Basic macros behind the buttons (Alt-F11; exit VB with Alt-q).

Model Usage Examples

1. Basic runs

a. Copy a model sheet, rename the new sheet, and give it a title in cell A1 and description in cell A2.
b. Rerun the simulation by clicking the Run button. Confirm that results are unchanged.
c. Rerun the simulation with an input change of interest. Verify that results changed in the expected direction.

2. Determine key uncertainties with a tornado chart.

a. Copy a model sheet, rename the new sheet, and give it a descriptive label and description in cells A1 and A2.
b. Update inputs including the table of Low, Base, and High New Product inputs as desired; add Low, Base, and High inputs for other inputs if needed.
c. Copy and rename one of the Tornado sheets; move it after the new model sheet.
d. On the model sheet, multiple-select Low, Base, and High values and then the output cell as instructed in the Tornado sheet.
e. Click the Make Tornado button on the Tornado sheet.
f. Clean up the resulting tornado chart, e.g., improve the title and axis scale.
g. Check that low and high inputs have the expected direction of effect (high or low) on the output, and that any inputs with no effect on the output are understood.

3. Evaluate tradeoffs with break-even analyses.

For any input resulting in a negative change in the tornado chart, find the value of another variable that exactly offsets this, restoring the base case.

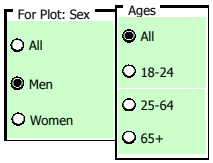
Model Table

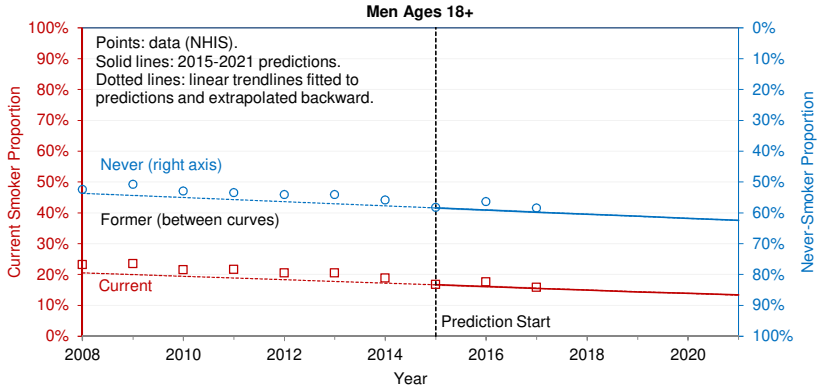
Tip: after using a hyperlink below, use Alt-LeftArrow to return here.

Sheet Name	Based on sheet	Title	Description
CC	Both	Population Dynamics Model	CC only, 9/2018 (same as Both model except no M_IntroYr)
Both	-	Population Dynamics Model	Both products, 9/2018
CCMandate	CC	Population Dynamics Model--Apelberg 2018-like	CC only, 11/2018
BothMandate	Both	Population Dynamics Model--Apelberg 2018-like	Both products, 11/2018
BothMandate2030	BothMandate	Population Dynamics Model--Apelberg 2018-like	Both products, 11/2018
CCNewOnly	Both	Population Dynamics Model--2015 New Pop. Cohort	CC only, 9/2018 (same as Both model except no M_IntroYr)
BothNewOnly	-	Population Dynamics Model--2015 New Pop. Cohort	Both products, 9/2018
CCto24	Both	Population Dynamics Model--2015 18-24 Year-Old Cohort	CC only, 9/2018 (same as Both model except no M_IntroYr)
BothTo24	-	Population Dynamics Model--2015 18-24 Year-Old Cohort	Both products, 9/2018
CC25to64	Both	Population Dynamics Model--2015 25-64 Year-Old Cohort	CC only, 9/2018 (same as Both model except no M_IntroYr)
Both25to64	-	Population Dynamics Model--2015 25-64 Year-Old Cohort	Both products, 9/2018
CCGT64	Both	Population Dynamics Model--2015 65+ Year-Old Cohort	CC only, 9/2018 (same as Both model except no M_IntroYr)
BothGT64wSum	-	Population Dynamics Model--2015 65+ Year-Old Cohort	Both products, 9/2018

NHIS Smoker Proportions Compared to Predictions Extrapolated Backward

		NHIS										From Model (CC sheet):						
Proportion	Year:	2008	2009	2010	2011	2012	2013	2014	**2015**	2016	2017	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*
Smoker		20.6%	20.6%	19.3%	19.0%	18.1%	17.8%	16.8%	15.1%	15.5%	14.0%	15.1%	14.5%	13.9%	13.4%	12.8%	12.4%	11.9%
Former smoker		21.6%	22.0%	21.7%	21.8%	22.2%	22.0%	21.9%	21.9%	22.2%	22.5%	21.9%	21.9%	21.9%	21.9%	21.9%	21.8%	21.7%
Never-smoker		*57.8%*	*57.4%*	*59.0%*	*59.2%*	*59.8%*	*60.2%*	*61.3%*	*63.0%*	*62.3%*	*63.6%*	63.0%	63.6%	64.2%	64.7%	65.3%	65.8%	66.4%
Smoker	Men	23.1%	23.5%	21.5%	21.6%	20.5%	20.5%	18.8%	16.7%	17.5%	15.8%	16.8%	16.1%	15.5%	14.9%	14.4%	13.9%	13.4%
Smoker	Women	18.3%	17.9%	17.3%	16.5%	15.8%	15.3%	14.8%	13.6%	13.5%	12.2%	13.5%	12.9%	12.4%	11.9%	11.4%	10.9%	10.5%
Smoker	Men 18-24	23.6%	28.0%	22.8%	21.3%	20.1%	21.9%	18.5%	15.0%	14.7%	12.0%	15.0%	15.7%	16.3%	16.9%	17.3%	17.7%	17.9%
Smoker	Women 18-24	19.0%	15.6%	17.4%	16.4%	14.5%	15.4%	14.8%	11.0%	11.5%	8.8%	11.0%	11.3%	11.6%	11.9%	12.0%	12.2%	12.2%
Smoker	Men 25-64	25.6%	25.5%	23.8%	24.4%	22.8%	22.6%	21.1%	18.9%	20.0%	18.4%	18.9%	18.0%	17.1%	16.4%	15.6%	14.9%	14.3%
Smoker	Women 25-64	20.8%	20.5%	19.5%	19.1%	18.4%	17.6%	17.0%	15.9%	15.7%	14.3%	15.9%	15.1%	14.4%	13.7%	13.1%	12.5%	11.9%
Smoker	Men 65+	10.5%	9.5%	9.7%	8.9%	10.6%	10.6%	9.8%	9.7%	10.1%	9.0%	9.7%	9.1%	8.7%	8.4%	8.1%	7.8%	7.5%
Smoker	Women 65+	8.3%	9.5%	9.3%	7.1%	7.5%	7.5%	7.5%	7.3%	7.7%	7.5%	7.3%	7.0%	6.8%	6.5%	6.3%	6.1%	5.9%
Plot:	*1=Men, 2=Women, 3=All*	1	*1=18-24, 2=25-64, 3=65+, 4=All*				4		Men Ages 18+									
Smoker		23.1%	23.5%	21.5%	21.6%	20.5%	20.5%	18.8%	16.7%	17.5%	15.8%	16.8%	16.1%	15.5%	14.9%	14.4%	13.9%	13.4%
Never-smoker		52.4%	50.8%	53.0%	53.5%	54.1%	54.1%	55.9%	58.3%	56.4%	58.5%	58.4%	59.1%	59.8%	60.5%	61.1%	61.8%	62.4%





Population Dynamics Model

Input | Input formula (OK to change) | Button output

CC only, 9/2018 (same as Both model except no M_IntroYr)

Based on: Both

Name	Value	Units	Description	Link	Source, Comments
Population Inputs					
Year0	2015		First forecast year		Changing requires updating data below.
Pop0	247.411	million	Initial US adult (≥18) population in first forecast year		2015 US Census estimates (see spreadsheet). Used only to scale calculated proportions to total counts.
Pop0Dists	(table)	%	Initial proportion of total population with each age & sex		same

	Age	Men	Women	Men/Total
PropMAt18	18	0.0087	0.00833	0.51108
	19	0.00881	0.00838	
	20	0.00904	0.00856	
	21	0.00923	0.00873	
	22	0.0094	0.00886	
	23	0.00963	0.00913	
	24	0.00976	0.00935	
	25	0.00972	0.00936	
	26	0.00933	0.009	
	27	0.0091	0.00881	
	28	0.00894	0.00867	
	29	0.00897	0.00872	
	30	0.00901	0.00882	
	31	0.0087	0.00858	
	32	0.00881	0.00873	
	33	0.00879	0.00874	
	34	0.00868	0.00866	
	35	0.00888	0.0088	
	36	0.00829	0.00829	
	37	0.00811	0.00814	
	38	0.00801	0.00808	
	39	0.00777	0.00785	
	40	0.00803	0.00807	
	41	0.00774	0.00785	
	42	0.00784	0.008	
	43	0.0082	0.00835	
	44	0.00866	0.00883	
	45	0.0088	0.0089	
	46	0.00833	0.00845	
	47	0.00814	0.00829	
	48	0.00813	0.00832	
	49	0.00828	0.00847	
	50	0.00877	0.00899	
	51	0.00889	0.00919	
	52	0.00886	0.0092	
	53	0.00882	0.00919	
	54	0.0089	0.00932	
	55	0.00899	0.00938	
	56	0.00865	0.0091	
	57	0.00857	0.00907	
	58	0.00844	0.00899	
	59	0.00811	0.00869	
	60	0.00802	0.00863	
	61	0.00764	0.00832	
	62	0.00733	0.00802	
	63	0.00703	0.00771	
	64	0.00677	0.0075	
	65	0.00661	0.00732	
	66	0.00639	0.00711	
	67	0.00631	0.00703	
	68	0.00656	0.00732	
	69	0.0048	0.00543	
	70	0.00469	0.00537	
	71	0.00453	0.00524	

72	0.00461	0.00537	
73	0.00397	0.0047	
74	0.00358	0.00432	
75	0.00335	0.00408	
76	0.00313	0.00383	
77	0.00294	0.00368	
78	0.00267	0.0034	
79	0.0025	0.00325	
80	0.00234	0.00312	
81	0.00205	0.0028	
82	0.00193	0.00271	
83	0.00179	0.00259	
84	0.00164	0.00246	
85	0.00151	0.00235	
86	0.00131	0.00211	
87	0.00116	0.00197	
88	0.001	0.00178	
89	0.00084	0.00157	
90	0.00071	0.0014	
91	0.00058	0.0012	
92	0.00046	0.001	
93	0.00036	0.00083	
94	0.00027	0.00067	
95	0.00019	0.00051	
96	0.00013	0.00036	
97	9.3E-05	0.00028	
98	5.9E-05	0.00019	
99	3.9E-05	0.00014	
100 +	6.1E-05	0.00025	
PropM 0.48679	0.48679	0.51321	

NewPop	2.010%	%/y	Annual new 18-year-olds plus additional net migration	Model of 2017 US Census projections (see spreadsheet). (Annual new 18-year-olds = initial pop. x 18yo proportion.)
NewPG1	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 1 https://wv	Model of 2017 US Census projections (see spreadsheet)
NewPY2	2035		First year of Period 2	same
NewPG2	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 2	same

Cigarette Initiation, Use Rate, and Cessation Inputs

InitRts (table) % — Proportion initiating cigarettes (modeled at 18 years old) — 2015 NHIS maximum prevalence over 18-25 yrs old.

InitRtAnMults (table) % — Annual multiplier for proportion initiating cigarettes — 2015-2017 NHIS max. prevalence change rate

Men	Women	Wtd. av.
22.20%	15.39%	18.70%
96.97%	96.28%	96.61%

	Low	Base	High
InitRtMult 1 — Initiation rate multiplier for sensitivity analysis	0.75	1	1.25

IStats (table) % — Smoking status proportions in initial population — 2015 NHIS

	Men			Women		
Age from to	Current	Former	Never	Current	Former	Never
18 24	15.02%	5.23%	79.75%	10.98%	4.27%	84.75%
25 64	18.87%	22.06%	59.08%	15.92%	17.79%	66.28%
65 +	9.70%	50.89%	39.41%	7.35%	31.25%	61.40%
Wtd. av.	8.12%	11.94%	28.62%	6.90%	9.63%	34.80%
M+W	15.02%	21.57%	63.42%			

Total Pop. Props.

Men	Women
0.07431	0.0707
0.32732	0.33475
0.08516	0.10775

Men			Women		
Current	Former	Never	Current	Former	Never
1.12%	0.39%	5.93%	0.78%	0.30%	5.99%
6.18%	7.22%	19.34%	5.33%	5.96%	22.19%
0.83%	4.33%	3.36%	0.79%	3.37%	6.62%

YrQuitSlp 0.515 — Slope of years since quitting vs. (age-18)--former smkrs. — 2017 NHIS (see spreadsheet). For initial population only (simulated after that). No sex difference seen.

CPDERSlope 0.35 — Slope of CPD-Excess Risk relationship — See CPDERFacs

Low	Base	High
0.1	0.35	0.6

CPDProps (table) % — Avg. proportions in CPD (on days smoked) categories — 2017 NHIS, on days smoked.

CPDDayFracs (table) % — Average fraction of days smoked (unused) — 2017 NHIS, mean # days smoked in last 30 days / 30

CPDERFacs (table) — ER (RR-1) factors to adjust for CPD — Simple model based on Thun 2013 (Table S3), Thun 1997, and Bjartveit 2005. See formulas and separate spreadsheet.

CPDRedFacs (table) — ER factors to adjust for reduced CPD — Same as CPDERFacs except at CPD reduced by M_CPDRed

	CPDProps		CPDDayFracs			Unscaled CPDERs		CPDERFacs		CPDRedFacs	
CPD from to	Men	Women	Men	Women	CPD Midpt.	Men	Women	Men	Women	Men	Women
0 1.5	6.80%	5.00%	35.53%	42.04%	0.75	0.233	(same)	0.205	0.149	0.108	0.079
1.5 5.5	23.71%	24.49%	67.24%	77.02%	3.5	0.800		0.703	0.512	0.420	0.306
5.5 15.5	38.48%	46.67%	94.60%	96.61%	10.5	1.542		1.355	0.987	0.916	0.668
15.5 25.5	24.63%	20.72%	99.02%	98.92%	20.5	2.101		1.846	1.345	1.339	0.975
25.5 35.5	3.84%	1.84%	99.83%	96.12%	30.5	2.457		2.160	1.573	1.623	1.182
35.5 +	2.54%	1.28%	97.83%	94.80%	*40.5*	2.720		2.390	1.741	1.837	1.338

	Wtd. Av. CPD	12.1703	11.1222	11.5738	10.6429	1.4798639	1.442646	1.30044	0.9236			0.89825	0.63142
		on days smoked		over all days		Wtd. Av. unscaled		Wtd. Av. CPDERFac (normalized to Smoker RR)					

QuitParms	(table)	Quit (cessation) rates by age & sex																	
		Men	Women																
	Quit rate at age 18	2.51%	2.52%																
	Linear Slope (%/y)	0.0442%	0.0437%																
	Age Exponential Starts	60	50																
	Quit rate at this age	4.30%	3.98%																
	Ann. Age Multiplier	1.036	1.031																
	Weighted Average	4.16%	4.82%	4.50%															
QuitRtMult	1	Quit rate multiplier for sensitivity analysis																	

Holford 2015: 1980 cohort, modeled (see spreadsheet), adjusted from 3.53% to reach 4.5% mean from Mendez 2016

	Low	Base	High
	0.75	1	1.25

Death Rate Inputs

DRMult	1.2	Multiplier to adjust all death rates (1=no change)																	
DRAnMult	0.99	Annual mortality rate multiplier																	
NSDRs, RRs	(table)	/100,000/y	Annual mortality rate and Relative Risk (RR)																
		Never-Smoker Rate/10^5		Smoker RR		Smoker Rate/10^5													
	Age from to	Men	Women	Men	Women	Men	Women												
	18 34	0	0	1	1	0	0												
	35 54	250	195	2.55	1.79	637.5	349.05												
	55 59	299	265	3.69	2.66	1102	705												
	60 64	530	361	3.39	2.96	1795	1069												
	65 69	826	577	3.49	3.12	2880	1799												
	70 74	1356	913	3.26	3.05	4424	2789												
	75 79	2323	1552	2.62	2.65	6078	4119												
	80 84	4340	2902	2.37	2.28	10278	6629												
	85 89	8108	5426	2.14	1.97	17380.3	10668.5												
	90 94	15149	10146	1.94	1.69	29390.3	17169.6												
	95 99	28302	18972	1.76	1.46	49699.5	27632.3												
	100 +	52875.2	35474.8	1.59	1.25	84042.8	44470.6												
	Wtd. Av.	627.906	608.02	2.30044	1.9236	1629.85	1315.9												
				Should = Wtd. Av. CPDERFacs + 1															

http://ww Thun 2013 Table S2 (5 contemporary cohorts, 2000-2010)

<35: simple assumptions since no data

http://ww USDHHS 2014 Table 12.3: RR for 35-54 age gr

Proportion of Pop.	
Men	Women
0.1546421	0.149448
0.1674547	0.1705781
0.0427553	0.0452407
0.0367839	0.0401857
0.0306662	0.0342217
0.0213879	0.0250049
0.0145852	0.0182364
0.009747	0.0136853
0.0058204	0.009782
0.0023756	0.0050931
0.0005158	0.0014792
6.101E-05	0.00025
0.4867949	0.5132051

ERChgs	(table)	1/y	ER change rate with years after quitting		
	Age quit from to	Men	Women		
	18 34	-0.095	-0.095		
	35 54	-0.095	-0.095		
	55 59	-0.0725	-0.0725		
	60 64	-0.06	-0.06		
	65 69	-0.05	-0.05		
	70 74	-0.04	-0.04		
	75 79	-0.03	-0.03		
	80 84	-0.02	-0.02		
	85 89	-0.01	-0.01		
	90 94	-0.01	-0.01		
	95 99	-0.01	-0.01		
	100 +	-0.01	-0.01		

Exponential declines toward ER=0, based on results in Mendez 2001 (see spreadsheet)

New Product (MRTP) Inputs

				Low	Base	High
M_IntroYr		Year VLN product is introduced	Set >= 1st year, or blank (none).			
M_CtoM	**7.1%**	C-I: Peak annual rate CC smokers switch to VLN		4.2%	7.1%	10.0%
M_CtoMYAM	1	C-Im: Young adult (<=24) multiplier for rate CC smokers switch		0.5	1	1.5
M_CtoMYr	**5**	Years until peak rate that CC smokers switch - linear growth	>=0	2	5	10
M_MtoS	50%	I-S: Proportion of initial VLN smokers sustaining use beyond 1 year	Remainder revert to CC. Cf. dropout	25%	50%	75%
M_StoC	**10%**	S-C: Annual rate sustaining VLN smokers relapse to CCs	(Can be correlated with above)	0%	10%	20%
M_CPDRedF	80%	CPDf: Proportion of VLN smokers reducing CPD	Hatsukami 2018 (approximated)	60%	80%	100%
M_CPDRed	50%	CPDr: Av. reduction in CPD among VLN smokers reducing CPD	Hatsukami 2018 (approximated)	40%	50%	60%
M_MtoFRel	118%	S-Fm: Quit rate for VLN smokers as % of CC quit rate		100%	118%	**150%**
M_ERR	100%	ERR: prop. of CC smoker Excess Risk experienced by VLN smokers		90%	100%	110%

Results

Run through year 2100

Last run took 3.92 seconds (12/9/2018 9:28:21 PM).

☐ Create workbook with detailed results (slow)

Year #:	0	1	2	3	4	5	6	7	8	9	15	25	35	45	55	85
Year:	*2015*	2016	2017	2018	2019	2020	2021	2022	2023	2024	2030	2040	2050	2060	2070	2100
1 Total adult population relative to that of 2015	1	1.00997	1.01999	1.02996	1.03987	1.04967	1.05938	1.06893	1.07831	1.08752	1.13873	1.20579	1.2542	1.2969	1.34226	1.44701
2 C: conventional cig. smoker proportion	15.10%	14.48%	13.90%	13.36%	12.85%	12.37%	11.91%	11.47%	11.05%	10.65%	8.59%	6.12%	4.45%	3.25%	2.35%	0.85%

3	C+M: CC + 1st-year New Product proportion				15.10%	14.48%	13.90%	13.36%	12.85%	12.37%	11.91%	11.47%	11.05%	10.65%	8.59%	6.12%	4.45%	3.25%	2.35%	0.85%
4	C+M+S: total smoker proportion				**15.10%**	**14.48%**	**13.90%**	**13.36%**	**12.85%**	**12.37%**	**11.91%**	**11.47%**	**11.05%**	**10.65%**	**8.59%**	**6.12%**	**4.45%**	**3.25%**	**2.35%**	**0.85%**
5	F: former smoker proportion				21.86%	21.91%	21.92%	21.90%	21.86%	21.80%	21.71%	21.61%	21.48%	21.35%	20.25%	17.74%	15.01%	12.19%	9.36%	3.56%
6	N: never-smoker proportion				63.04%	63.62%	64.18%	64.74%	65.29%	65.84%	66.38%	66.92%	67.46%	68.00%	71.17%	76.15%	80.54%	84.56%	88.29%	95.59%
7	D: annual deaths as proportion of initial population				0	0.01013	0.01009	0.01013	0.0102	0.0103	0.0104	0.01055	0.01073	0.01089	0.0121	0.01443	0.01577	0.01576	0.01557	0.01771
8	Total smoker death rate				0.00%	1.55%	1.43%	1.35%	1.29%	1.24%	1.21%	1.19%	1.17%	1.15%	1.07%	0.98%	0.87%	0.80%	0.79%	0.76%
9	Former smoker death rate				0.00%	1.59%	1.62%	1.66%	1.69%	1.73%	1.75%	1.78%	1.82%	1.86%	2.10%	2.47%	2.69%	3.10%	3.67%	3.96%
10	Never-smoker death rate				0.00%	0.68%	0.68%	0.68%	0.68%	0.69%	0.69%	0.70%	0.70%	0.71%	0.77%	0.92%	1.01%	0.96%	0.90%	1.13%
11	Men 18-24				0.06459	0.0651	0.06574	0.06661	0.06765	0.06889	0.07035	0.07192	0.07192	0.07192	0.07192	0.07192	0.07192	0.07192	0.07192	0.07192
12	All 18-24				0.12592	0.12691	0.12826	0.1301	0.13224	0.13475	0.13765	0.14073	0.14073	0.14073	0.14073	0.14073	0.14073	0.14073	0.14073	0.14073
13	+ Men 25-64				0.46297	0.46552	0.46814	0.47082	0.47342	0.47591	0.4786	0.4811	0.48205	0.48298	0.48861	0.50724	0.52569	0.53648	0.54084	0.54431
14	All 18-64				0.80709	0.81061	0.81382	0.81657	0.81887	0.82064	0.82244	0.82374	0.82496	0.82619	0.83373	0.86576	0.89816	0.91867	0.92668	0.93217
15	+ Men 65+				0.89225	0.89851	0.9047	0.91066	0.91637	0.92179	0.92718	0.93225	0.93721	0.9421	0.96963	1.01724	1.05795	1.09238	1.12136	1.17707
16	All		(Same as top row)		1	1.00997	1.01999	1.02996	1.03987	1.04967	1.05938	1.06893	1.07831	1.08752	1.13873	1.20579	1.2542	1.2969	1.34226	1.44701
17	Men	C+M+S	(Proportion of total adult pop.)		8.15%	7.83%	7.54%	7.26%	7.01%	6.76%	6.53%	6.31%	6.10%	5.90%	4.85%	3.57%	2.69%	2.03%	1.51%	0.59%
18	Women	C+M+S			6.94%	6.64%	6.36%	6.09%	5.84%	5.60%	5.38%	5.16%	4.95%	4.76%	3.74%	2.54%	1.76%	1.22%	0.84%	0.26%
19	Men	F			12.11%	12.08%	12.04%	11.99%	11.92%	11.85%	11.77%	11.67%	11.58%	11.47%	10.71%	9.22%	7.82%	6.43%	5.02%	2.10%
20	Women	F			9.75%	9.83%	9.88%	9.92%	9.94%	9.95%	9.94%	9.93%	9.91%	9.88%	9.54%	8.52%	7.19%	5.76%	4.34%	1.46%
21	Men	N			28.42%	28.76%	29.10%	29.43%	29.76%	30.09%	30.41%	30.74%	31.06%	31.38%	33.25%	36.13%	38.66%	41.00%	43.15%	47.10%
22	Women	N			34.62%	34.86%	35.08%	35.31%	35.53%	35.75%	35.97%	36.19%	36.40%	36.62%	37.92%	40.01%	41.88%	43.56%	45.15%	48.49%
23	Men 18-24	C+M+S			0.97%	1.01%	1.05%	1.09%	1.13%	1.16%	1.19%	1.22%	1.17%	1.13%	0.89%	0.62%	0.44%	0.31%	0.22%	0.08%
24	All 18-24	C+M+S			1.64%	1.71%	1.77%	1.82%	1.87%	1.92%	1.97%	2.01%	1.92%	1.84%	1.44%	0.97%	0.67%	0.47%	0.32%	0.11%
25	+ Men 25-64	C+M+S			8.00%	7.73%	7.48%	7.23%	7.00%	6.78%	6.57%	6.36%	6.13%	5.90%	4.79%	3.54%	2.67%	2.00%	1.44%	0.53%
26	All 18-64	C+M+S			13.48%	12.90%	12.36%	11.84%	11.34%	10.87%	10.43%	10.01%	9.62%	9.24%	7.39%	5.36%	3.94%	2.91%	2.05%	0.71%
27	+ Men 65+	C+M+S			14.31%	13.70%	13.13%	12.60%	12.10%	11.62%	11.17%	10.74%	10.34%	9.95%	7.99%	5.74%	4.20%	3.09%	2.22%	0.80%
28	All	C+M+S			15.10%	14.48%	13.90%	13.36%	12.85%	12.37%	11.91%	11.47%	11.05%	10.65%	8.59%	6.12%	4.45%	3.25%	2.35%	0.85%
29	Men 18-24	F			0.34%	0.31%	0.27%	0.24%	0.20%	0.17%	0.14%	0.10%	0.10%	0.10%	0.08%	0.05%	0.04%	0.03%	0.02%	0.01%
30	All 18-24	F			0.60%	0.54%	0.48%	0.42%	0.36%	0.29%	0.23%	0.17%	0.16%	0.16%	0.12%	0.08%	0.06%	0.04%	0.03%	0.01%
31	+ Men 25-64	F			8.03%	8.01%	7.95%	7.88%	7.80%	7.69%	7.57%	7.44%	7.32%	7.20%	6.36%	5.01%	3.53%	2.36%	1.72%	0.64%
32	All 18-64	F			14.16%	14.17%	14.15%	14.08%	13.98%	13.84%	13.68%	13.49%	13.28%	13.06%	11.50%	8.92%	6.05%	3.85%	2.72%	0.95%
33	+ Men 65+	F			18.49%	18.48%	18.44%	18.37%	18.26%	18.12%	17.97%	17.79%	17.60%	17.39%	15.89%	13.16%	10.36%	7.93%	6.03%	2.41%
34	All	F			21.86%	21.91%	21.92%	21.90%	21.86%	21.80%	21.71%	21.61%	21.48%	21.35%	20.25%	17.74%	15.01%	12.19%	9.36%	3.56%
35	Men 18-24	N			5.15%	5.13%	5.12%	5.14%	5.18%	5.23%	5.31%	5.41%	5.40%	5.39%	5.35%	5.29%	5.26%	5.21%	5.12%	4.88%
36	All 18-24	N			10.35%	10.32%	10.33%	10.39%	10.49%	10.62%	10.79%	10.99%	10.96%	10.94%	10.80%	10.62%	10.49%	10.35%	10.13%	9.60%
37	+ Men 25-64	N			30.26%	30.36%	30.47%	30.60%	30.73%	30.87%	31.04%	31.20%	31.25%	31.31%	31.76%	33.51%	35.72%	37.01%	37.14%	36.44%
38	All 18-64	N			53.07%	53.18%	53.28%	53.37%	53.43%	53.47%	53.52%	53.56%	53.61%	53.67%	54.33%	57.52%	61.61%	64.08%	64.27%	62.76%
39	+ Men 65+	N			56.43%	56.78%	57.12%	57.45%	57.77%	58.07%	58.38%	58.68%	58.98%	59.29%	61.26%	65.47%	69.79%	73.21%	75.29%	78.14%
40	All	N			63.04%	63.62%	64.18%	64.74%	65.29%	65.84%	66.38%	66.92%	67.46%	68.00%	71.17%	76.15%	80.54%	84.56%	88.29%	95.59%
41	Cigarette-attributable deaths relative to initial population				0	0.00196	0.0019	0.00186	0.00182	0.0018	0.00179	0.00178	0.00177	0.00176	0.00169	0.00152	0.0012	0.00099	0.00086	0.00038
	Annual US adult death rate				0.00%	1.00%	0.99%	0.98%	0.98%	0.98%	0.98%	0.99%	1.00%	1.00%	1.06%	1.20%	1.26%	1.22%	1.16%	1.22%
	Annual US adult deaths (millions)				0	2.50619	2.49524	2.50748	2.52334	2.54837	2.57185	2.61068	2.65463	2.69455	2.9932	3.57066	3.90122	3.89935	3.85194	4.38243
	Avoided deaths through each year vs. CC Only (1000s)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Avoided cigarette-attributable deaths through each year vs. CC Only (1000s)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Life-years gained through each year vs. CC only (1000s)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
For plots:					247.411	249.879	252.358	254.825	257.275	259.701	262.103	264.466	266.786	269.065	281.735	298.326	310.303	320.868	332.091	358.008
	Market penetration ((M+S)/(C+M+S))				0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Smoker + former smoker proportion				36.96%	36.38%	35.82%	35.26%	34.71%	34.16%	33.62%	33.08%	32.54%	32.00%	28.83%	23.85%	19.46%	15.44%	11.71%	4.41%
	Population breakdown	M			48.68%	49.16%	49.65%	50.14%	50.63%	51.12%	51.60%	52.08%	52.55%	53.01%	55.57%	58.99%	61.67%	64.14%	66.67%	72.04%
		F			51.32%	51.84%	52.35%	52.85%	53.35%	53.85%	54.33%	54.81%	55.28%	55.74%	58.30%	61.59%	63.75%	65.55%	67.55%	72.66%
		M	18-24		6.46%	6.51%	6.57%	6.66%	6.77%	6.89%	7.04%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%
		M	25-64		33.70%	33.86%	33.99%	34.07%	34.12%	34.12%	34.10%	34.04%	34.13%	34.23%	34.79%	36.65%	38.50%	39.57%	40.01%	40.36%
		M	65+		8.52%	8.79%	9.09%	9.41%	9.75%	10.11%	10.47%	10.85%	11.22%	11.59%	13.59%	15.15%	15.98%	17.37%	19.47%	24.49%
		F	18-24		6.13%	6.18%	6.25%	6.35%	6.46%	6.59%	6.73%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%
		F	25-64		34.41%	34.51%	34.57%	34.57%	34.55%	34.47%	34.38%	34.26%	34.29%	34.32%	34.51%	35.85%	37.25%	38.22%	38.58%	38.79%
		F	65+		10.78%	11.15%	11.53%	11.93%	12.35%	12.79%	13.22%	13.67%	14.11%	14.54%	16.91%	18.86%	19.63%	20.45%	22.09%	26.99%
	Smoker breakdown	M			16.75%	16.09%	15.49%	14.92%	14.39%	13.89%	13.41%	12.95%	12.51%	12.10%	9.93%	7.31%	5.47%	4.10%	3.03%	1.18%
		F			13.53%	12.94%	12.39%	11.88%	11.39%	10.92%	10.48%	10.06%	9.66%	9.28%	7.31%	4.98%	3.45%	2.41%	1.67%	0.52%

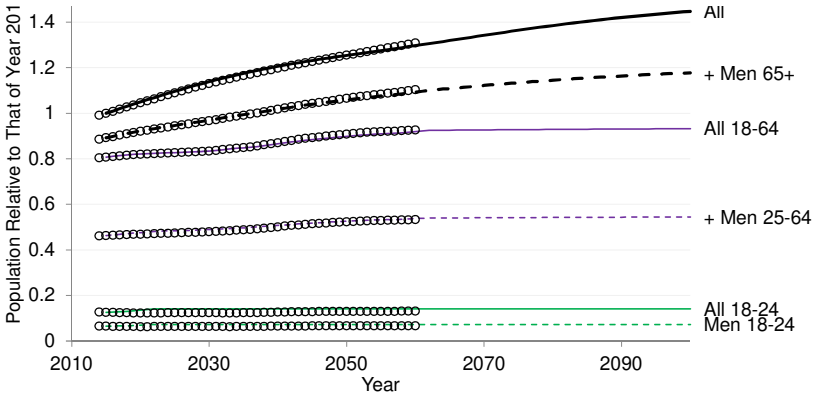
Historical data for calibration				2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Smokers				0.20633	0.20586	0.19349	0.18989	0.18064	0.17815	0.16762	0.15107	0.15466	0.13955
Smokers - backwards extrap. from 2015-20	0.96093	0.15073		0.19923	0.19145	0.18397	0.17678	0.16987	0.16323	0.15686	0.15073	0.14484	0.13918
Former smokers				0.21584	0.22015	0.21699	0.21847	0.22151	0.21958	0.219	0.21868	0.22247	0.22471
Smoker + former smoker proportion				0.42217	0.42601	0.41048	0.40837	0.40215	0.39773	0.38663	0.36975	0.37714	0.36426
Population breakdown for smoker data	M	18-24		14.2869	14.4955	14.789	15.0661	15.0046	15.1748	15.2013	15.0071	14.8735	14.6829
	M	25-64		77.2563	78.5337	78.8207	79.3137	78.98	79.5745	79.8712	80.8266	81.5595	81.647

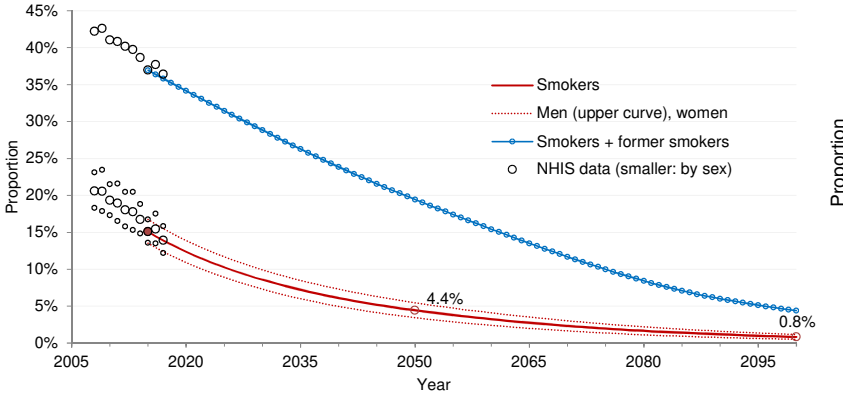
	M	65+	15.8402	16.3168	16.6556	17.3792	18.1936	19.1155	19.7837	20.6116	21.3337	22.06
	F	18-24	14.3693	14.4224	14.5507	14.7116	15.0269	15.0474	14.976	14.7565	14.7769	14.6967
	F	25-64	80.105	81.4769	81.4747	82.1393	82.6652	83.5005	83.7576	84.7056	85.2261	85.3839
	F	65+	20.8631	21.3189	21.702	22.1549	23.1771	24.1104	24.8161	25.6695	26.4953	27.214
	All		*222.72*	*226.56*	*227.99*	*230.76*	*233.05*	*236.52*	*238.41*	*241.58*	*244.27*	*245.68*
Smoker breakdown	M		0.23112	0.23459	0.21516	0.21598	0.20488	0.20496	0.18829	0.16747	0.17544	0.15847
	F		0.18325	0.17907	0.17319	0.16539	0.15815	0.15326	0.14841	0.13581	0.13532	0.12195
	M	18-24	0.23614	0.28002	0.22806	0.21309	0.20122	0.21926	0.18456	0.15017	0.14698	0.11994
	M	25-64	0.25607	0.25515	0.23772	0.24434	0.22829	0.22609	0.21143	0.18865	0.20001	0.18378
	M	65+	0.1049	0.09526	0.09695	0.08906	0.10628	0.10564	0.09775	0.097	0.10135	0.09042
	F	18-24	0.18957	0.15593	0.17359	0.16436	0.14505	0.15423	0.14847	0.10983	0.1154	0.08809
	F	25-64	0.20812	0.2051	0.19455	0.191	0.18372	0.1758	0.17015	0.15923	0.15692	0.14272
	F	65+	0.08341	0.09524	0.09275	0.07113	0.07542	0.0746	0.07496	0.07346	0.07696	0.07507
Smoker cumulative breakdown												
Men 18-24			0.01515	0.01792	0.01479	0.01391	0.01296	0.01407	0.01177	0.00933	0.00895	0.00717
All 18-24			0.02738	0.02784	0.02587	0.02439	0.02231	0.02388	0.02109	0.01604	0.01593	0.01244
+ Men 25-64			0.1162	0.11628	0.10805	0.10837	0.09967	0.09994	0.09193	0.07916	0.08271	0.07351
All 18-64			0.19106	0.19004	0.17758	0.17636	0.16484	0.16201	0.15171	0.13499	0.13746	0.12311
+ Men 65+			0.19852	0.1969	0.18466	0.18306	0.17314	0.17055	0.15982	0.14326	0.14631	0.13123
All			0.20633	0.20586	0.19349	0.18989	0.18064	0.17815	0.16762	0.15107	0.15466	0.13955

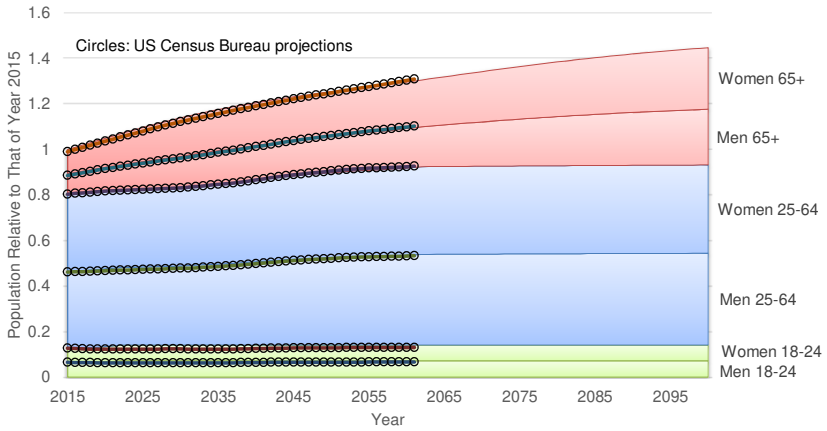
Projections from US Census Bureau (millions)	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2030	2040	2050	2060
Men 18-24	16.1117	15.9795	15.8192	15.6902	15.6436	15.592	15.5264	15.5139	15.535	15.5548	15.582	15.637	15.9602	16.3443	16.5127
All 18-24	31.428	31.1549	30.8438	30.6098	30.5492	30.4781	30.3801	30.3776	30.4275	30.4742	30.531	30.6117	31.2436	32.0147	32.3619
+ Men 25-64	114.212	114.545	114.702	115.021	115.431	115.758	115.965	116.233	116.492	116.747	117.025	118.571	123.974	129.408	131.903
All 18-64	198.834	199.683	200.241	200.975	201.693	202.26	202.621	203.018	203.351	203.681	204.047	206.311	215.445	224.732	229.233
+ Men 65+	219.167	220.752	222.034	223.525	225.029	226.413	227.635	228.872	230.079	231.27	232.473	239.233	251.769	263.463	272.896
All	245.051	247.411	249.485	251.807	254.185	256.486	258.673	260.861	263.062	265.235	267.401	279.449	296.272	310.406	323.909
Scaled to 2015															
Men 18-24	0.06512	0.06459	0.06394	0.06342	0.06323	0.06302	0.06276	0.06271	0.06279	0.06287	0.06298	0.0632	0.06451	0.06606	0.06674
All 18-24	0.12703	0.12592	0.12467	0.12372	0.12348	0.12319	0.12279	0.12278	0.12298	0.12317	0.1234	0.12373	0.12628	0.1294	0.1308
+ Men 25-64	0.46163	0.46297	0.46361	0.4649	0.46655	0.46788	0.46871	0.4698	0.47084	0.47187	0.473	0.47925	0.50109	0.52305	0.53313
All 18-64	0.80366	0.80709	0.80934	0.81231	0.81521	0.81751	0.81896	0.82057	0.82192	0.82325	0.82473	0.83388	0.8708	0.90833	0.92653
+ Men 65+	0.88584	0.89225	0.89743	0.90346	0.90953	0.91513	0.92007	0.92507	0.92994	0.93476	0.93962	0.96694	1.01761	1.06488	1.10301
All	0.99046	**1**	1.00838	1.01777	1.02738	1.03668	1.04552	1.05436	1.06326	1.07204	1.08079	1.12949	1.19749	1.25462	1.30919
Un-accumulated by Age Group for Plot															
Men 18-24	0.06512	0.06459	0.06394	0.06342	0.06323	0.06302	0.06276	0.06271	0.06279	0.06287	0.06298	0.0632	0.06451	0.06606	0.06674
Women 18-24	0.06191	0.06134	0.06073	0.0603	0.06025	0.06017	0.06004	0.06008	0.06019	0.0603	0.06042	0.06053	0.06177	0.06334	0.06406
Men 25-64	0.3346	0.33705	0.33894	0.34118	0.34308	0.34469	0.34592	0.34702	0.34786	0.3487	0.3496	0.35552	0.3748	0.39365	0.40233
Women 25-64	0.34203	0.34412	0.34574	0.34741	0.34866	0.34963	0.35025	0.35077	0.35107	0.35137	0.35173	0.35463	0.36971	0.38528	0.39339
Men 65+	0.08218	0.08516	0.08808	0.09115	0.09432	0.09762	0.1011	0.1045	0.10803	0.11151	0.1149	0.13306	0.14681	0.15655	0.17648
Women 65+	0.10462	0.10775	0.11095	0.11431	0.11784	0.12155	0.12545	0.12929	0.13331	0.13728	0.14117	0.16255	0.17987	0.18974	0.20619

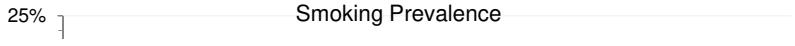
Pop. Unaccumulated By Age Group for Plot																
Men 18-24	0.06459	0.0651	0.06574	0.06661	0.06765	0.06889	0.07035	0.07192	0.07192	0.07192	0.07192	0.07192	0.07192	0.07192	0.07192	0.07192
Women 18-24	0.06134	0.06181	0.06252	0.06349	0.06459	0.06586	0.0673	0.06881	0.06881	0.06881	0.06881	0.06881	0.06881	0.06881	0.06881	0.06881
Men 25-64	0.33705	0.33861	0.33988	0.34072	0.34118	0.34117	0.34095	0.34037	0.34132	0.34225	0.34788	0.36651	0.38496	0.39575	0.40011	0.40358
Women 25-64	0.34412	0.34509	0.34568	0.34575	0.34545	0.34473	0.34383	0.34264	0.34292	0.3432	0.34512	0.35852	0.37247	0.38219	0.38584	0.38787
Men 65+	0.08516	0.0879	0.09089	0.09409	0.0975	0.10114	0.10474	0.10851	0.11225	0.11591	0.1359	0.15148	0.15979	0.17371	0.19468	0.2449
Women 65+	0.10775	0.11146	0.11529	0.1193	0.1235	0.12788	0.1322	0.13668	0.1411	0.14542	0.1691	0.18855	0.19625	0.20452	0.2209	0.26994

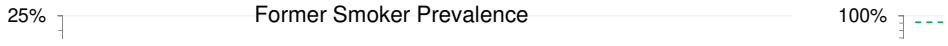
1.6
I5

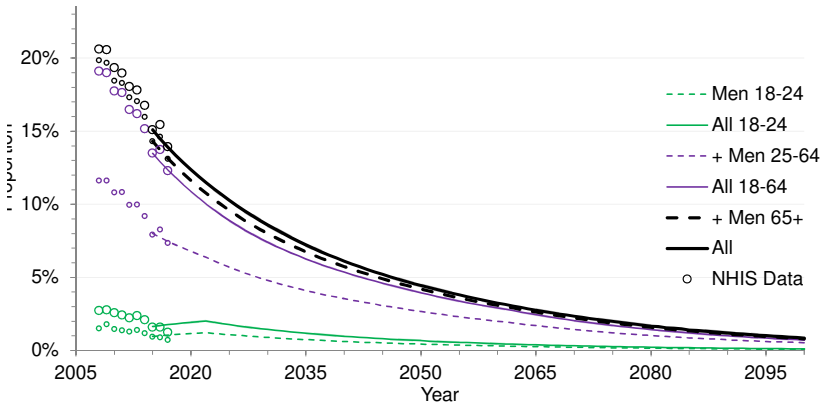

Population Relative to That of Year 201
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2010
2030
2050
2070
2090
Year
All
+ Men 65+
All 18-64
+ Men 25-64
All 18-24
Men 18-24

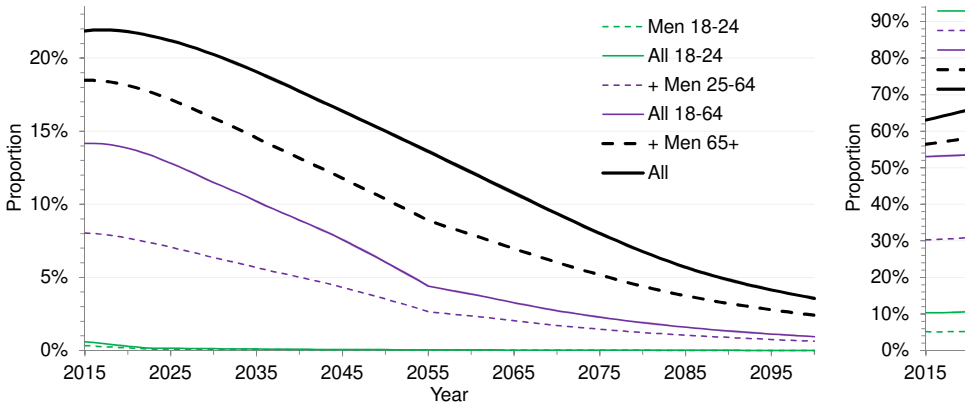

Proportion
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
2005
2020
2035
2050
2065
2080
2095
Year
Smokers
Men (upper curve), women
Smokers + former smokers
NHIS data (smaller: by sex)
4.4%
0.8%

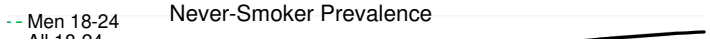

Circles: US Census Bureau projections
Population Relative to That of Year 2015
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2015
2025
2035
2045
2055
2065
2075
2085
2095
Year
Women 65+
Men 65+
Women 25-64
Men 25-64
Women 18-24
Men 18-24

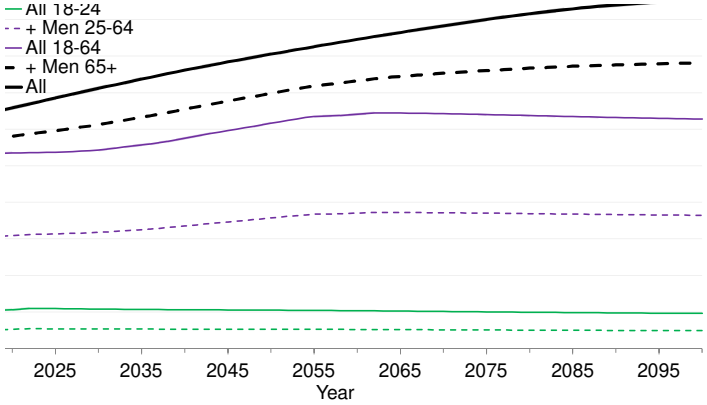

25%
Smoking Prevalence


25%
Former Smoker Prevalence
100%


20%
15%
10%
5%
0%
2005
2020
2035
2050
2065
2080
2095
Year
Men 18-24
All 18-24
+ Men 25-64
All 18-64
+ Men 65+
All
NHIS Data


Proportion
20%
15%
10%
5%
0%
2015
2025
2035
2045
2055
2065
2075
2085
2095
Year
Men 18-24
All 18-24
+ Men 25-64
All 18-64
+ Men 65+
All
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2015


Men 18-24
Never-Smoker Prevalence


All 18-24
+ Men 25-64
All 18-64
+ Men 65+
All
2025
2035
2045
2055
2065
2075
2085
2095
Year

Population Dynamics Model

Both products, 9/2018

Based on:

Input | Input formula (OK to change) | Button output

Name	Value	Units	Description	Link	Source, Comments
Population Inputs					
Year0	2015		First forecast year		Changing requires updating data below.
Pop0	247.411	million	Initial US adult (≥18) population in first forecast year		2015 US Census estimates (see spreadsheet). Used only to scale calculated proportions to total counts.
Pop0Dists	(table)	%	Initial proportion of total population with each age & sex		same
PropMAt18	Age		Men: 18: 0.0087; 19: 0.00881; 100 +: 6.1E-05		Women: 18: 0.00833; 19: 0.00838; 100 +: 0.00025; Men/Total: 0.51108
PropM	0.48679		0.48679		0.51321
NewPop	2.010%	%/y	Annual new 18-year-olds plus additional net migration		Model of 2017 US Census projections (see spreadsheet)
NewPG1	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 1	https://ww	Model of 2017 US Census projections (see spreadsheet)
NewPY2	2035		First year of Period 2		same
NewPG2	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 2		same
Cigarette Initiation, Use Rate, and Cessation Inputs					
InitRts	(table)	%	Proportion initiating cigarettes (modeled at 18 years old)		2015 NHIS maximum prevalence over 18-25 yrs old.
InitRtAnMults	(table)	%	Annual multiplier for proportion initiating cigarettes		2015-2017 NHIS max. prevalence change rate

Men	Women	Wtd. av.
22.20%	15.39%	18.70%
96.97%	96.28%	96.61%

	Low	Base	High
InitRtMult	0.75	1	1.25

Initiation rate multiplier for sensitivity analysis

IStats (table) % — Smoking status proportions in initial population — 2015 NHIS

Age from to	Men Current	Men Former	Men Never	Women Current	Women Former	Women Never
18 24	15.02%	5.23%	79.75%	10.98%	4.27%	84.75%
25 64	18.87%	22.06%	59.08%	15.92%	17.79%	66.28%
65 +	9.70%	50.89%	39.41%	7.35%	31.25%	61.40%
Wtd. av.	8.12%	11.94%	28.62%	6.90%	9.63%	34.80%
M+W	15.02%	21.57%	63.42%			

Total Pop. Props. Men	Total Pop. Props. Women	Men Current	Men Former	Men Never	Women Current	Women Former	Women Never
0.07431	0.0707	1.12%	0.39%	5.93%	0.78%	0.30%	5.99%
0.32732	0.33475	6.18%	7.22%	19.34%	5.33%	5.96%	22.19%
0.08516	0.10775	0.83%	4.33%	3.36%	0.79%	3.37%	6.62%

YrQuitSlp	0.515		Slope of years since quitting vs. (age-18)--former smkrs. — 2017 NHIS (see spreadsheet). For initial population only (simulated after that). No sex difference seen.
CPDERSlope	0.35		Slope of CPD-Excess Risk relationship — See CPDERFacs
CPDProps	(table)	%	Avg. proportions in CPD (on days smoked) categories — 2017 NHIS, on days smoked.
CPDDayFracs	(table)	%	Average fraction of days smoked (unused) — 2017 NHIS, mean # days smoked in last 30 days / 30
CPDERFacs	(table)		ER (RR-1) factors to adjust for CPD — Simple model based on Thun 2013 (Table S3), Thun 1997, and Bjartveit 2005. See formulas and separate spreadsheet.
CPDRedFacs	(table)		ER factors to adjust for reduced CPD — Same as CPDERFacs except at CPD reduced by M_CPDRed

	Low	Base	High
	0.1	0.35	0.6

CPD from to	CPDProps Men	CPDProps Women	CPDDayFracs Men	CPDDayFracs Women	CPD Midpt.	Unscaled CPDERs Men	Unscaled CPDERs Women	CPDERFacs Men	CPDERFacs Women	CPDRedFacs Men	CPDRedFacs Women
0 1.5	6.80%	5.00%	35.53%	42.04%	0.75	0.233	(same)	0.205	0.149	0.108	0.079
1.5 5.5	23.71%	24.49%	67.24%	77.02%	3.5	0.800		0.703	0.512	0.420	0.306
5.5 15.5	38.48%	46.67%	94.60%	96.61%	10.5	1.542		1.355	0.987	0.916	0.668
15.5 25.5	24.63%	20.72%	99.02%	98.92%	20.5	2.101		1.846	1.345	1.339	0.975
25.5 35.5	3.84%	1.84%	99.83%	96.12%	30.5	2.457		2.160	1.573	1.623	1.182
35.5 +	2.54%	1.28%	97.83%	94.80%	*40.5*	2.720		2.390	1.741	1.837	1.338
Wtd. Av. CPD	12.1703	11.1222	11.5738	10.6429		1.4798639	1.442646	1.30044	0.9236	0.89825	0.63142
	on days smoked		over all days			Wtd. Av. unscaled		Wtd. Av. CPDERFac (normalized to Smoker RR)			

QuitParms (table) — Quit (cessation) rates by age & sex — Holford 2015: 1980 cohort, modeled (see spreadsheet), adjusted from 3.53% to reach 4.5% mean from Mendez 2016

	Men	Women	
Quit rate at age 18	2.51%	2.52%	
Linear Slope (%/y)	0.0442%	0.0437%	
Age Exponential Starts	60	50	
Quit rate at this age	4.30%	3.98%	
Ann. Age Multiplier	1.036	1.031	
Weighted Average	4.16%	4.82%	4.50%

	Low	Base	High
QuitRtMult	0.75	1	1.25

Quit rate multiplier for sensitivity analysis

Death Rate Inputs			
DRMult	1.2	Multiplier to adjust all death rates (1=no change)	To agree with US Census Bureau projecti

Low	Base	High
1	1.2	1.4

DRAnMult	0.99		Annual mortality rate multiplier						0.98	0.99	1	
NSDRs, RRs	(table)	/100,000/y	Annual mortality rate and Relative Risk (RR)					http://ww	Thun 2013 Table S2 (5 contemporary cohorts, 2000-2010)			
	Wtd. Av.		627.906	608.02	2.30044	1.9236	1629.85	1315.9			0.4867949	0.5132051
					Should = Wtd. Av. CPDERFacs + 1							

ERChgs	(table)	1/y	ER change rate with years after quitting	Exponential declines toward ER=0, based on results in Mendez 2001 (see spreadsheet)
Age quit from	to	Men	Women	
18	34	-0.095	-0.095	
35	54	-0.095	-0.095	
55	59	-0.0725	-0.0725	
60	64	-0.06	-0.06	
65	69	-0.05	-0.05	
70	74	-0.04	-0.04	
75	79	-0.03	-0.03	
80	84	-0.02	-0.02	
85	89	-0.01	-0.01	
90	94	-0.01	-0.01	
95	99	-0.01	-0.01	
100	+	-0.01	-0.01	

New Product (MRTP) Inputs

				Low	Base	High
M_IntroYr	**2021**	Year VLN product is introduced	Set >= 1st year, or blank (none).	2020	2021	2025
M_CtoM	**7.1%**	C-I: Peak annual rate CC smokers switch to VLN		4.2%	7.1%	10.0%
M_CtoMYAM	1	C-Im: Young adult (<=24) multiplier for rate CC smokers switch		0.5	1	1.5
M_CtoMYr	**5**	Years until peak rate that CC smokers switch - linear growth	>=0	2	5	10
M_MtoS	50%	I-S: Proportion of initial VLN smokers sustaining use beyond 1 year	Remainder revert to CC. Cf. dropout	25%	50%	75%
M_StoC	**10%**	S-C: Annual rate sustaining VLN smokers relapse to CCs	(Can be correlated with above)	0%	10%	20%
M_CPDRedF	80%	CPDf: Proportion of VLN smokers reducing CPD	Hatsukami 2018 (approximated)	60%	80%	100%
M_CPDRed	50%	CPDr: Av. reduction in CPD among VLN smokers reducing CPD	Hatsukami 2018 (approximated)	40%	50%	60%
M_MtoFRel	**118%**	S-Fm: Quit rate for VLN smokers as % of CC quit rate		100%	118%	150%
M_ERR	100%	ERR: prop. of CC smoker Excess Risk experienced by VLN smokers		90%	100%	110%

Results

Run through year 2100 — Last run took 3.62 seconds (12/13/2018 8:09:11 PM). — ☐ Create workbook with detailed results (slow)

Year #:			0	1	2	3	4	5	6	7	8	9	15	25	35	45	55	85
Year:			*2015*	2016	2017	2018	2019	2020	2021	2022	2023	2024	2030	2040	2050	2060	2070	2100
1	Total adult population relative to that of 2015		1	1.00997	1.01999	1.02996	1.03987	1.04967	1.05938	1.06893	1.07831	1.08753	1.13887	1.20616	1.25468	1.29743	1.34281	1.44738
2	C: conventional cig. smoker proportion		15.10%	14.48%	13.90%	13.36%	12.85%	12.37%	11.91%	11.31%	10.68%	10.02%	6.95%	4.58%	3.26%	2.36%	1.69%	0.61%
3	C+M: CC + 1st-year New Product proportion		15.10%	14.48%	13.90%	13.36%	12.85%	12.37%	11.91%	11.47%	10.98%	10.45%	7.44%	4.90%	3.49%	2.52%	1.81%	0.65%
4	C+M+S: total smoker proportion		**15.10%**	**14.48%**	**13.90%**	**13.36%**	**12.85%**	**12.37%**	**11.91%**	**11.47%**	**11.05%**	**10.65%**	**8.55%**	**6.02%**	**4.34%**	**3.15%**	**2.27%**	**0.81%**
5	F: former smoker proportion		21.86%	21.91%	21.92%	21.90%	21.86%	21.80%	21.71%	21.61%	21.49%	21.35%	20.29%	17.85%	15.14%	12.32%	9.48%	3.62%
6	N: never-smoker proportion		63.04%	63.62%	64.18%	64.74%	65.29%	65.84%	66.38%	66.92%	67.46%	68.00%	71.16%	76.12%	80.51%	84.53%	88.26%	95.57%
7	D: annual deaths as proportion of initial population		0	0.01013	0.01009	0.01013	0.0102	0.0103	0.0104	0.01055	0.01073	0.01088	0.01207	0.01441	0.01576	0.01576	0.01557	0.01772
41	Cigarette-attributable deaths relative to initial population		0	0.00196	0.0019	0.00186	0.00182	0.0018	0.00179	0.00178	0.00177	0.00175	0.00166	0.0015	0.00118	0.00097	0.00084	0.00037
	Annual US adult death rate		0.00%	1.00%	0.99%	0.98%	0.98%	0.98%	0.98%	0.99%	0.99%	1.00%	1.06%	1.20%	1.26%	1.21%	1.16%	1.22%
	Annual US adult deaths (millions)		0	2.50619	2.49524	2.50748	2.52334	2.54837	2.57185	2.61068	2.65383	2.69268	2.98645	3.56634	3.8995	3.89859	3.85197	4.3851
	Avoided deaths through each year vs. CC Only (1000s)		0	0	0	0	0	0	0	0	0	0.80653	2.67815	35.3378	92.5813	119.71	130.859	134.199	89.7493
	Avoided cigarette-attributable deaths through each year vs. CC Only (1000s)		0	0	0	0	0	0	0	0	0	0.80653	2.69348	36.8265	106.464	159.47	205.364	248.938	340.055
	Life-years gained through each year vs. CC only (1000s)		0	0	0	0	0	0	0	0	5.5E-11	0.80653	3.48469	121.086	812.755	1908.31	3173.84	4507.07	8048.92
For plots:																			
	Market penetration ((M+S)/(C+M+S))			0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.39%	3.40%	5.93%	18.67%	23.98%	24.94%	25.22%	25.36%	25.47%
	Smoker + former smoker proportion			36.96%	36.38%	35.82%	35.26%	34.71%	34.16%	33.62%	33.08%	32.54%	32.00%	28.84%	23.88%	19.49%	15.47%	11.74%	4.43%
	Population breakdown	M		48.68%	49.16%	49.65%	50.14%	50.63%	51.12%	51.60%	52.08%	52.55%	53.01%	55.58%	59.02%	61.70%	64.17%	66.71%	72.07%
		F		51.32%	51.84%	52.35%	52.85%	53.35%	53.85%	54.33%	54.81%	55.28%	55.74%	58.31%	61.60%	63.77%	65.57%	67.57%	72.67%
		M	18-24	6.46%	6.51%	6.57%	6.66%	6.77%	6.89%	7.04%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%
		M	25-64	33.70%	33.86%	33.99%	34.07%	34.12%	34.12%	34.10%	34.04%	34.13%	34.23%	34.79%	36.66%	38.51%	39.59%	40.02%	40.36%
		M	65+	8.52%	8.79%	9.09%	9.41%	9.75%	10.11%	10.47%	10.85%	11.22%	11.59%	13.60%	15.16%	16.00%	17.40%	19.50%	24.51%
		F	18-24	6.13%	6.18%	6.25%	6.35%	6.46%	6.59%	6.73%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%
		F	25-64	34.41%	34.51%	34.57%	34.57%	34.55%	34.47%	34.38%	34.26%	34.29%	34.32%	34.51%	35.85%	37.25%	38.22%	38.59%	38.79%
		F	65+	10.78%	11.15%	11.53%	11.93%	12.35%	12.79%	13.22%	13.67%	14.11%	14.54%	16.91%	18.86%	19.64%	20.47%	22.10%	27.00%
	Smoker breakdown	M		16.75%	16.09%	15.49%	14.92%	14.39%	13.89%	13.41%	12.95%	12.51%	12.09%	9.89%	7.21%	5.36%	3.99%	2.94%	1.14%
		F		13.53%	12.94%	12.39%	11.88%	11.39%	10.92%	10.48%	10.06%	9.66%	9.28%	7.27%	4.89%	3.36%	2.33%	1.60%	0.50%

Summary Tables

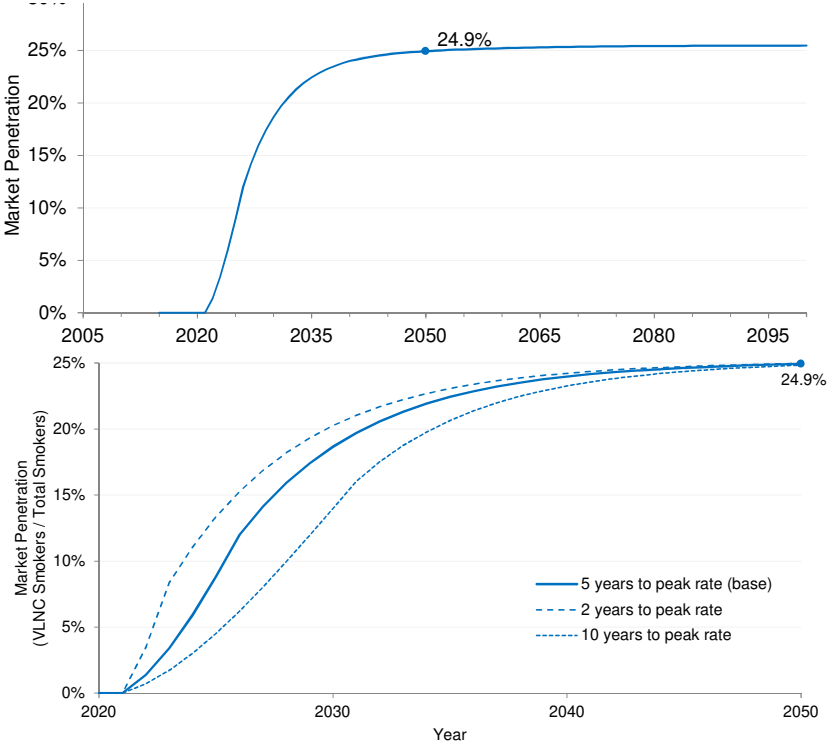
	2050	2100

30%

Total population ≥18 years old (millions)	310.4	358.1
Cigarette-attributable deaths since 2015 (1000s)		
CC-only case	13934.1	23364.9
With new product	13774.6	23024.8
Avoided	159.5	340.1
Life-years gained since 2015		
vs. CC-only (1000s)	1908.3	8048.9
Per avoided cigarette-attributable death	12.0	23.7

	2015	2020	2025	2050	2075	2100
Total population ≥18 years old (millions)	247.4	259.7	271.3	310.4	337.7	358.1
Smoking prevalence:						
CC	15.10%	12.37%	9.36%	3.26%	1.43%	0.61%
VLN	0.00%	0.00%	0.91%	1.08%	0.49%	0.21%
Total current	**15.10%**	**12.37%**	**10.26%**	**4.34%**	**1.91%**	**0.81%**
Former	21.86%	21.80%	21.20%	15.14%	8.12%	3.62%
Never (remainder)	63.04%	65.84%	68.53%	80.51%	89.97%	95.57%
Total current smoker breakdown:						
Men 18-24	0.97%	1.16%	1.08%	0.44%	0.19%	0.08%
Women 18-24	0.67%	0.76%	0.68%	0.23%	0.08%	0.03%
Men 25-64	6.36%	4.86%	3.92%	1.95%	0.91%	0.40%
Women 25-64	5.48%	4.10%	3.19%	1.24%	0.48%	0.18%
Men 65+	0.83%	0.75%	0.70%	0.25%	0.15%	0.08%
Women 65+	0.79%	0.75%	0.69%	0.23%	0.10%	0.04%
Cumulative results from 2015:						
Total adult deaths (millions)	0.0	12.6	25.8	111.1	208.2	312.1
Cig.-attributable deaths (1000s)	0.0	2310.2	4494.1	13774.6	19585.4	23024.8
Avoided cig.-attributable deaths (1000s)	0.0	0.0	5.8	159.5	269.1	340.1
Life-years gained (1000s)	0.0	0.0	9.3	1908.3	5174.4	8048.9
Cigarette-attributable morbidity ($billions)	0.0	0.0	3.0	83.4	140.7	177.8

Morbidity at: 0.52288 million $/avoided cig-attrib. death



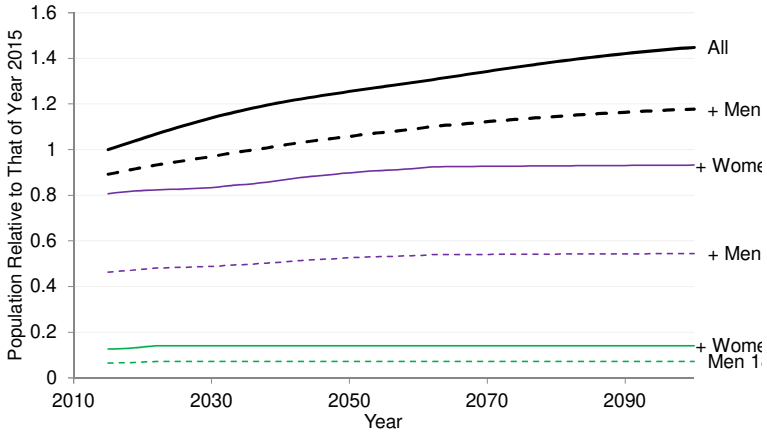
CAUTION: market penetration plot & the pair of 4-scenario plots include frozen results.

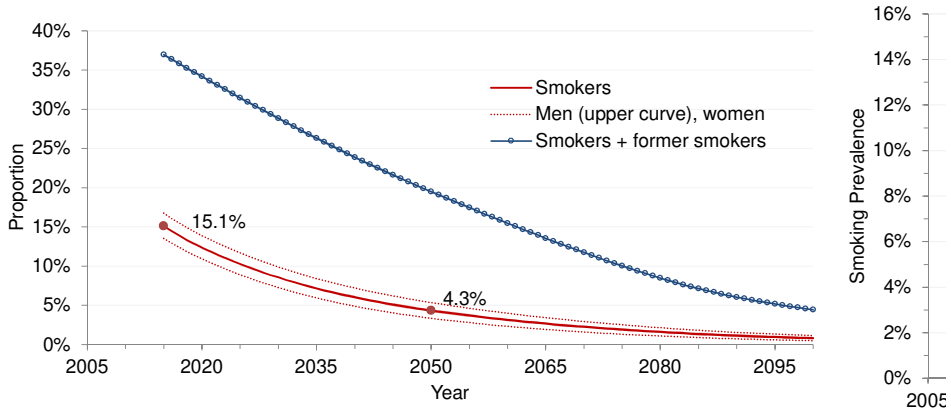
For plot: pop. un-accumulated by age group

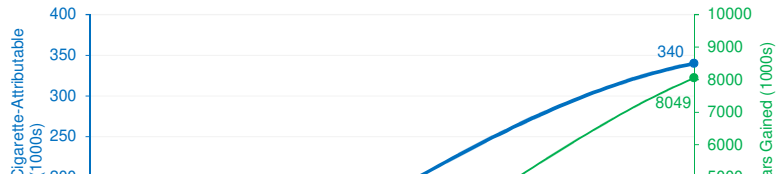
Men 18-24 (lower)	0.97%	1.01%	1.05%	1.09%	1.13%	1.16%	1.19%	1.22%	1.17%	1.13%	0.89%	0.62%	0.44%	0.31%	0.22%	0.08%
Women 18-24 (upper)	0.67%	0.69%	0.71%	0.73%	0.75%	0.76%	0.78%	0.79%	0.75%	0.72%	0.54%	0.35%	0.23%	0.15%	0.10%	0.03%
Men 25-64 (lower)	6.36%	6.03%	5.71%	5.41%	5.13%	4.86%	4.60%	4.36%	4.21%	4.06%	3.33%	2.53%	1.95%	1.49%	1.08%	0.40%
Women 25-64 (upper)	5.48%	5.17%	4.88%	4.60%	4.34%	4.10%	3.87%	3.65%	3.49%	3.34%	2.59%	1.78%	1.24%	0.88%	0.59%	0.18%
Men 65+ (lower)	0.83%	0.80%	0.78%	0.76%	0.76%	0.75%	0.74%	0.73%	0.72%	0.71%	0.60%	0.38%	0.25%	0.17%	0.16%	0.08%
Women 65+ (upper)	0.79%	0.78%	0.77%	0.76%	0.75%	0.75%	0.74%	0.73%	0.72%	0.70%	0.59%	0.36%	0.23%	0.15%	0.11%	0.04%
	15.1%												4.3%			0.8%

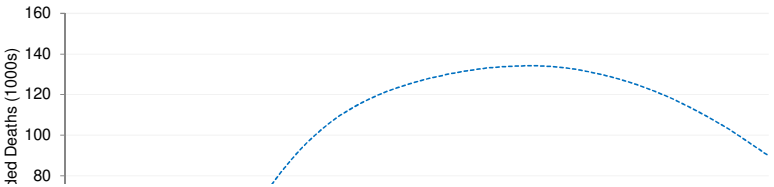
	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2100
Total pop. ≥18 years old (millions)	247.4	259.7	271.3	281.8	290.8	298.4	304.8	310.4	315.7	321.0	326.6	332.2	358.1
Smoking prevalence:													
CC	15.10%	12.37%	9.36%	6.95%	5.55%	4.58%	3.85%	3.26%	2.77%	2.36%	2.00%	1.69%	0.61%
VLN	0.00%	0.00%	0.91%	1.60%	1.61%	1.44%	1.26%	1.08%	0.93%	0.79%	0.68%	0.57%	0.21%
Total current	**15.10%**	**12.37%**	**10.26%**	**8.55%**	**7.16%**	**6.02%**	**5.10%**	**4.34%**	**3.70%**	**3.15%**	**2.68%**	**2.27%**	**0.81%**
Former	21.86%	21.80%	21.20%	20.29%	19.15%	17.85%	16.51%	15.14%	13.75%	12.32%	10.89%	9.48%	3.62%
Never (remainder)	63.04%	65.84%	68.53%	71.16%	73.70%	76.12%	78.39%	80.51%	82.55%	84.53%	86.44%	88.26%	95.57%
Total current smoker breakdown													
Men 18-24	0.97%	1.16%	1.08%	0.89%	0.74%	0.62%	0.52%	0.44%	0.37%	0.31%	0.26%	0.22%	0.08%
Women 18-24	0.67%	0.76%	0.68%	0.54%	0.44%	0.35%	0.28%	0.23%	0.19%	0.15%	0.12%	0.10%	0.03%
Men 25-64	6.36%	4.86%	3.92%	3.33%	2.89%	2.53%	2.23%	1.95%	1.70%	1.49%	1.28%	1.08%	0.40%
Women 25-64	5.48%	4.10%	3.19%	2.59%	2.14%	1.78%	1.49%	1.24%	1.03%	0.88%	0.72%	0.59%	0.18%
Men 65+	0.83%	0.75%	0.70%	0.60%	0.48%	0.38%	0.30%	0.25%	0.21%	0.17%	0.16%	0.16%	0.08%
Women 65+	0.79%	0.75%	0.69%	0.59%	0.47%	0.36%	0.29%	0.23%	0.20%	0.15%	0.13%	0.11%	0.04%
Cumulative results from 2015:													
Total adult deaths (millions)	0.0	12.6	25.8	40.3	56.1	73.3	91.8	111.1	130.7	150.2	169.6	188.8	312.1
Cig.-attributable deaths (1000s)	0.0	2310.2	4494.1	6591.2	8611.1	10523.1	12251.5	13774.6	15139.2	16383.4	17524.1	18585.7	23024.8

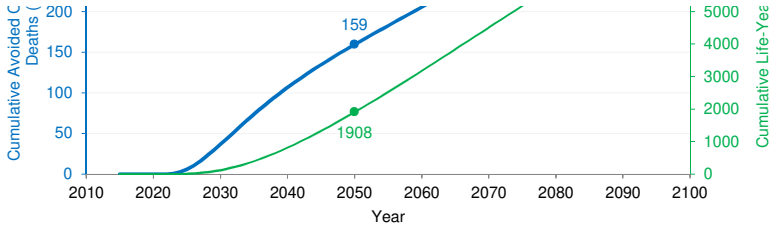
Avoided cig.-attributable deaths (1000s)	0.0	0.0	5.8	36.8	73.5	106.5	134.6	159.5	182.7	205.4	227.5	248.9	340.1
Life-years gained (1000s)	0.0	0.0	9.3	121.1	396.4	812.8	1328.7	1908.3	2527.8	3173.8	3836.7	4507.1	8048.9
Avoided cigarette-attributable morbidity ($billions)	0.0	0.0	3.0	19.3	38.4	55.7	70.4	83.4	95.5	107.4	119.0	130.2	177.8

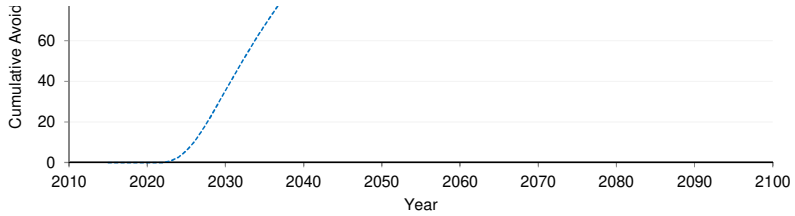

Population Relative to That of Year 2015
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2010
2030
2050
2070
2090
Year
All
+ Men
+ Wome
+ Men
+ Wome
Men 1

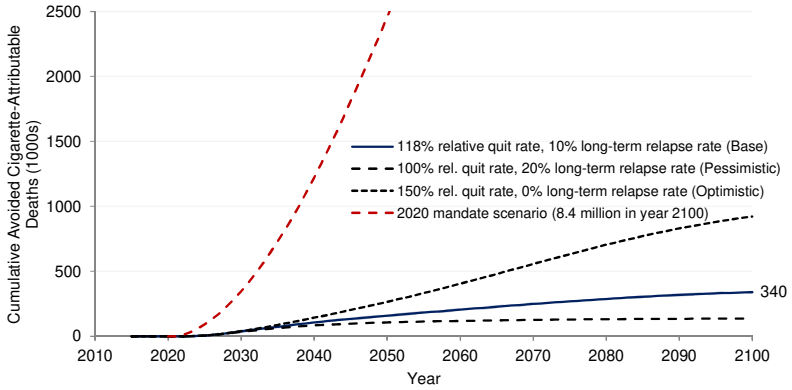

Proportion
40%
35%
30%
25%
20%
15%
10%
5%
0%
2005
2020
2035
2050
2065
2080
2095
Year
Smokers
Men (upper curve), women
Smokers + former smokers
15.1%
4.3%
Smoking Prevalence
16%
14%
12%
10%
8%
6%
4%
2%
0%
2005

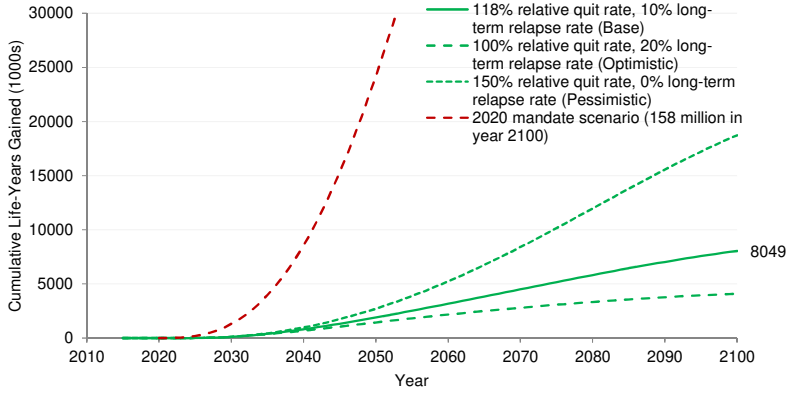

400
350
300
250
10000
9000
8000
7000
6000
340
8049

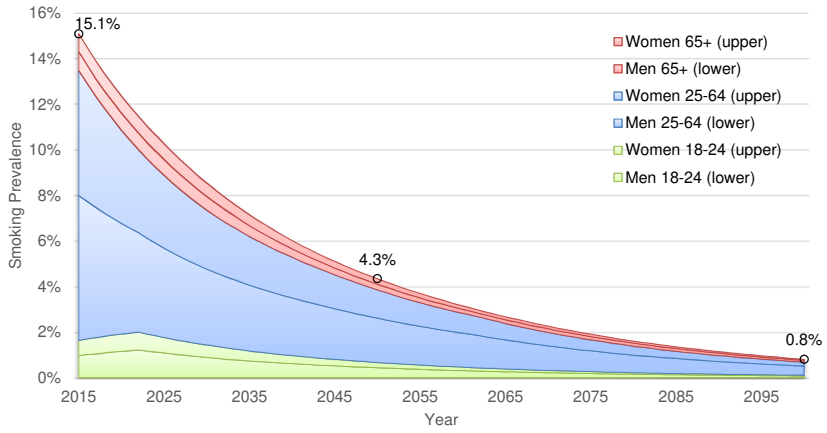

160
140
120
100
80

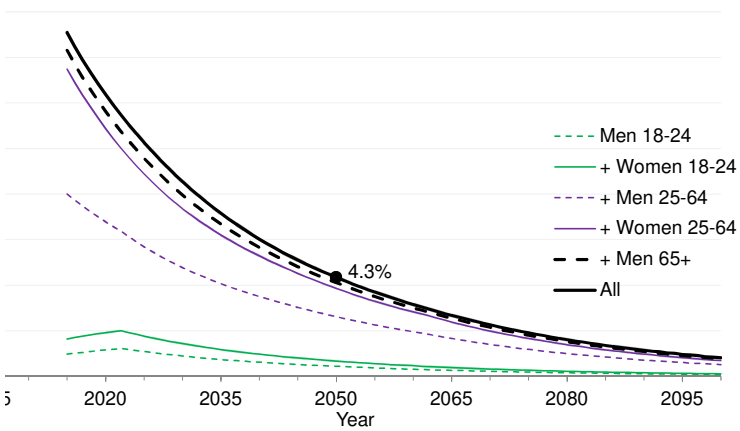

Cumulative Avoided C
Deaths (
Cumulative Life-Yea
159
1908
Year

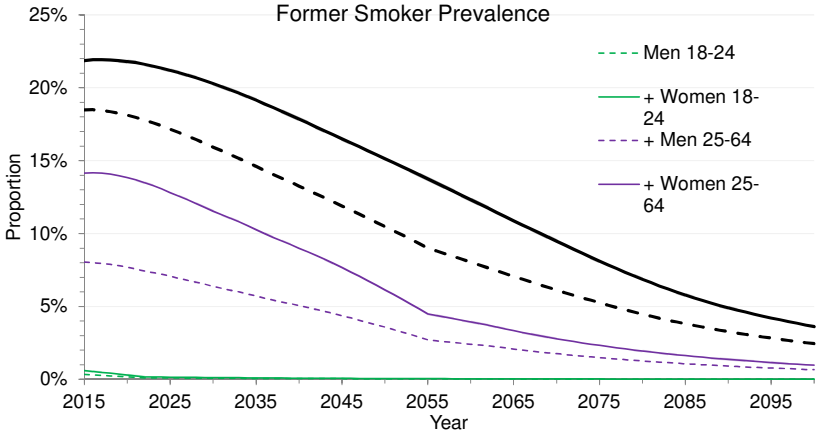

Cumulative Avoid
Year

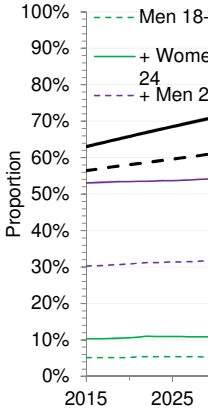

Cumulative Avoided Cigarette-Attributable Deaths (1000s)
118% relative quit rate, 10% long-term relapse rate (Base)
100% rel. quit rate, 20% long-term relapse rate (Pessimistic)
150% rel. quit rate, 0% long-term relapse rate (Optimistic)
2020 mandate scenario (8.4 million in year 2100)
340
Year

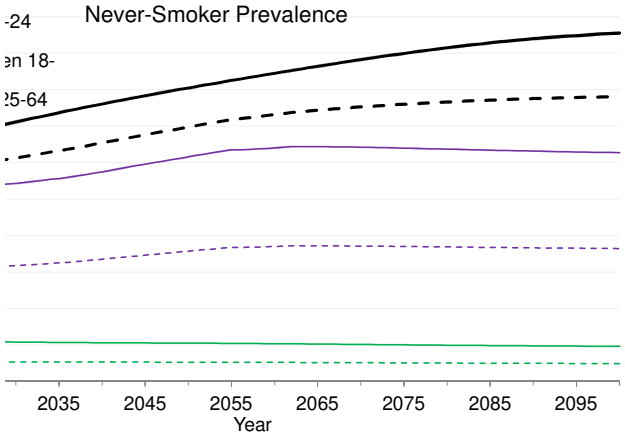

Cumulative Life-Years Gained (1000s)
118% relative quit rate, 10% long-term relapse rate (Base)
100% relative quit rate, 20% long-term relapse rate (Optimistic)
150% relative quit rate, 0% long-term relapse rate (Pessimistic)
2020 mandate scenario (158 million in year 2100)
8049
Year


Smoking Prevalence
15.1%
4.3%
0.8%
Women 65+ (upper)
Men 65+ (lower)
Women 25-64 (upper)
Men 25-64 (lower)
Women 18-24 (upper)
Men 18-24 (lower)
Year


Men 18-24
+ Women 18-24
+ Men 25-64
+ Women 25-64
+ Men 65+
All
4.3%
2020
2035
2050
2065
2080
2095
Year


Former Smoker Prevalence
25%
20%
15%
10%
5%
0%
Proportion
Men 18-24
+ Women 18-24
+ Men 25-64
+ Women 25-64
2015
2025
2035
2045
2055
2065
2075
2085
2095
Year


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Proportion
Men 18-
+ Wome
24
+ Men 2
2015
2025


Never-Smoker Prevalence
-24
en 18-
25-64
2035
2045
2055
2065
2075
2085
2095
Year

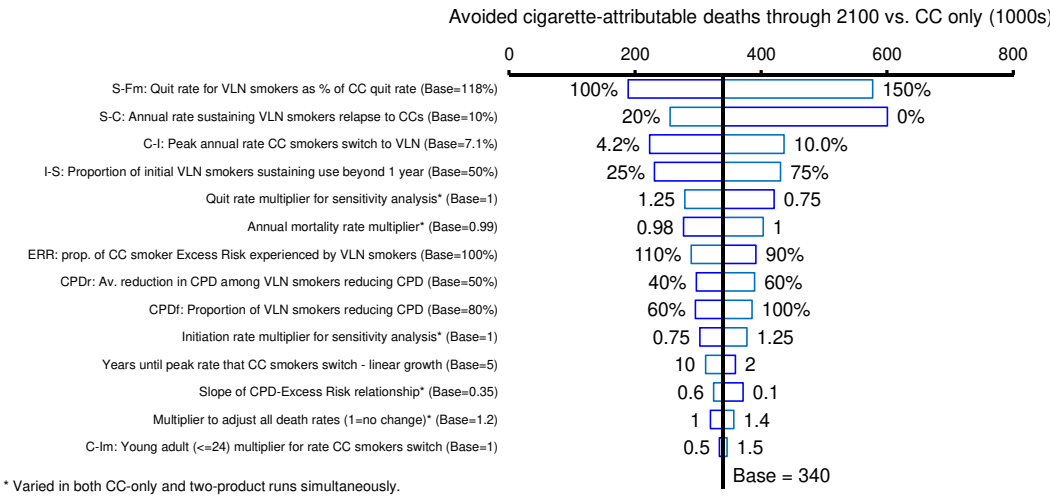
Tornado Chart Template

Displays one-at-a-time sensitivities around a base value, sorted in descending order of range.

This style indicates inputs. ©2018, Certara
This style indicates button outputs (or inputs if you wish to override or make tornado manually).

±%age Change for each Bar	
Label Col. # in Previous Sheet	4
Units Col. # in Previous Sheet	3
Sig. Digits for Plot (blank=all)	5
Chart Title	Avoided cigarette-attributable deaths through 2100 vs. CC only (1000s)
Base Case Output	340.055
Base Case Number Format	0
Last tornado run time (s)	260.14

☑ Show each run (slower)



* Varied in both CC-only and two-product runs simultaneously.

14 variables found. Sum = 430008.39

☐ Show Extrapolation

Bar Label	Base Label	Low Label	High Label	Low Output	High Output	Squared Range	Variability	Cumul. Variability	Base Input Format	Translated Base Input Format	Bar Label with Base	"Base =" Label	Base Series for Label	Linear Extrapo-lation -Low	Linear Extrapo-lation -High
S-Fm: Quit rate for VLN smokers	118%	100%	150%	188.794	576.942	150659	35%	35.0%	P0	0%	S-Fm: Quit rat		340.055	#N/A	#N/A
S-C: Annual rate sustaining VLN s	10%	0%	20%	600.593	255.52	119075	28%	62.7%	P0	0%	S-C: Annual ra		340.055	#N/A	#N/A
C-I: Peak annual rate CC smoker	7.1%	4.2%	10.0%	222.994	436.077	45404.5	11%	73.3%	P1	0.0%	C-I: Peak annu		340.055	#N/A	#N/A
I-S: Proportion of initial VLN smol	50%	25%	75%	230.758	430.887	40051.7	9%	82.6%	P0	0%	I-S: Proportion		340.055	#N/A	#N/A
Quit rate multiplier for sensitivity a	1	0.75	1.25	420.582	278.82	20096.5	5%	87.3%	G	General	Quit rate multi		340.055	#N/A	#N/A
Annual mortality rate multiplier*	0.99	0.98	1	276.888	403.167	15946.6	4%	91.0%	G	General	Annual mortali		340.055	#N/A	#N/A
ERR: prop. of CC smoker Excess	100%	90%	110%	391.789	289.182	10528.3	2%	93.4%	P0	0%	ERR: prop. of		340.055	#N/A	#N/A
CPDr: Av. reduction in CPD amo	50%	40%	60%	296.993	389.478	8553.48	2%	95.4%	P0	0%	CPDr: Av. red		340.055	#N/A	#N/A
CPDf: Proportion of VLN smoker	80%	60%	100%	295.388	385.328	8089.18	2%	97.3%	P0	0%	CPDf: Proport		340.055	#N/A	#N/A
Initiation rate multiplier for sensitiv	1	0.75	1.25	302.575	377.536	5619.17	1%	98.6%	G	General	Initiation rate r		340.055	#N/A	#N/A
Years until peak rate that CC smc	5	2	10	359.132	311.624	2257.02	1%	99.1%	G	General	Years until pea		340.055	#N/A	#N/A
Slope of CPD-Excess Risk relatio	0.35	0.1	0.6	371.505	324.688	2191.83	1%	99.6%	G	General	Slope of CPD-		340.055	#N/A	#N/A
Multiplier to adjust all death rates	1.2	1	1.4	319.402	356.716	1392.39	0%	100.0%	G	General	Multiplier to ad		340.055	#N/A	#N/A
C-Im: Young adult (<=24) multipli	1	0.5	1.5	333.751	345.747	143.904	0%	100.0%	G	General	C-Im: Young a		340.055	#N/A	#N/A
						0	0%	100.0%	G	General		Base = 340	340.055	#N/A	#N/A

Population Dynamics Model--Apelberg 2018-like

CC only, 11/2018

Based on: CC

Input | Input formula (OK to change) | Button output

Name	Value	Units	Description	Link	Source, Comments
Population Inputs					
Year0	**2020**		First forecast year		Changing requires updating data below.
Pop0	**258.673**	million	Initial US adult (≥18) population in first forecast year		US Census estimates (see spreadsheet). Used only to scale calculated proportions to total counts.
Pop0Dists	(table)	%	Initial proportion of total population with each age & sex		same

Age	Men	Women	Men/Total
18	0.0087	0.00833	0.51108
19	0.00881	0.00838	
24	0.00976	0.00935	0.12592
25	0.00972	0.00936	
64	0.00677	0.0075	0.68117
65	0.00661	0.00732	
100 +	6.1E-05	0.00025	0.19291
PropM	0.48679		0.48679 0.51321

NewPop	2.010%	%/y	Annual new 18-year-olds plus additional net migration		Model of 2017 US Census projections (see spreadsheet). (Annual new 18-year-olds = initial pop. x 18yo proportion.)
NewPG1	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 1	https://ww	Model of 2017 US Census projections (see spreadsheet)
NewPY2	2035		First year of Period 2		same
NewPG2	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 2		same

Cigarette Initiation, Use Rate, and Cessation Inputs

InitRts	(table)	%	Proportion initiating cigarettes (modeled at 18 years old)	2015 NHIS maximum prevalence over 18-25 yrs old.
InitRtAnMults	(table)		Annual multiplier for proportion initiating cigarettes	**No change, as in Apelberg**

Men	Women	Wtd. av.
22.20%	15.39%	18.70%
1	**1**	1

InitRtMult	1		Initiation rate multiplier for sensitivity analysis
IStats	(table)	%	Smoking status proportions in initial population

2015 NHIS, adjusted to give Apelberg prevalence in initial year

Age from to	Men Current	Men Former	Men Never	Women Current	Women Former	Women Never
18 24	**13.00%**	**7.23%**	79.77%	**9.00%**	**6.30%**	84.70%
25 64	**16.90%**	**24.10%**	59.00%	**13.90%**	**19.80%**	66.30%
65 +	**7.70%**	**52.90%**	39.40%	**5.30%**	**33.30%**	61.40%
Wtd. av.	7.15%	12.93%	28.60%	5.86%	10.66%	34.80%
M+W	**13.01%**	23.59%	63.39%			

Total Pop. Props. Men	Total Pop. Props. Women	Men Current	Men Former	Men Never	Women Current	Women Former	Women Never
0.07431	0.0707	0.97%	0.54%	5.93%	0.64%	0.45%	5.99%
0.32732	0.33475	5.53%	7.89%	19.31%	4.65%	6.63%	22.19%
0.08516	0.10775	0.66%	4.50%	3.36%	0.57%	3.59%	6.62%

YrQuitSlp	0.515		Slope of years since quitting vs. (age-18)--former smkrs.		2017 NHIS (see spreadsheet). For initial population only (simulated after that). No sex difference seen.
CPDProps	(table)	%	Avg. proportions in CPD (on days smoked) categories		2017 NHIS, on days smoked.
CPDDayFracs	(table)	%	Average fraction of days smoked (unused)		2017 NHIS, mean # days smoked in last 30 days / 30
CPDERFacs	(table)		ER (RR-1) factors to adjust for CPD		Simple model based on Thun 2013 (Table S3), Thun 1997, and Bjartveit 2005. See formulas and separate spreadsheet.
CPDRedFacs	(table)		ER factors to adjust for reduced CPD		Same as CPDERFacs except at CPD reduced by M_CPDRed
CPDERSlope	0.35		Slope of CPD-Excess Risk relationship		See CPDERFacs

CPD from to	CPDProps Men	CPDProps Women	CPDDayFracs Men	CPDDayFracs Women	Unscaled CPDERs CPD Midpt.	Unscaled CPDERs Men	Unscaled CPDERs Women	CPDERFacs Men	CPDERFacs Women	CPDRedFacs Men	CPDRedFacs Women
0 1.5	6.80%	5.00%	35.53%	42.04%	0.75	0.233	(same)	0.205	0.149	0.205	0.149
1.5 5.5	23.71%	24.49%	67.24%	77.02%	3.5	0.800		0.703	0.512	0.703	0.512
5.5 15.5	38.48%	46.67%	94.60%	96.61%	10.5	1.542		1.355	0.987	1.355	0.987
15.5 25.5	24.63%	20.72%	99.02%	98.92%	20.5	2.101		1.846	1.345	1.846	1.345
25.5 35.5	3.84%	1.84%	99.83%	96.12%	30.5	2.457		2.160	1.573	2.160	1.573
35.5 +	2.54%	1.28%	97.83%	94.80%	*40.5*	2.720		2.390	1.741	2.390	1.741
Wtd. Av. CPD	12.1703	11.1222	11.5738	10.6429		1.4798639	1.442646	1.30044	0.9236	1.30044	0.9236
	on days smoked		over all days			Wtd. Av. unscaled		Wtd. Av. CPDERFac (normalized to Smoker RR)			

QuitParms	(table)		Quit (cessation) rates by age & sex	Holford 2015: 1980 cohort, modeled (see spreadsheet), adjusted from 3.53% to reach 4.5% mean from Mendez 2016

	Men	Women	
Quit rate at age 18	2.51%	2.52%	
Linear Slope (%/y)	0.0442%	0.0437%	
Age Exponential Starts	60	50	
Quit rate at this age	4.30%	3.98%	
Ann. Age Multiplier	1.036	1.031	
Weighted Average	4.16%	4.82%	4.50%

QuitRtMult	**0.77**		**Quit rate multiplier, tuned to give Apelberg baseline prevalence**							
Death Rate Inputs										
DRMult	1.2		Multiplier to adjust all death rates (1=no change)					To agree with US Census Bureau projections; see spreadsheet		
DRAnMult	0.99		Annual mortality rate multiplier							
NSDRs, RRs	(table)	/100,000/y	Annual mortality rate and Relative Risk (RR)					http://ww	Thun 2013 Table S2 (5 contemporary cohorts, 2000-2010)	
	Wtd. Av.		627.906	608.02	2.30044	1.9236	1629.85	1315.9	0.4867949	0.5132051
					Should = Wtd. Av. CPDERFacs + 1					
ERChgs	(table)	1/y	ER change rate with years after quitting					Exponential declines toward ER=0, based on results in Mendez 2001 (see spreadsheet)		

New Product (MRTP) Inputs

			Low	Base	High
M_IntroYr		Year VLN product is introduced	Set >= 1st year, or blank (none).		
M_CtoM	%/yr	C-I: Peak annual rate CC smokers switch to VLN			
M_CtoMYAM		C-Im: Young adult (<=24) multiplier for rate CC smokers switch			
M_CtoMYr	yr	Years until peak rate that CC smokers switch - linear growth	>=0		
M_MtoS	%	I-S: Proportion of initial VLN smokers sustaining use beyond 1 year	Remainder revert to CC. Cf. dropout rate by 20 wk in Hatsukami 2018: 32% total, 4% for product dissatisfaction (immediate red. group)		
M_StoC	%/yr	S-C: Annual rate sustaining VLN smokers relapse to CCs	(Can be correlated with above)		
M_CPDRedF	%	CPDf: Proportion of VLN smokers reducing CPD			
M_CPDRed	%	CPDr: Av. reduction in CPD among VLN smokers reducing CPD	Hatsukami 2018 (approximated)		
M_MtoFRel	%	S-Fm: Quit rate for VLN smokers as % of CC quit rate			
M_ERR	%	ERR: prop. of CC smoker Excess Risk experienced by VLN smokers			

Results

Run through year 2100 — Last run took 3.74 seconds (12/9/2018 9:36:05 PM). — ☐ Create workbook with detailed results (slow)

				Year #:	0	1	2	3	4	5	6	7	8	9	15	25	30	35	45	55
				Year:	*2020*	2021	2022	2023	2024	2025	2026	2027	2028	2029	2035	2045	2050	2055	2065	2075
1	Total adult population relative to that of 2020				1	1.01019	1.0204	1.03054	1.04061	1.05055	1.06039	1.07006	1.07954	1.08885	1.14039	1.20715	1.23244	1.25449	1.29594	1.33981
2	C: conventional cig. smoker proportion				13.10%	12.74%	12.41%	12.10%	11.82%	11.56%	11.31%	11.08%	10.87%	10.66%	9.69%	8.76%	8.52%	8.37%	8.21%	8.08%
3	C+M: CC + 1st-year New Product proportion				13.10%	12.74%	12.41%	12.10%	11.82%	11.56%	11.31%	11.08%	10.87%	10.66%	9.69%	8.76%	8.52%	8.37%	8.21%	8.08%
4	C+M+S: total smoker proportion				**13.10%**	**12.74%**	**12.41%**	**12.10%**	**11.82%**	**11.56%**	**11.31%**	**11.08%**	**10.87%**	**10.66%**	**9.69%**	**8.76%**	**8.52%**	**8.37%**	**8.21%**	**8.08%**
5	F: former smoker proportion				23.88%	23.70%	23.50%	23.29%	23.08%	22.85%	22.63%	22.39%	22.16%	21.91%	20.40%	17.82%	16.63%	15.55%	13.59%	11.92%
6	N: never-smoker proportion				63.02%	63.57%	64.10%	64.61%	65.10%	65.59%	66.06%	66.52%	66.98%	67.42%	69.91%	73.42%	74.85%	76.08%	78.20%	80.01%
7	D: annual deaths as proportion of initial population				0	0.00991	0.00989	0.00996	0.01004	0.01016	0.01027	0.01043	0.01062	0.0108	0.01207	0.01451	0.01538	0.01589	0.01589	0.01574
41	Cigarette-attributable deaths relative to initial population				0	0.00175	0.00169	0.00166	0.00164	0.00163	0.00162	0.00162	0.00162	0.00162	0.0016	0.00152	0.0014	0.00127	0.00112	0.00104
	Annual US adult death rate				0.00%	0.98%	0.97%	0.97%	0.97%	0.97%	0.97%	0.98%	0.98%	0.99%	1.06%	1.20%	1.25%	1.27%	1.23%	1.17%
	Annual US adult deaths (millions)				0	2.56406	2.55932	2.57695	2.59762	2.62745	2.65547	2.69921	2.74818	2.79288	3.12199	3.75249	3.97887	4.1102	4.11102	4.07071
	Avoided deaths through each year vs. CC Only (1000s)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Avoided cigarette-attributable deaths through each year vs. CC Only (1000s)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Life-years gained through each year vs. CC only (1000s)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
For plots:																				
	Market penetration ((M+S)/(C+M+S))				0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Smoker + former smoker proportion				36.98%	36.43%	35.90%	35.39%	34.90%	34.41%	33.94%	33.48%	33.02%	32.58%	30.09%	26.58%	25.15%	23.92%	21.80%	19.99%
	Population breakdown	M			48.68%	49.17%	49.68%	50.18%	50.68%	51.18%	51.67%	52.15%	52.63%	53.09%	55.67%	59.07%	60.44%	61.68%	64.06%	66.48%
		F			51.32%	51.84%	52.36%	52.88%	53.38%	53.88%	54.37%	54.86%	55.33%	55.79%	58.37%	61.64%	62.81%	63.77%	65.53%	67.50%
		M	18-24		6.46%	6.51%	6.57%	6.66%	6.77%	6.89%	7.04%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%
		M	25-64		33.70%	33.86%	34.00%	34.08%	34.13%	34.13%	34.11%	34.06%	34.15%	34.25%	34.81%	36.66%	37.68%	38.47%	39.49%	39.88%
		M	65+		8.52%	8.80%	9.11%	9.44%	9.78%	10.16%	10.52%	10.90%	11.28%	11.65%	13.67%	15.22%	15.56%	16.02%	17.38%	19.41%
		F	18-24		6.13%	6.18%	6.25%	6.35%	6.46%	6.59%	6.73%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%
		F	25-64		34.41%	34.51%	34.57%	34.58%	34.55%	34.48%	34.39%	34.27%	34.30%	34.33%	34.52%	35.86%	36.65%	37.24%	38.20%	38.55%
		F	65+		10.78%	11.15%	11.54%	11.95%	12.37%	12.82%	13.25%	13.70%	14.15%	14.59%	16.97%	18.90%	19.28%	19.64%	20.45%	22.07%
	Smoker breakdown	M			14.77%	14.38%	14.02%	13.69%	13.39%	13.12%	12.86%	12.62%	12.39%	12.19%	11.20%	10.33%	10.11%	9.98%	9.83%	9.67%
		F			11.51%	11.18%	10.88%	10.59%	10.33%	10.08%	9.84%	9.62%	9.41%	9.21%	8.24%	7.25%	6.98%	6.81%	6.63%	6.51%

Historical data for calibration			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Smokers			0.20633	0.20586	0.19349	0.18989	0.18064	0.17815	0.16762	0.15107	0.15466	0.13955
Smokers - backwards extrap. from 2015-20	0.97534	0.13066	0.17632	0.17197	0.16773	0.16359	0.15956	0.15562	0.15178	0.14804	0.14439	0.14083
Former smokers			0.21584	0.22015	0.21699	0.21847	0.22151	0.21958	0.219	0.21868	0.22247	0.22471
Smoker + former smoker proportion			0.42217	0.42601	0.41048	0.40837	0.40215	0.39773	0.38663	0.36975	0.37714	0.36426
Population breakdown for smoker data	M	18-24	14.2869	14.4955	14.789	15.0661	15.0046	15.1748	15.2013	15.0071	14.8735	14.6829
	M	25-64	77.2563	78.5337	78.8207	79.3137	78.98	79.5745	79.8712	80.8266	81.5595	81.647
	M	65+	15.8402	16.3168	16.6556	17.3792	18.1936	19.1155	19.7837	20.6116	21.3337	22.06
	F	18-24	14.3693	14.4224	14.5507	14.7116	15.0269	15.0474	14.976	14.7565	14.7769	14.6967
	F	25-64	80.105	81.4769	81.4747	82.1393	82.6652	83.5005	83.7576	84.7056	85.2261	85.3839
	F	65+	20.8631	21.3189	21.702	22.1549	23.1771	24.1104	24.8161	25.6695	26.4953	27.214
	All		*222.72*	*226.56*	*227.99*	*230.76*	*233.05*	*236.52*	*238.41*	*241.58*	*244.27*	*245.68*

Smoker breakdown	M		0.23112	0.23459	0.21516	0.21598	0.20488	0.20496	0.18829	0.16747	0.17544	0.15847
	F		0.18325	0.17907	0.17319	0.16539	0.15815	0.15326	0.14841	0.13581	0.13532	0.12195
	M	18-24	0.23614	0.28002	0.22806	0.21309	0.20122	0.21926	0.18456	0.15017	0.14698	0.11994
	M	25-64	0.25607	0.25515	0.23772	0.24434	0.22829	0.22609	0.21143	0.18865	0.20001	0.18378
	M	65+	0.1049	0.09526	0.09695	0.08906	0.10628	0.10564	0.09775	0.097	0.10135	0.09042
	F	18-24	0.18957	0.15593	0.17359	0.16436	0.14505	0.15423	0.14847	0.10983	0.1154	0.08809
	F	25-64	0.20812	0.2051	0.19455	0.191	0.18372	0.1758	0.17015	0.15923	0.15692	0.14272
	F	65+	0.08341	0.09524	0.09275	0.07113	0.07542	0.0746	0.07496	0.07346	0.07696	0.07507
Smoker cumulative breakdown												
Men 18-24			0.01515	0.01792	0.01479	0.01391	0.01296	0.01407	0.01177	0.00933	0.00895	0.00717
All 18-24			0.02738	0.02784	0.02587	0.02439	0.02231	0.02388	0.02109	0.01604	0.01593	0.01244
+ Men 25-64			0.1162	0.11628	0.10805	0.10837	0.09967	0.09994	0.09193	0.07916	0.08271	0.07351
All 18-64			0.19106	0.19004	0.17758	0.17636	0.16484	0.16201	0.15171	0.13499	0.13746	0.12311
+ Men 65+			0.19852	0.1969	0.18466	0.18306	0.17314	0.17055	0.15982	0.14326	0.14631	0.13123
All			0.20633	0.20586	0.19349	0.18989	0.18064	0.17815	0.16762	0.15107	0.15466	0.13955

Projections from US Census Bureau (millions)		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2030	2040	2045	2050	2060
	Men 18-24	16.1117	15.9795	15.8192	15.6902	15.6436	15.592	15.5264	15.5139	15.535	15.5548	15.582	15.637	15.9602	16.2461	16.3443	16.5127
	All 18-24	31.428	31.1549	30.8438	30.6098	30.5492	30.4781	30.3801	30.3776	30.4275	30.4742	30.531	30.6117	31.2436	31.8151	32.0147	32.3619
	+ Men 25-64	114.212	114.545	114.702	115.021	115.431	115.758	115.965	116.233	116.492	116.747	117.025	118.571	123.974	127.149	129.408	131.903
	All 18-64	198.834	199.683	200.241	200.975	201.693	202.26	202.621	203.018	203.351	203.681	204.047	206.311	215.445	220.781	224.732	229.233
	+ Men 65+	219.167	220.752	222.034	223.525	225.029	226.413	227.635	228.872	230.079	231.27	232.473	239.233	251.769	258.046	263.463	272.896
	All	245.051	247.411	249.485	251.807	254.185	256.486	258.673	260.861	263.062	265.235	267.401	279.449	296.272	303.615	310.406	323.909
Scaled to 2015	Men 18-24	0.06512	0.06459	0.06394	0.06342	0.06323	0.06302	0.06276	0.06271	0.06279	0.06287	0.06298	0.0632	0.06451	0.06566	0.06606	0.06674
	All 18-24	0.12703	0.12592	0.12467	0.12372	0.12348	0.12319	0.12279	0.12278	0.12298	0.12317	0.1234	0.12373	0.12628	0.12859	0.1294	0.1308
	+ Men 25-64	0.46163	0.46297	0.46361	0.4649	0.46655	0.46788	0.46871	0.4698	0.47084	0.47187	0.473	0.47925	0.50109	0.51392	0.52305	0.53313
	All 18-64	0.80366	0.80709	0.80934	0.81231	0.81521	0.81751	0.81896	0.82057	0.82192	0.82325	0.82473	0.83388	0.8708	0.89236	0.90833	0.92653
	+ Men 65+	0.88584	0.89225	0.89743	0.90346	0.90953	0.91513	0.92007	0.92507	0.92994	0.93476	0.93962	0.96694	1.01761	1.04298	1.06488	1.10301
	All	0.99046	**1**	1.00838	1.01777	1.02738	1.03668	1.04552	1.05436	1.06326	1.07204	1.08079	1.12949	1.19749	1.22717	1.25462	1.30919

80	85
2100	2105
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7.76%	
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10.11%	
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70.82%	0.00%
71.82%	0.00%
7.19%	0.00%
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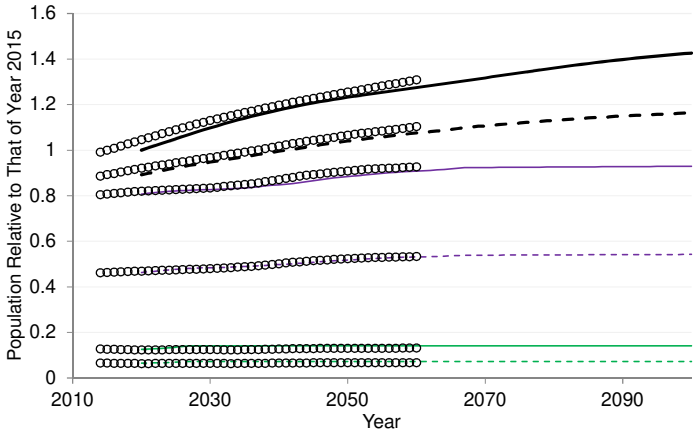

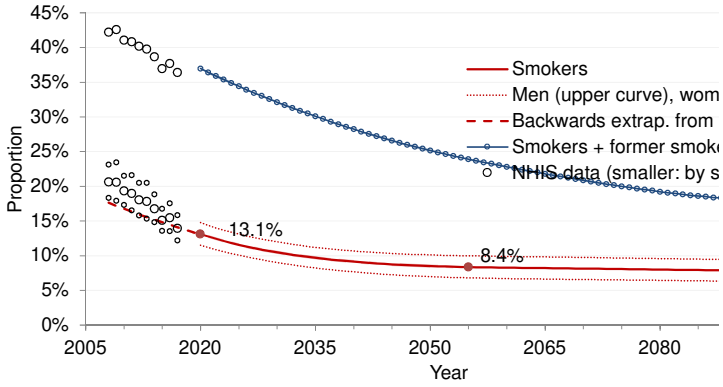

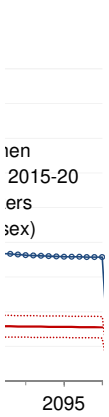
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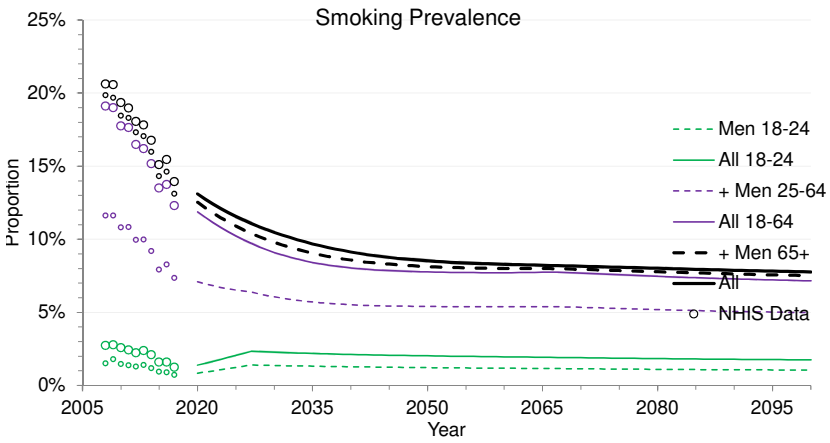
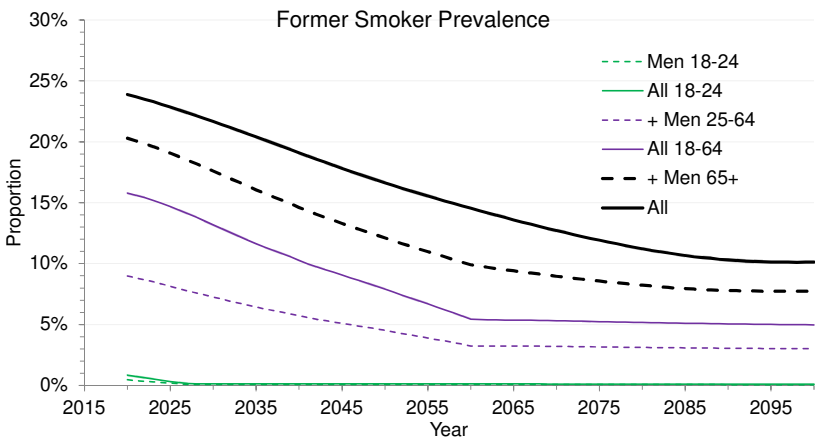
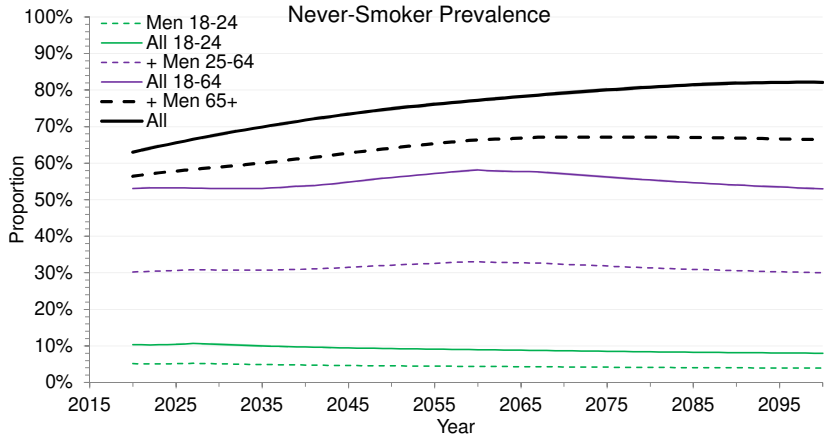

Smoking Prevalence
25%
20%
15%
10%
5%
0%
Proportion
2005
2020
2035
2050
2065
2080
2095
Year
Men 18-24
All 18-24
+ Men 25-64
All 18-64
+ Men 65+
All
NHIS Data


Former Smoker Prevalence
30%
25%
20%
15%
10%
5%
0%
Proportion
2015
2025
2035
2045
2055
2065
2075
2085
2095
Year
Men 18-24
All 18-24
+ Men 25-64
All 18-64
+ Men 65+
All


Never-Smoker Prevalence
Men 18-24
All 18-24
+ Men 25-64
All 18-64
+ Men 65+
All
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Proportion
2015
2025
2035
2045
2055
2065
2075
2085
2095
Year

Population Dynamics Model--Apelberg 2018-like

Input | Input formula (OK to change) | Button output

Both products, 11/2018

Based on: Both

Name	Value	Units	Description	Link	Source, Comments
Population Inputs					
Year0	**2020**		First forecast year		Changing requires updating data below.
Pop0	**258.673**	million	Initial US adult (≥18) population in first forecast year		US Census estimates (see spreadsheet). Used only to scale calculated proportions to total counts.
Pop0Dists	(table)	%	Initial proportion of total population with each age & sex		same

Age	Men	Women	Men/Total
18	0.0087	0.00833	0.51108
19	0.00881	0.00838	
100 +	6.1E-05	0.00025	
PropM	0.48679	0.51321	

NewPop	2.010%	%/y	Annual new 18-year-olds plus additional net migration		Model of 2017 US Census projections (see spreadsheet)
NewPG1	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 1	https://ww	Model of 2017 US Census projections (see spreadsheet)
NewPY2	2035		First year of Period 2		same
NewPG2	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 2		same
Cigarette Initiation, Use Rate, and Cessation Inputs					
InitRts	(table)	%	Proportion initiating cigarettes (modeled at 18 years old)		2015 NHIS maximum prevalence over 18-25 yrs old.
InitRtAnMults	(table)		Annual multiplier for proportion initiating cigarettes		**No change, as in Apelberg**

Men	Women	Wtd. av.
22.20%	15.39%	18.70%
1	**1**	1

InitRtMult	**0.5**		Initiation rate multiplier for sensitivity analysis
IStats	(table)	%	Smoking status proportions in initial population

2015 NHIS, adjusted to give Apelberg prevalence in initial year

Age from to	Men Current	Men Former	Men Never	Women Current	Women Former	Women Never
18 24	**13.00%**	**7.23%**	79.77%	**9.00%**	**6.30%**	84.70%
25 64	**16.90%**	**24.10%**	59.00%	**13.90%**	**19.80%**	66.30%
65 +	**7.70%**	**52.90%**	39.40%	**5.30%**	**33.30%**	61.40%
Wtd. av.	7.15%	12.93%	28.60%	5.86%	10.66%	34.80%
M+W	13.01%	23.59%	63.39%			

Total Pop. Props. Men	Total Pop. Props. Women	Men Current	Men Former	Men Never	Women Current	Women Former	Women Never
0.07431	0.0707	0.97%	0.54%	5.93%	0.64%	0.45%	5.99%
0.32732	0.33475	5.53%	7.89%	19.31%	4.65%	6.63%	22.19%
0.08516	0.10775	0.66%	4.50%	3.36%	0.57%	3.59%	6.62%

YrQuitSlp	0.515		Slope of years since quitting vs. (age-18)--former smkrs.	2017 NHIS (see spreadsheet). For initial population only (simulated after that). No sex difference seen.
CPDProps	(table)	%	Avg. proportions in CPD (on days smoked) categories	2017 NHIS, on days smoked.
CPDDayFracs	(table)	%	Average fraction of days smoked (unused)	2017 NHIS, mean # days smoked in last 30 days / 30
CPDERFacs	(table)		ER (RR-1) factors to adjust for CPD	Simple model based on Thun 2013 (Table S3), Thun 1997, and Bjartveit 2005. See formulas and separate spreadsheet.
CPDRedFacs	(table)		ER factors to adjust for reduced CPD	Same as CPDERFacs except at CPD reduced by M_CPDRed
CPDERSlope	0.35		Slope of CPD-Excess Risk relationship	See CPDERFacs

CPD from to	CPDProps Men	CPDProps Women	CPDDayFracs Men	CPDDayFracs Women	CPD Midpt.	Unscaled CPDERs Men	Unscaled CPDERs Women	CPDERFacs Men	CPDERFacs Women	CPDRedFacs Men	CPDRedFacs Women
0 1.5	6.80%	5.00%	35.53%	42.04%	0.75	0.233	(same)	0.205	0.149	0.205	0.149
1.5 5.5	23.71%	24.49%	67.24%	77.02%	3.5	0.800		0.703	0.512	0.703	0.512
5.5 15.5	38.48%	46.67%	94.60%	96.61%	10.5	1.542		1.355	0.987	1.355	0.987
15.5 25.5	24.63%	20.72%	99.02%	98.92%	20.5	2.101		1.846	1.345	1.846	1.345
25.5 35.5	3.84%	1.84%	99.83%	96.12%	30.5	2.457		2.160	1.573	2.160	1.573
35.5 +	2.54%	1.28%	97.83%	94.80%	*40.5*	2.720		2.390	1.741	2.390	1.741
Wtd. Av. CPD	12.1703	11.1222	11.5738	10.6429		1.4798639	1.442646	1.30044	0.9236	1.30044	0.9236
	on days smoked		over all days			Wtd. Av. unscaled		Wtd. Av. CPDERFac (normalized to Smoker RR)			

QuitParms	(table)		Quit (cessation) rates by age & sex	Holford 2015: 1980 cohort, modeled (see spreadsheet), adjusted from 3.53% to reach 4.5% mean from Mendez 2016

	Men	Women	
Quit rate at age 18	2.51%	2.52%	
Linear Slope (%/y)	0.0442%	0.0437%	
Age Exponential Starts	60	50	
Quit rate at this age	4.30%	3.98%	
Ann. Age Multiplier	1.036	1.031	
Weighted Average	4.16%	4.82%	4.50%

QuitRtMult	**3.42222**		**Quit rate multiplier (Apelberg policy scenario)**
Death Rate Inputs			
DRMult	1.2		Multiplier to adjust all death rates (1=no change)

To agree with US Census Bureau projections; see spreadsheet

DRAnMult	0.99		Annual mortality rate multiplier						
NSDRs, RRs	(table)	/100,000/y	Annual mortality rate and Relative Risk (RR)					http://ww	Thun 2013 Table S2 (5 contemporary cohorts, 2000-2010)
	Wtd. Av.		627.906	608.02	2.30044	1.9236	1629.85	1315.9	0.4867949 0.5132051
					Should = Wtd. Av. CPDERFacs + 1				
ERChgs	(table)	1/y	ER change rate with years after quitting						Exponential declines toward ER=0, based on results in Mendez 2001 (see spreadsheet)

New Product (MRTP) Inputs

			Low	Base	High
M_IntroYr	**2020**	Year VLN product is introduced		Set >= 1st year, or blank (none).	
M_CtoM	**5.0%** %/yr	C-I: Peak annual rate CC smokers switch to VLN			
M_CtoMYAM	1	C-Im: Young adult (<=24) multiplier for rate CC smokers switch			
M_CtoMYr	**0** yr	Years until peak rate that CC smokers switch - linear growth		>=0	
M_MtoS	**100%** %	I-S: Proportion of initial VLN smokers sustaining use beyond 1 year		Remainder revert to CC. Cf. dropout rate by 20 wk in Hatsukami 2018: 32% total, 4% for product dissatisfaction (immediate red. group)	
M_StoC	**0%** %/yr	S-C: Annual rate sustaining VLN smokers relapse to CCs		(Can be correlated with above)	
M_CPDRedF	**0%** %	CPDf: Proportion of VLN smokers reducing CPD			
M_CPDRed	0% %	CPDr: Av. reduction in CPD among VLN smokers reducing CPD		Hatsukami 2018 (approximated)	
M_MtoFRel	**100%** %	S-Fm: Quit rate for VLN smokers as % of CC quit rate			
M_ERR	**18%** %	ERR: prop. of CC smoker Excess Risk experienced by VLN smokers			

NOTE: "VLN" product here now represents non-combusted products, with VLNC combined with CC as in Apelberg.

Results

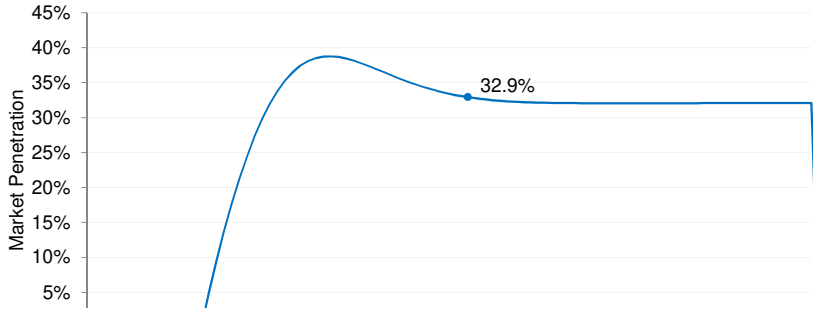
Run through year 2100 — Last run took 3.68 seconds (12/9/2018 9:36:14 PM). ☐ Create workbook with detailed results (slow)

				Year #:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
				Year:	*2020*	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
1	Total adult population relative to that of 2020				1	1.01019	1.02045	1.03066	1.04083	1.0509	1.06088	1.07072	1.08039	1.0899	1.09924	1.10843	1.1174	1.12614	1.13468	1.143
2	C: conventional cig. smoker proportion				13.10%	10.81%	9.00%	7.55%	6.38%	5.43%	4.66%	4.03%	3.52%	3.09%	2.75%	2.46%	2.23%	2.04%	1.88%	1.75%
3	C+M: CC + 1st-year New Product proportion				13.10%	11.36%	9.46%	7.94%	6.71%	5.71%	4.90%	4.23%	3.69%	3.25%	2.88%	2.59%	2.34%	2.14%	1.97%	1.84%
4	C+M+S: total smoker proportion				**13.10%**	**11.36%**	**9.94%**	**8.76%**	**7.75%**	**6.90%**	**6.17%**	**5.55%**	**5.01%**	**4.55%**	**4.15%**	**3.81%**	**3.51%**	**3.26%**	**3.04%**	**2.85%**
5	F: former smoker proportion				23.88%	24.88%	25.59%	26.09%	26.43%	26.63%	26.72%	26.73%	26.66%	26.53%	26.34%	26.12%	25.85%	25.56%	25.25%	24.91%
6	N: never-smoker proportion				63.02%	63.76%	64.46%	65.15%	65.82%	66.47%	67.10%	67.72%	68.33%	68.92%	69.51%	70.07%	70.63%	71.18%	71.71%	72.24%
7	D: annual deaths as proportion of initial population				0	0.00991	0.00985	0.00989	0.00994	0.01003	0.01012	0.01027	0.01044	0.01059	0.01077	0.01092	0.01113	0.01136	0.01156	0.01178
41	Cigarette-attributable deaths relative to initial population				0	0.00175	0.00165	0.00159	0.00154	0.0015	0.00147	0.00144	0.00142	0.0014	0.00138	0.00135	0.00133	0.00131	0.00129	0.00127
	Annual US adult death rate				0.00%	0.98%	0.97%	0.96%	0.96%	0.95%	0.95%	0.96%	0.97%	0.97%	0.98%	0.98%	1.00%	1.01%	1.02%	1.03%
	Annual US adult deaths (millions)				0	2.56406	2.54798	2.55748	2.57146	2.59536	2.61755	2.6558	2.6996	2.73945	2.78466	2.82348	2.88002	2.93964	2.99152	3.04665
	Avoided deaths through each year vs. CC Only (1000s)			0	0	0	11.3472	30.8168	56.9745	89.0651	126.977	170.388	218.974	272.404	330.437	392.768	459.012	528.684	601.359	676.704
	Avoided cigarette-attributable deaths through each year vs. CC Only (1000s)			0	0	0	11.3472	31.1206	57.952	91.1169	130.552	176.017	227.261	284.023	346.134	413.459	485.773	562.713	643.935	729.198
	Life-years gained through each year vs. CC only (1000s)			0	0	1.7E-10	11.3472	42.164	99.1384	188.204	315.181	485.569	704.543	976.947	1307.38	1700.15	2159.16	2687.85	3289.21	3965.91
For plots:																				
	Market penetration ((M+S)/(C+M+S))				0.00%	4.92%	9.51%	13.77%	17.69%	21.25%	24.46%	27.32%	29.83%	31.99%	33.82%	35.32%	36.52%	37.43%	38.08%	38.50%
	Smoker + former smoker proportion				36.98%	36.24%	35.54%	34.85%	34.18%	33.53%	32.90%	32.28%	31.67%	31.08%	30.49%	29.93%	29.37%	28.82%	28.29%	27.76%
	Population breakdown		M		48.68%	49.17%	49.68%	50.19%	50.70%	51.20%	51.70%	52.20%	52.69%	53.17%	53.64%	54.10%	54.56%	55.00%	55.43%	55.85%
			F		51.32%	51.84%	52.36%	52.88%	53.39%	53.89%	54.39%	54.87%	55.35%	55.82%	56.29%	56.74%	57.18%	57.61%	58.04%	58.45%
			M	18-24	6.46%	6.51%	6.57%	6.66%	6.77%	6.89%	7.04%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%
			M	25-64	33.70%	33.86%	34.00%	34.09%	34.14%	34.14%	34.13%	34.08%	34.18%	34.28%	34.36%	34.44%	34.55%	34.65%	34.76%	34.88%
			M	65+	8.52%	8.80%	9.11%	9.44%	9.79%	10.17%	10.54%	10.93%	11.31%	11.69%	12.09%	12.47%	12.82%	13.16%	13.48%	13.78%
			F	18-24	6.13%	6.18%	6.25%	6.35%	6.46%	6.59%	6.73%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%
			F	25-64	34.41%	34.51%	34.57%	34.58%	34.55%	34.48%	34.40%	34.28%	34.31%	34.34%	34.35%	34.36%	34.40%	34.44%	34.48%	34.54%
			F	65+	10.78%	11.15%	11.54%	11.95%	12.38%	12.82%	13.26%	13.72%	14.16%	14.60%	15.06%	15.49%	15.90%	16.30%	16.68%	17.03%
	Smoker breakdown		M		14.77%	12.95%	11.44%	10.16%	9.07%	8.13%	7.32%	6.62%	6.01%	5.49%	5.03%	4.63%	4.29%	3.99%	3.73%	3.50%
			F		11.51%	9.86%	8.52%	7.42%	6.50%	5.73%	5.08%	4.53%	4.06%	3.66%	3.32%	3.03%	2.78%	2.56%	2.38%	2.22%

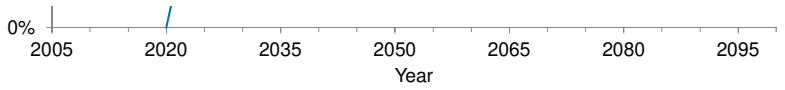
Summary Tables

	2050	2100
Total population ≥18 years old (millions)	320.7	372.3
Cigarette-attributable deaths since 2015 (1000s)		
CC-only case	9813.3	17467.1
With new product	12269.9	25849.1
Avoided	2456.5	8382.1
Life-years gained since 2015		
vs. CC-only (1000s)	24196.0	157743.2
Per avoided cigarette-attributable death	9.8	18.8

	2020	2025	2050	2075	2100
Total population ≥18 years old (millions)	258.7	271.8	320.7	349.2	372.3
Smoking prevalence:					
CC	13.10%	5.43%	1.15%	1.04%	0.98%



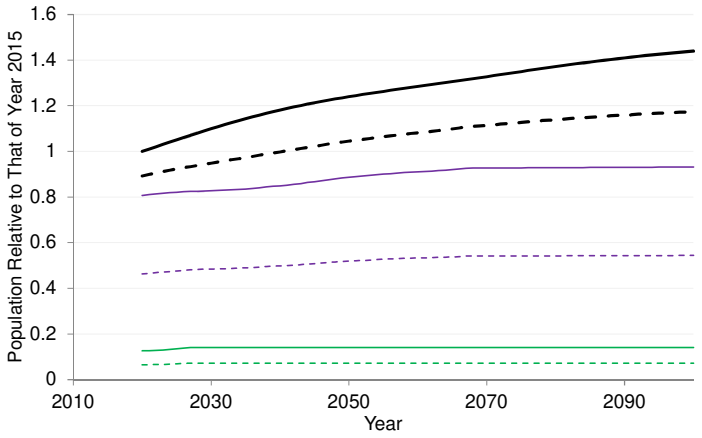
VLN	0.00%	1.47%	0.59%	0.49%	0.46%
Total current	**13.10%**	**6.90%**	**1.75%**	**1.53%**	**1.44%**
Former	23.88%	26.63%	19.29%	11.55%	7.86%
Never (remainder)	63.02%	66.47%	78.96%	86.92%	90.70%
Total current smoker breakdown:					
Men 18-24					
Women 18-24					
Men 25-64					
Women 25-64					
Men 65+					
Women 65+					
Cumulative results from 2015:					
Total adult deaths (millions)	0.0	12.8	94.0	195.5	302.4
Cig.-attributable deaths (1000s)	0.0	2073.3	9813.3	14410.7	17467.1
Avoided cig.-att. deaths (1000s)	0.0	91.1	2456.5	5352.3	8382.1
Life-years gained (1000s)	0.0	188.2	24196.0	83994.7	157743.2
Cig.-attributable morbidity ($billions)	0.0	47.6	1284.5	2798.6	4382.8

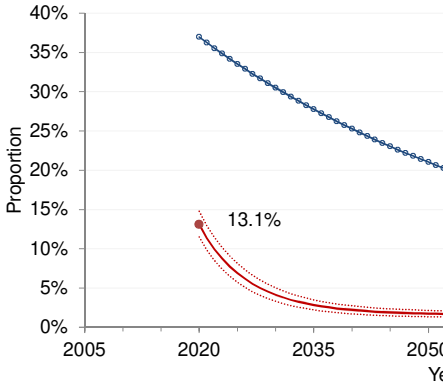


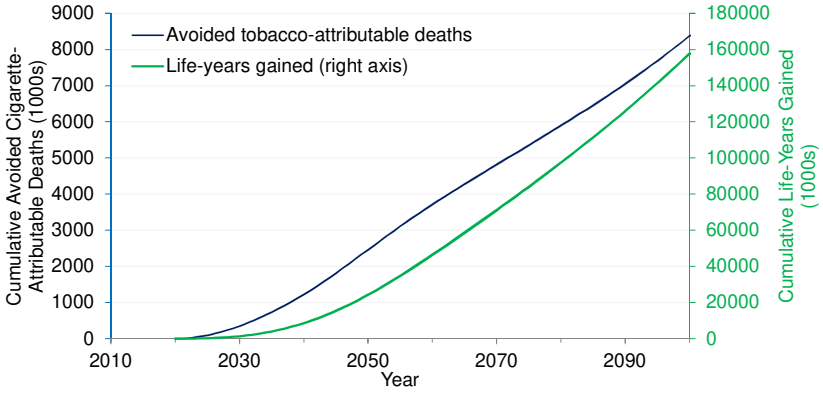
Morbidity at: 0.52288 million $/avoided cig-attrib. death

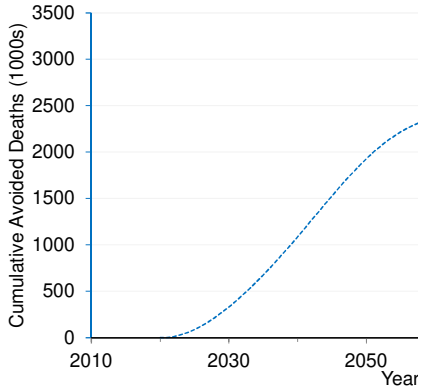
	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075	2080	2085	2090	2095	2100
Total pop. ≥18 years old (millions)	258.7	271.8	284.3	295.7	305.5	313.8	320.7	326.7	332.2	337.7	343.4	349.2	354.8	359.9	364.5	368.7	372.3	0.0
Smoking prevalence:																		
CC	13.10%	5.43%	2.75%	1.75%	1.37%	1.22%	1.15%	1.12%	1.09%	1.08%	1.06%	1.04%	1.02%	1.01%	1.00%	0.99%	0.98%	0.00%
VLN	0.00%	1.47%	1.40%	1.10%	0.84%	0.69%	0.59%	0.55%	0.52%	0.51%	0.50%	0.49%	0.48%	0.48%	0.47%	0.47%	0.46%	0.00%
Total current	**13.10%**	**6.90%**	**4.15%**	**2.85%**	**2.21%**	**1.90%**	**1.75%**	**1.66%**	**1.62%**	**1.58%**	**1.56%**	**1.53%**	**1.51%**	**1.49%**	**1.47%**	**1.45%**	**1.44%**	**0.00%**
Former	23.88%	26.63%	26.34%	24.91%	23.06%	21.14%	19.29%	17.57%	15.93%	14.37%	12.90%	11.55%	10.34%	9.31%	8.54%	8.07%	7.86%	0.00%
Never (remainder)	63.02%	66.47%	69.51%	72.24%	74.72%	76.96%	78.96%	80.77%	82.45%	84.05%	85.54%	86.92%	88.15%	89.20%	89.99%	90.48%	90.70%	0.00%
Total current smoker breakdown																		
Men 18-24	0.84%	0.59%	0.56%	0.54%	0.52%	0.51%	0.50%	0.49%	0.48%	0.47%	0.47%	0.46%	0.45%	0.44%	0.44%	0.43%	0.43%	0.00%
Women 18-24	0.55%	0.39%	0.37%	0.36%	0.35%	0.34%	0.33%	0.32%	0.32%	0.31%	0.31%	0.30%	0.30%	0.29%	0.29%	0.29%	0.28%	0.00%
Men 25-64	5.70%	3.08%	1.73%	1.08%	0.77%	0.62%	0.54%	0.51%	0.49%	0.48%	0.47%	0.46%	0.46%	0.45%	0.45%	0.44%	0.44%	0.00%
Women 25-64	4.78%	2.33%	1.23%	0.74%	0.51%	0.40%	0.35%	0.33%	0.32%	0.31%	0.31%	0.30%	0.30%	0.29%	0.29%	0.29%	0.28%	0.00%
Men 65+	0.66%	0.29%	0.16%	0.09%	0.05%	0.03%	0.02%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Women 65+	0.57%	0.21%	0.09%	0.04%	0.02%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Cumulative results from 2015:																		
Total adult deaths (millions)	0.0	12.8	26.3	41.0	57.2	74.9	94.0	114.0	134.5	155.0	175.3	195.5	215.9	236.8	258.2	280.0	302.4	302.4
Cig.-attributable deaths (1000s)	0.0	2073.3	3912.3	5609.0	7177.2	8592.7	9813.3	10862.5	11825.2	12734.3	13592.3	14410.7	15201.3	15941.1	16578.0	17078.4	17467.1	17467.1
Avoided cig.-att. deaths (1000s)	0.0	91.1	346.1	729.2	1220.3	1809.5	2456.5	3106.3	3710.4	4274.0	4814.7	5352.3	5898.1	6457.4	7047.4	7687.6	8382.1	8382.1
Life-years gained (1000s)	0.0	188.2	1307.4	3965.9	8561.9	15327.9	24196.0	34758.6	46370.0	58546.2	71086.5	83994.7	97371.8	111322.2	125968.9	141445.8	157743.2	157743.2
Avoided cigarette-attributable morbidity ($billions)	0.0	47.6	181.0	381.3	638.1	946.1	1284.5	1624.2	1940.1	2234.8	2517.5	2798.6	3084.0	3376.4	3684.9	4019.7	4382.8	4382.8

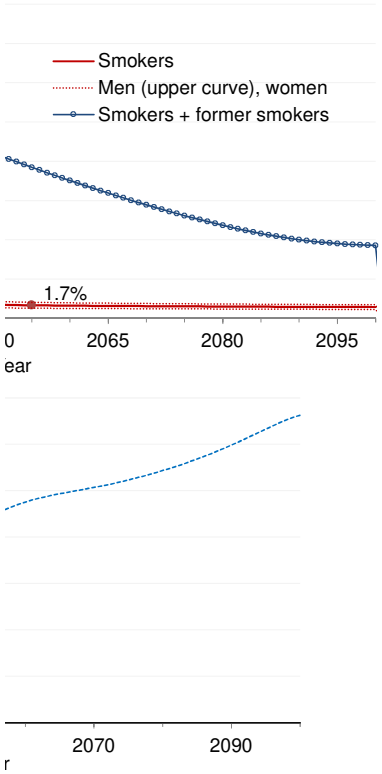
25	30	35	45	55	80	85
2045	2050	2055	2065	2075	2100	2105
1.21306	1.23989	1.26306	1.30547	1.34992	1.43923	
1.22%	1.15%	1.12%	1.08%	1.04%	0.98%	
1.27%	1.20%	1.17%	1.12%	1.09%	1.02%	
1.90%	**1.75%**	**1.66%**	**1.58%**	**1.53%**	**1.44%**	
21.14%	19.29%	17.57%	14.37%	11.55%	7.86%	
76.96%	78.96%	80.77%	84.05%	86.92%	90.70%	
0.01417	0.0151	0.01571	0.01584	0.01567	0.0175	
0.00104	0.00089	0.00078	0.00069	0.00062	0.00028	
1.17%	1.22%	1.24%	1.21%	1.16%	1.22%	#DIV/0!
3.66537	3.90475	4.06306	4.09623	4.05279	4.52613	#N/A
1528.71	1927.63	2217.49	2467.47	2615.73	3314.33	#N/A
1809.46	2456.53	3106.33	4274.03	5352.33	**8382.07**	8382.07
15327.9	24196	34758.6	58546.2	83994.7	**157743**	157743
36.01%	34.09%	32.91%	32.12%	32.05%	32.09%	#DIV/0!
23.04%	21.04%	19.23%	15.95%	13.08%	9.30%	0.00%
59.46%	60.93%	62.24%	64.71%	67.21%	71.78%	0.00%
61.84%	63.06%	64.06%	65.83%	67.78%	72.14%	0.00%
7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	0.00%
36.78%	37.84%	38.65%	39.72%	40.11%	40.32%	0.00%
15.49%	15.90%	16.40%	17.80%	19.91%	24.26%	0.00%
6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	0.00%
35.89%	36.68%	37.28%	38.25%	38.60%	38.76%	0.00%
19.07%	19.50%	19.90%	20.70%	22.30%	26.51%	0.00%
2.36%	2.16%	2.04%	1.93%	1.86%	1.74%	#DIV/0!
1.46%	1.35%	1.29%	1.24%	1.21%	1.14%	#DIV/0!

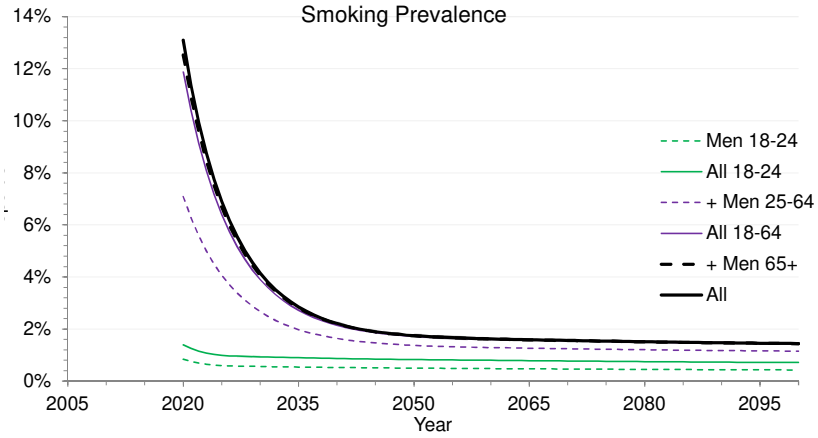


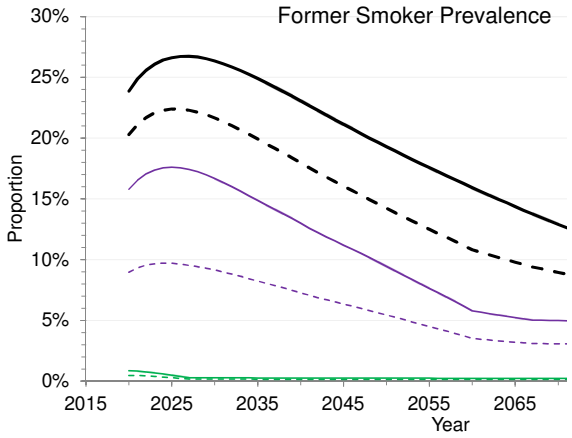


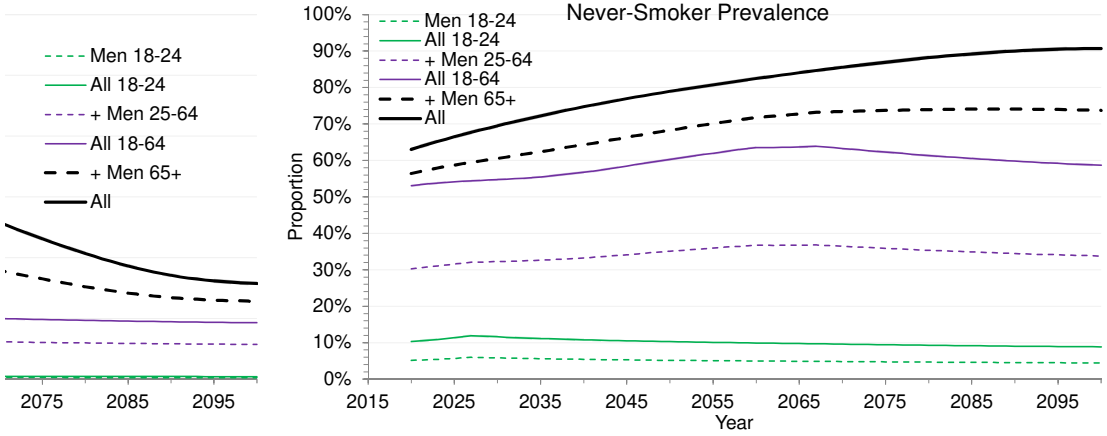





Smokers
Men (upper curve), women
Smokers + former smokers
1.7%
0
2065
2080
2095
ear
2070
2090
r


Smoking Prevalence
14%
12%
10%
8%
6%
4%
2%
0%
2005
2020
2035
2050
2065
2080
2095
Year
Men 18-24
All 18-24
+ Men 25-64
All 18-64
+ Men 65+
All


Former Smoker Prevalence
30%
25%
20%
15%
10%
5%
0%
Proportion
2015
2025
2035
2045
2055
2065
Year


Men 18-24
All 18-24
+ Men 25-64
All 18-64
+ Men 65+
All
2075
2085
2095
Never-Smoker Prevalence
Men 18-24
All 18-24
+ Men 25-64
All 18-64
+ Men 65+
All
Proportion
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2015
2025
2035
2045
2055
2065
2075
2085
2095
Year

Population Dynamics Model--Apelberg 2018-like

Input | Input formula (OK to change) | Button output

Both products, 11/2018

Based on: BothMandate

Name	Value	Units	Description	Link	Source, Comments
Population Inputs					
Year0	**2030**		First forecast year		Changing requires updating data below.
Pop0	**279.449**	million	Initial US adult (≥18) population in first forecast year		US Census estimates (see spreadsheet). Used only to scale calculated proportions to total counts.
Pop0Dists	(table)	%	Initial proportion of total population with each age & sex		same

Age	Men	Women	Men/Total
18	0.0087	0.00833	0.51108
19	0.00881	0.00838	
100 +	6.1E-05	0.00025	
PropM	0.48679	0.51321	

NewPop	2.010%	%/y	Annual new 18-year-olds plus additional net migration		Model of 2017 US Census projections (see spreadsheet)
NewPG1	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 1	https://ww	Model of 2017 US Census projections (see spreadsheet)
NewPY2	2035		First year of Period 2		same
NewPG2	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 2		same

Cigarette Initiation, Use Rate, and Cessation Inputs

InitRts	(table)	%	Proportion initiating cigarettes (modeled at 18 years old)		2015 NHIS maximum prevalence over 18-25 yrs old.
InitRtAnMults	(table)		Annual multiplier for proportion initiating cigarettes		**No change, as in Apelberg**

Men	Women	Wtd. av.
22.20%	15.39%	18.70%
1	**1**	1

InitRtMult	**0.5**		Initiation rate multiplier for sensitivity analysis
IStats	(table)	%	Smoking status proportions in initial population

2015 NHIS, adjusted to give Apelberg prevalence in initial year

Age from to	Men Current	Men Former	Men Never	Women Current	Women Former	Women Never
18 24	**10.00%**	**10.23%**	79.77%	**6.50%**	**8.80%**	84.70%
25 64	**13.90%**	**27.10%**	59.00%	**11.40%**	**22.30%**	66.30%
65 +	**4.70%**	**55.90%**	39.40%	**4.80%**	**35.80%**	59.40%
Wtd. av.	5.69%	14.39%	28.60%	4.79%	11.94%	34.58%
M+W	**10.49%**	26.34%	63.18%			

Total Pop. Props. Men	Total Pop. Props. Women	Men Current	Men Former	Men Never	Women Current	Women Former	Women Never
0.07431	0.0707	0.74%	0.76%	5.93%	0.46%	0.62%	5.99%
0.32732	0.33475	4.55%	8.87%	19.31%	3.82%	7.47%	22.19%
0.08516	0.10775	0.40%	4.76%	3.36%	0.52%	3.86%	6.40%

YrQuitSlp	0.515		Slope of years since quitting vs. (age-18)--former smkrs.		2017 NHIS (see spreadsheet). For initial population only (simulated after that). No sex difference seen.
CPDProps	(table)	%	Avg. proportions in CPD (on days smoked) categories		2017 NHIS, on days smoked.
CPDDayFracs	(table)	%	Average fraction of days smoked (unused)		2017 NHIS, mean # days smoked in last 30 days / 30
CPDERFacs	(table)		ER (RR-1) factors to adjust for CPD		Simple model based on Thun 2013 (Table S3), Thun 1997, and Bjartveit 2005. See formulas and separate spreadsheet.
CPDRedFacs	(table)		ER factors to adjust for reduced CPD		Same as CPDERFacs except at CPD reduced by M_CPDRed
CPDERSlope	0.35		Slope of CPD-Excess Risk relationship		See CPDERFacs

CPD from to	CPDProps Men	CPDProps Women	CPDDayFracs Men	CPDDayFracs Women	CPD Midpt.	Unscaled CPDERs Men	Unscaled CPDERs Women	CPDERFacs Men	CPDERFacs Women	CPDRedFacs Men	CPDRedFacs Women
0 1.5	6.80%	5.00%	35.53%	42.04%	0.75	0.233	(same)	0.205	0.149	0.205	0.149
1.5 5.5	23.71%	24.49%	67.24%	77.02%	3.5	0.800		0.703	0.512	0.703	0.512
5.5 15.5	38.48%	46.67%	94.60%	96.61%	10.5	1.542		1.355	0.987	1.355	0.987
15.5 25.5	24.63%	20.72%	99.02%	98.92%	20.5	2.101		1.846	1.345	1.846	1.345
25.5 35.5	3.84%	1.84%	99.83%	96.12%	30.5	2.457		2.160	1.573	2.160	1.573
35.5 +	2.54%	1.28%	97.83%	94.80%	*40.5*	2.720		2.390	1.741	2.390	1.741
Wtd. Av. CPD	12.1703	11.1222	11.5738	10.6429		1.4798639	1.442646	1.30044	0.9236	1.30044	0.9236
	on days smoked		over all days			Wtd. Av. unscaled		Wtd. Av. CPDERFac (normalized to Smoker RR)			

QuitParms	(table)		Quit (cessation) rates by age & sex		Holford 2015: 1980 cohort, modeled (see spreadsheet), adjusted from 3.53% to reach 4.5% mean from Mendez 2016

	Men	Women	
Quit rate at age 18	2.51%	2.52%	
Linear Slope (%/y)	0.0442%	0.0437%	
Age Exponential Starts	60	50	
Quit rate at this age	4.30%	3.98%	
Ann. Age Multiplier	1.036	1.031	
Weighted Average	4.16%	4.82%	4.50%

QuitRtMult	**3.42222**		**Quit rate multiplier (Apelberg policy scenario)**

Death Rate Inputs

DRMult	1.2		Multiplier to adjust all death rates (1=no change)	To agree with US Census Bureau projections; see spreadsheet

DRAnMult	0.99		Annual mortality rate multiplier						
NSDRs, RRs	(table)	/100,000/y	Annual mortality rate and Relative Risk (RR)					http://ww	Thun 2013 Table S2 (5 contemporary cohorts, 2000-2010)
	Wtd. Av.		627.906	608.02	2.30044	1.9236	1629.85	1315.9	0.4867949 0.5132051
					Should = Wtd. Av. CPDERFacs + 1				
ERChgs	(table)	1/y	ER change rate with years after quitting						Exponential declines toward ER=0, based on results in Mendez 2001 (see spreadsheet)

New Product (MRTP) Inputs

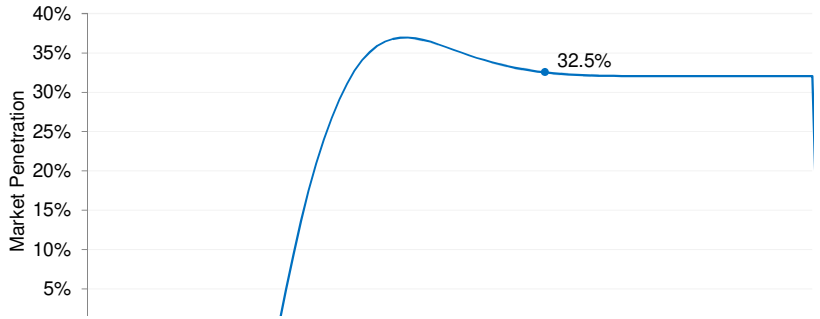
				Low	Base	High
M_IntroYr	**2030**		Year VLN product is introduced		Set >= 1st year, or blank (none).	
M_CtoM	**5.0%**	%/yr	C-I: Peak annual rate CC smokers switch to VLN			
M_CtoMYAM	1		C-Im: Young adult (<=24) multiplier for rate CC smokers switch			
M_CtoMYr	**0**	yr	Years until peak rate that CC smokers switch - linear growth		>=0	
M_MtoS	**100%**	%	I-S: Proportion of initial VLN smokers sustaining use beyond 1 year		Remainder revert to CC. Cf. dropout rate by 20 wk in Hatsukami 2018: 32% total, 4% for product dissatisfaction (immediate red. group)	
M_StoC	**0%**	%/yr	S-C: Annual rate sustaining VLN smokers relapse to CCs		(Can be correlated with above)	
M_CPDRedF	**0%**	%	CPDf: Proportion of VLN smokers reducing CPD			
M_CPDRed	0%	%	CPDr: Av. reduction in CPD among VLN smokers reducing CPD		Hatsukami 2018 (approximated)	
M_MtoFRel	**100%**	%	S-Fm: Quit rate for VLN smokers as % of CC quit rate			
M_ERR	**18%**	%	ERR: prop. of CC smoker Excess Risk experienced by VLN smokers			

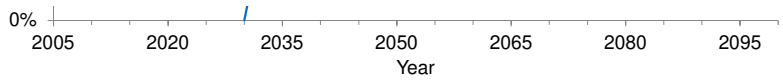
NOTE: "VLN" product here now represents non-combusted products, with VLNC combined with CC as in Apelberg.

Results

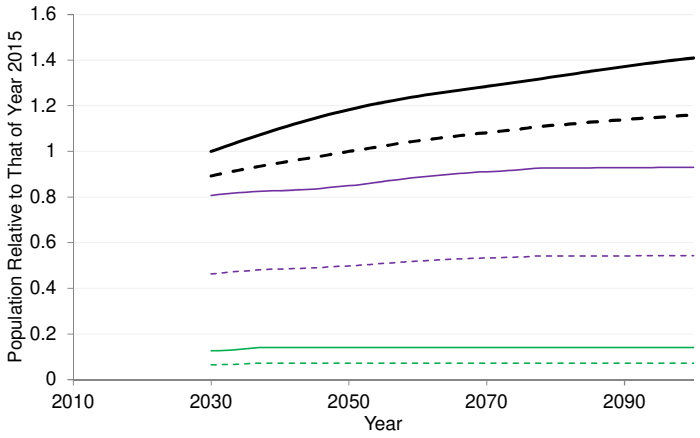
Run through year 2100 — Last run took 3.33 seconds (12/9/2018 9:36:34 PM). ☐ Create workbook with detailed results (slow)

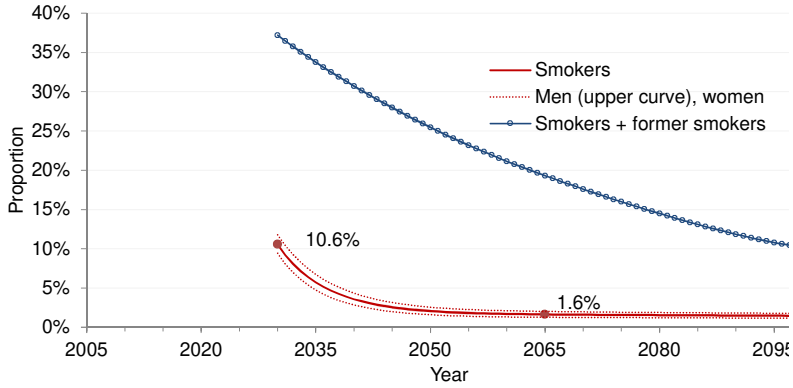
			Year #:	0	1	2	3	4	5	6	7	8	9	15	25	30	35	45	55
			Year:	*2030*	2031	2032	2033	2034	2035	2036	2037	2038	2039	2045	2055	2060	2065	2075	2085
1	Total adult population relative to that of 2030			1	1.01043	1.02089	1.03128	1.0416	1.05182	1.06194	1.07189	1.08167	1.09129	1.14482	1.2149	1.24149	1.26432	1.30612	1.35022
2	C: conventional cig. smoker proportion			10.57%	8.76%	7.34%	6.20%	5.28%	4.53%	3.92%	3.42%	3.01%	2.68%	1.62%	1.20%	1.14%	1.11%	1.07%	1.04%
3	C+M: CC + 1st-year New Product proportion			10.57%	9.22%	7.71%	6.51%	5.54%	4.76%	4.11%	3.59%	3.16%	2.81%	1.70%	1.25%	1.20%	1.16%	1.12%	1.09%
4	C+M+S: total smoker proportion			**10.57%**	**9.22%**	**8.10%**	**7.18%**	**6.39%**	**5.73%**	**5.16%**	**4.67%**	**4.25%**	**3.89%**	**2.57%**	**1.84%**	**1.71%**	**1.65%**	**1.58%**	**1.53%**
5	F: former smoker proportion			26.63%	27.25%	27.66%	27.90%	28.02%	28.03%	27.97%	27.84%	27.65%	27.41%	25.40%	21.35%	19.44%	17.67%	14.41%	11.57%
6	N: never-smoker proportion			62.80%	63.53%	64.24%	64.92%	65.59%	66.24%	66.87%	67.49%	68.10%	68.70%	72.03%	76.81%	78.85%	80.68%	84.01%	86.90%
7	D: annual deaths as proportion of initial population			0	0.00967	0.00965	0.00971	0.00978	0.00989	0.00999	0.01015	0.01033	0.01049	0.01173	0.0142	0.01516	0.01578	0.01588	0.01569
41	Cigarette-attributable deaths relative to initial population			0	0.00151	0.00144	0.00139	0.00135	0.00132	0.0013	0.00128	0.00127	0.00125	0.00116	0.00099	0.00086	0.00077	0.00069	0.00063
	Annual US adult death rate			0.00%	0.96%	0.95%	0.94%	0.94%	0.94%	0.94%	0.95%	0.95%	0.96%	1.02%	1.17%	1.22%	1.25%	1.22%	1.16%
	Annual US adult deaths (millions)			0	2.7032	2.69645	2.71335	2.7335	2.76345	2.79088	2.83522	2.88533	2.93107	3.27771	3.9685	4.23508	4.40881	4.43881	4.38562
	Avoided deaths through each year vs. CC Only (1000s)		0	0	-139.13	-276.26	-412.66	-548.54	-684.54	-819.96	-955.97	-1093.1	-1231.3	-2111.6	-3972.6	-5174	-6585.8	-9801.5	-13004
	Avoided cigarette-attributable deaths through each year vs. CC Only (1000s)		0	0	66.8089	138.587	214.879	295.315	379.76	468.636	562.019	659.804	761.716	1450.6	2827.83	3571.58	4289.81	5553.57	6712.24
	Life-years gained through each year vs. CC only (1000s)		0	-6E-11	66.8089	202.054	407.876	686.459	1040.07	1471.56	1983.83	2579.68	3261.67	9273.54	26839.6	38798.8	52154.5	80365.6	109077
For plots:																			
	Market penetration ((M+S)/(C+M+S))			0.00%	4.90%	9.45%	13.65%	17.47%	20.93%	24.02%	26.73%	29.08%	31.08%	36.78%	34.72%	33.32%	32.53%	32.07%	32.05%
	Smoker + former smoker proportion			37.20%	36.47%	35.76%	35.08%	34.41%	33.76%	33.13%	32.51%	31.90%	31.30%	27.97%	23.19%	21.15%	19.32%	15.99%	13.10%
	Population breakdown	M		48.68%	49.20%	49.72%	50.24%	50.76%	51.28%	51.79%	52.30%	52.79%	53.28%	56.00%	59.60%	61.04%	62.33%	64.76%	67.23%
		F		51.32%	51.85%	52.37%	52.89%	53.40%	53.90%	54.40%	54.89%	55.37%	55.85%	58.48%	61.89%	63.11%	64.10%	65.85%	67.79%
		M	18-24	6.46%	6.51%	6.57%	6.66%	6.77%	6.89%	7.04%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%	7.19%
		M	25-64	33.70%	33.87%	34.01%	34.10%	34.16%	34.16%	34.15%	34.10%	34.21%	34.31%	34.90%	36.80%	37.85%	38.66%	39.72%	40.11%
		M	65+	8.52%	8.82%	9.14%	9.48%	9.84%	10.23%	10.61%	11.00%	11.40%	11.78%	13.90%	15.60%	16.00%	16.48%	17.84%	19.93%
		F	18-24	6.13%	6.18%	6.25%	6.35%	6.46%	6.59%	6.73%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%	6.88%
		F	25-64	34.41%	34.51%	34.57%	34.58%	34.56%	34.49%	34.40%	34.28%	34.31%	34.35%	34.55%	35.89%	36.69%	37.28%	38.25%	38.60%
		F	65+	10.78%	11.15%	11.54%	11.95%	12.38%	12.83%	13.27%	13.73%	14.18%	14.62%	17.06%	19.12%	19.54%	19.94%	20.72%	22.31%
	Smoker breakdown	M		11.77%	10.41%	9.27%	8.30%	7.47%	6.75%	6.12%	5.58%	5.11%	4.70%	3.16%	2.27%	2.11%	2.02%	1.93%	1.85%
		F		9.43%	8.08%	6.99%	6.11%	5.37%	4.75%	4.24%	3.80%	3.43%	3.12%	2.00%	1.42%	1.33%	1.28%	1.24%	1.21%

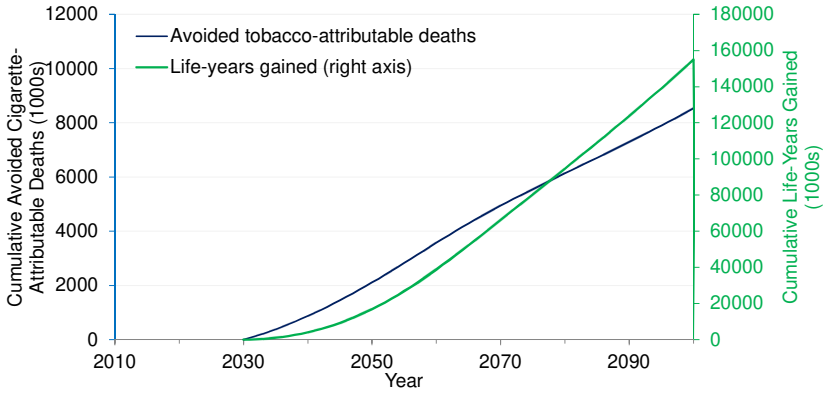


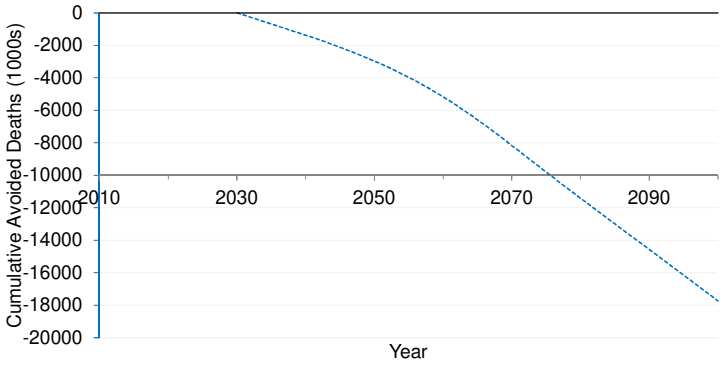

0%
2005
2020
2035
2050
2065
2080
2095
Year

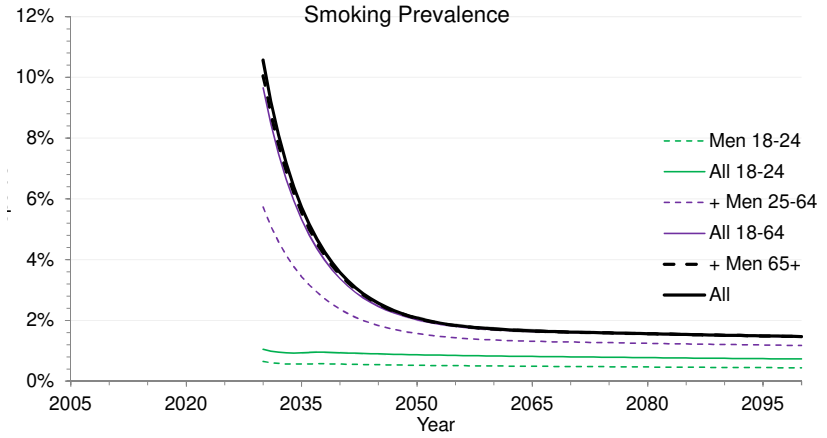
70	85
2100	2115
1.40935	
1.00%	
1.04%	
1.47%	
8.55%	
89.99%	
0.01669	
0.00046	
1.18%	#DIV/0!
4.66429	#N/A
-17728	#N/A
8534.86	10937.3
155037	-4E+06
32.07%	#DIV/0!
10.01%	0.00%
70.31%	0.00%
70.63%	0.00%
7.19%	0.00%
40.24%	0.00%
22.87%	0.00%
6.88%	0.00%
38.70%	0.00%
25.05%	0.00%
1.78%	#DIV/0!
1.16%	#DIV/0!

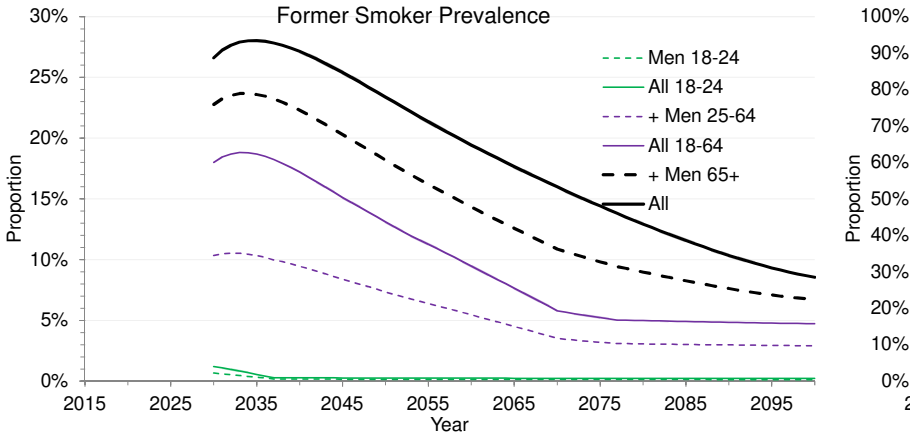


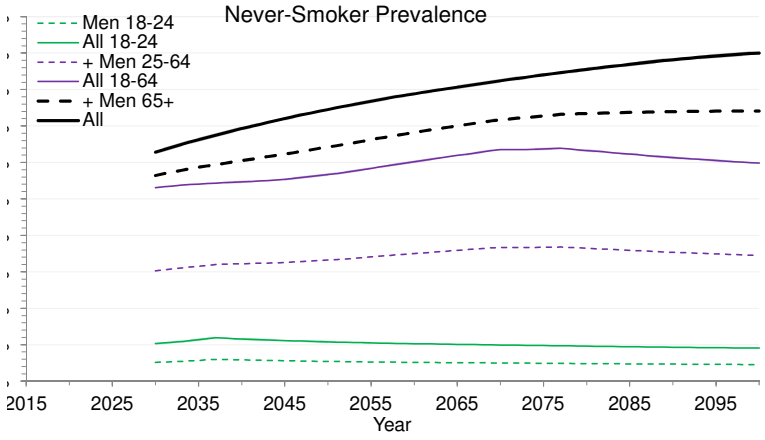






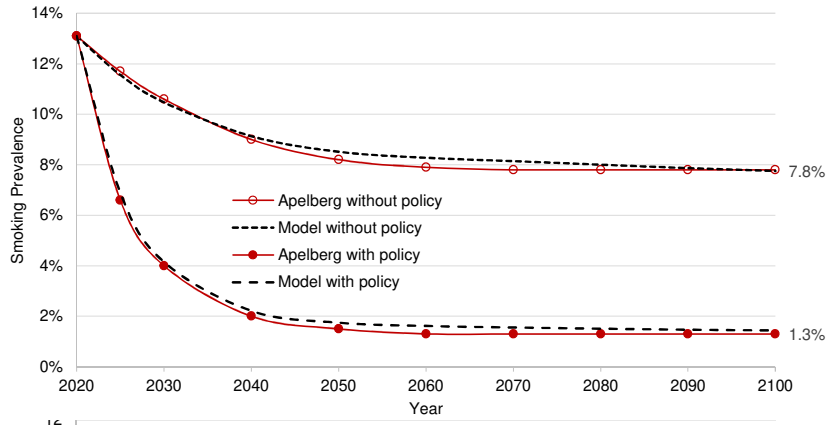

Smoking Prevalence
12%
10%
8%
6%
4%
2%
0%
2005
2020
2035
2050
2065
2080
2095
Year
Men 18-24
All 18-24
+ Men 25-64
All 18-64
+ Men 65+
All

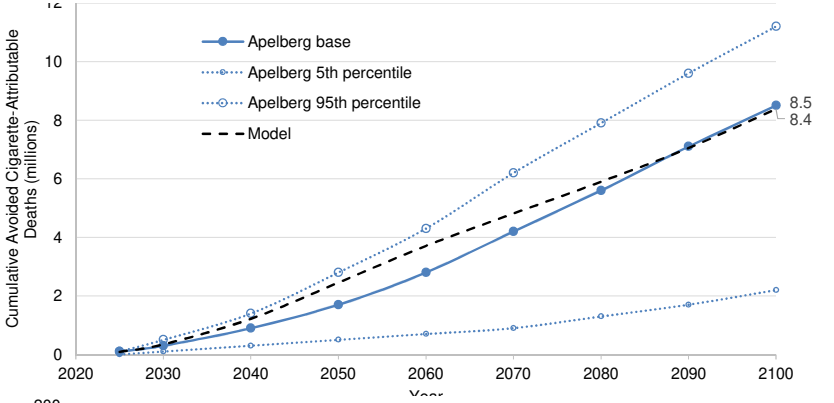

Former Smoker Prevalence
30%
25%
20%
15%
10%
5%
0%
Proportion
2015
2025
2035
2045
2055
2065
2075
2085
2095
Year
Men 18-24
All 18-24
+ Men 25-64
All 18-64
+ Men 65+
All
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Proportion

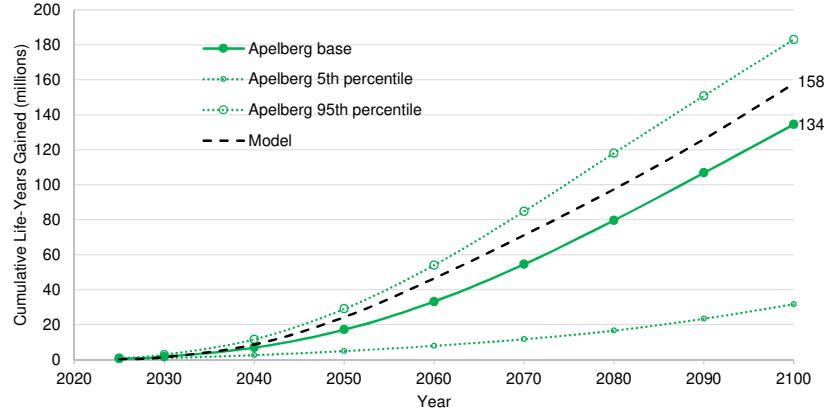

Never-Smoker Prevalence
Men 18-24
All 18-24
+ Men 25-64
All 18-64
+ Men 65+
All
2015
2025
2035
2045
2055
2065
2075
2085
2095
Year

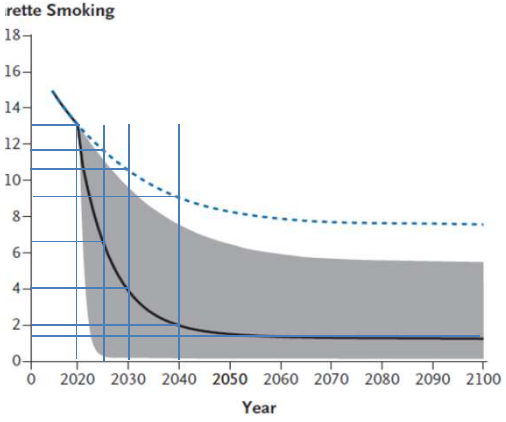
Model tuned to match Apelberg's mandated nicotine reduction scenario

Year	2020	2025	2030	2040	**2050**	2060	2070	2080	2090	2100
Smoking Prevalence										
Model without policy	13.1%	11.6%	10.5%	9.1%	8.5%	8.3%	8.1%	8.0%	7.9%	7.8%
Apelberg without policy	13.1%	11.7%	10.6%	9.0%	8.2%	7.9%	7.8%	7.8%	7.8%	7.8%
Model with policy	13.1%	6.9%	4.2%	2.2%	1.7%	1.6%	1.6%	1.5%	1.5%	1.4%
Apelberg with policy	13.1%	6.6%	4.0%	2.0%	1.5%	1.3%	1.3%	1.3%	1.3%	1.3%
Avoided Cigarette-Attributable Deaths										
Model	0.00	0.09	0.35	1.22	2.46	3.71	4.81	5.90	7.05	**8.38**
Model with mandate delayed to 2030			0.00	0.87	2.11	3.57	4.95	6.13	7.30	8.53
Apelberg base		0.1	0.3	0.9	1.7	2.8	4.2	5.6	7.1	8.5
Apelberg 5th percentile		0	0.1	0.3	0.5	0.7	0.9	1.3	1.7	2.2
Apelberg 95th percentile		0.1	0.5	1.4	2.8	4.3	6.2	7.9	9.6	11.2
Life-Years Gained										
Model	0	0.188	1.307	8.562	24.2	46.37	71.09	97.37	126	**157.7**
Model with mandate delayed to 2030			-6E-14	4.032	16.89	38.8	66.16	94.64	123.8	155
Apelberg base		0.4	1.6	6.8	17	33.1	54.4	79.6	106.7	134.4
Apelberg 5th percentile		0.2	0.8	2.5	4.8	7.8	11.6	16.5	23.3	31.6
Apelberg 95th percentile		0.7	2.7	11.5	28.9	53.9	84.7	118	150.8	183









3. Projected Cumulative Number of Tobacco-Related Deaths Averted and Life-Years Gained after the mentation of a Nicotine-Reduction Policy in 2020.*

Tobacco-Related Deaths Averted			Life-Years Gained		
5th Percentile	Median	95th Percentile	5th Percentile	Median	95th Percentile
millions					
0	0.1	0.1	0.2	0.4	0.7
0.1	0.3	0.5	0.8	1.6	2.7
0.3	0.9	1.4	2.5	6.8	11.5
0.5	1.7	2.8	4.8	17.0	28.9
0.7	2.8	4.3	7.8	33.1	53.9
0.9	4.2	6.2	11.6	54.4	84.7
1.3	5.6	7.9	16.5	79.6	118.0
1.7	7.1	9.6	23.3	106.7	150.8
2.2	8.5	11.2	31.6	134.4	183.0

Population Dynamics Model--2015 New Pop. Cohort

Input | Input formula (OK to change) | Button output

CC only, 9/2018 (same as Both model except no M_IntroYr)

Based on: Both

Name	Value	Units	Description	Link	Source, Comments
Population Inputs					
Year0	2015		First forecast year		Changing requires updating data below.
Pop0	**1.5**	million	Initial US adult (≥18) population in first forecast year		**SET TO A SMALL #. FOR SOME REASON THIS WORKS BETTER THAN A VERY SMALL #.**
Pop0Dists	(table)	%	Initial proportion of total population with each age & sex		same

Age	Men	Women	Men/Total
18	**0.5**	**0.5**	*0.5*
19	0	0	
24	0	0	
25	0	0	
64	0	0	
65	0	0	
100 +	0	0	
PropM	0.5	0.5	

NewPop	332%	%/y	Annual new 18-year-olds plus additional net migration		Model of 2017 US Census projections (see spreadsheet). (Annual new 18-year-olds = initial pop. x 18yo proportion.)
NewPG1	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 1	https://ww	Model of 2017 US Census projections (see spreadsheet)
NewPY2	2035		First year of Period 2		same
NewPG2	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 2		same
Cigarette Initiation, Use Rate, and Cessation Inputs					
InitRts	(table)	%	Proportion initiating cigarettes (modeled at 18 years old)		2015 NHIS maximum prevalence over 18-25 yrs old.
InitRtAnMults	(table)	%	Annual multiplier for proportion initiating cigarettes		2015-2017 NHIS max. prevalence change rate

Men	Women	Wtd. av.
22.20%	15.39%	18.79%
96.97%	96.28%	96.62%

	Low	Base	High
InitRtMult	1.25	1	0.75

IStats	(table)	%	Smoking status proportions in initial population		2015 NHIS
YrQuitSlp	0.515		Slope of years since quitting vs. (age-18)--former smkrs.		2017 NHIS (see spreadsheet). For initial population only (simulated after that). No sex difference seen.
CPDERSlope	0.35				

	Low	Base	High
	0.7	0.35	0.175

CPDProps	(table)	%	Avg. proportions in CPD (on days smoked) categories	2017 NHIS, on days smoked.
CPDDayFracs	(table)	%	Average fraction of days smoked (unused)	2017 NHIS, mean # days smoked in last 30 days / 30
CPDERFacs	(table)		ER (RR-1) factors to adjust for CPD	Simple model based on Thun 2013 (Table S3), Thun 1997, and Bjartveit 2005. See formulas and separate spreadsheet.
CPDRedFacs	(table)		ER factors to adjust for reduced CPD	Same as CPDERFacs except at CPD reduced by M_CPDRed
QuitParms	(table)		Quit (cessation) rates by age & sex	Holford 2015: 1980 cohort, modeled (see spreadsheet), adjusted from 3.53% to reach 4.5% mean from Mendez 2016

Weighted Average	2.51%	2.52%	2.51%

	Low	Base	High
QuitRtMult	0.75	1	1.25

Death Rate Inputs					
DRMult	1.2		Multiplier to adjust all death rates (1=no change)	To agree with US Census Bureau projectio	
DRAnMult	0.99		Annual mortality rate multiplier		

	Low	Base	High
	1	1.2	1.4
	0.98	0.99	1

NSDRs, RRs	(table)	/100,000/y	Annual mortality rate and Relative Risk (RR)	http://ww	Thun 2013 Table S2 (5 contemporary cohorts, 2000-2010)

Wtd. Av.	627.906	608.02	2.30044	1.9236	1629.85	1315.9	0.4867949 0.5132051

Should = Wtd. Av. CPDERFacs + 1

ERChgs	(table)	1/y	ER change rate with years after quitting		Exponential declines toward ER=0, based on results in Mendez 2001 (see spreadsheet)
New Product (MRTP) Inputs					

	Low	Base	High
M_IntroYr			
M_CtoM			
M_CtoMYAM			
M_CtoMYr			
M_MtoS			
M_StoC			
M_CPDRedF			
M_CPDRed			
M_MtoFRel			
M_ERR			

M_IntroYr			Year VLN product is introduced		Set >= 1st year, or blank (none).
M_CtoM	**7.1%**	%/yr	C-I: Peak annual rate CC smokers switch to VLN		
M_CtoMYAM	1		C-Im: Young adult (<=24) multiplier for rate CC smokers switch		
M_CtoMYr	**5**	yr	Years until peak rate that CC smokers switch - linear growth		>=0
M_MtoS	50%	%	I-S: Proportion of initial VLN smokers sustaining use beyond 1 year		Cf. dropout rate by 20 wk in Hatsukami 2018: 32% total, 4% for product dissatisfaction (immediate red. group)
M_StoC	**10%**	%/yr	S-C: Annual rate sustaining VLN smokers relapse to CCs		(Can be correlated with above)
M_CPDRedF	80%	%	CPDf: Proportion of VLN smokers reducing CPD		Hatsukami 2018 (approximated)
M_CPDRed	50%	%	CPDr: Av. reduction in CPD among VLN smokers reducing CPD		Hatsukami 2018 (approximated)
M_MtoFRel	118%	%	S-Fm: Quit rate for VLN smokers as % of CC quit rate		
M_ERR	100%	%	ERR: prop. of CC smoker Excess Risk experienced by VLN smokers		

Results

Run through year 2100

Last run took 3.87 seconds (12/13/2018 10:38:00 AM).

☐ Create workbook with detailed results (slow)

Year #:	0	1	2	3	4	5	6	7	8	9	15	25	35	45	55	85

		Year:	*2015*	2016	2017	2018	2019	2020	2021	2022	2023	2024	2030	2040	2050	2060	2070	2100
1	Total adult population relative to that of 2015		1	4.316	7.632	10.948	14.264	17.58	20.896	24.212	27.528	30.844	50.74	83.5739	115.717	147.243	177.618	237.886
2	C: conventional cig. smoker proportion		13.00%	16.90%	16.94%	16.65%	16.27%	15.85%	15.42%	14.98%	14.55%	14.13%	11.75%	8.47%	5.98%	4.14%	2.78%	0.84%
3	C+M: CC + 1st-year New Product proportion		13.00%	16.90%	16.94%	16.65%	16.27%	15.85%	15.42%	14.98%	14.55%	14.13%	11.75%	8.47%	5.98%	4.14%	2.78%	0.84%
4	C+M+S: total smoker proportion		**13.00%**	**16.90%**	**16.94%**	**16.65%**	**16.27%**	**15.85%**	**15.42%**	**14.98%**	**14.55%**	**14.13%**	**11.75%**	**8.47%**	**5.98%**	**4.14%**	**2.78%**	**0.84%**
5	F: former smoker proportion		4.75%	1.18%	0.91%	0.94%	1.05%	1.20%	1.36%	1.53%	1.70%	1.87%	2.82%	4.02%	4.76%	5.14%	5.23%	3.51%
6	N: never-smoker proportion		82.25%	81.93%	82.15%	82.41%	82.68%	82.95%	83.22%	83.48%	83.74%	84.00%	85.43%	87.51%	89.27%	90.72%	91.99%	95.65%
7	D: annual deaths as proportion of initial population	44.9743	0	0	0	0	0	0	0	0	0	0	0	0.06725	0.12698	0.20154	0.36134	2.69063
41	Tobacco-attributable deaths relative to initial population	2.10667	0	0	0	0	0	0	0	0	0	0	0	0.01063	0.01534	0.02237	0.03322	0.05939
	Annual US adult death rate		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.08%	0.11%	0.14%	0.20%	1.13%
	Annual US adult deaths (millions)		0	0	0	0	0	0	0	0	0	0	0	0.10087	0.19047	0.30232	0.54201	4.03595
	Avoided deaths through each year vs. CC Only (1000s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Avoided tobacco-attributable deaths through each year vs. CC Only (1000s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Life-years gained through each year vs. CC only (1000s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

357.06

Population Dynamics Model--2015 New Pop. Cohort

Input | Input formula (OK to change) | Button output

Both products, 9/2018

Based on:

Name	Value	Units	Description	Link	Source, Comments
Population Inputs					
Year0	2015		First forecast year		Changing requires updating data below.
Pop0	**1.5**	million	Initial US adult (≥18) population in first forecast year		**SET TO A SMALL #. FOR SOME REASON THIS WORKS BETTER THAN A VERY SMALL #.**
Pop0Dists	(table)	%	Initial proportion of total population with each age & sex		same

Age	Men	Women	Men/Total
PropMAt18 18	**0.5**	**0.5**	*0.5*
19	0	0	
24	0	0	
25	0	0	
26	0	0	
27	0	0	
28	0	0	
29	0	0	
30	0	0	
31	0	0	
100 +	0	0	
PropM 0.5	0.5	0.5	

NewPop	332%	%/y	Annual new 18-year-olds plus additional net migration		Model of 2017 US Census projections (see spreadsheet)
NewPG1	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 1	https://ww	Model of 2017 US Census projections (see spreadsheet)
NewPY2	2035		First year of Period 2		same
NewPG2	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 2		same

Cigarette Initiation, Use Rate, and Cessation Inputs

InitRts	(table)	%	Proportion initiating cigarettes (modeled at 18 years old)	2015 NHIS maximum prevalence over 18-25 yrs old.
InitRtAnMults	(table)	%	Annual multiplier for proportion initiating cigarettes	2015-2017 NHIS max. prevalence change rate

Men	Women	Wtd. av.
22.20%	15.39%	18.79%
96.97%	96.28%	96.62%

	Low	Base	High
InitRtMult 1	1.25	1	0.75

IStats	(table)	%	Smoking status proportions in initial population	2015 NHIS
YrQuitSlp	0.515		Slope of years since quitting vs. (age-18)--former smkrs.	2017 NHIS (see spreadsheet). For initial population only (simulated after that). No sex difference seen.
CPDERSlope	0.35			0.7 | 0.35 | 0.175
CPDProps	(table)	%	Avg. proportions in CPD (on days smoked) categories	2017 NHIS, on days smoked.
CPDDayFracs	(table)	%	Average fraction of days smoked (unused)	2017 NHIS, mean # days smoked in last 30 days / 30
CPDERFacs	(table)		ER (RR-1) factors to adjust for CPD	Simple model based on Thun 2013 (Table S3), Thun 1997, and Bjartveit 2005. See formulas and separate spreadsheet.
CPDRedFacs	(table)		ER factors to adjust for reduced CPD	Same as CPDERFacs except at CPD reduced by M_CPDRed

CPD from to	CPDProps Men	CPDProps Women	CPDDayFracs Men	CPDDayFracs Women	CPD Midpt.	Unscaled CPDERs Men	Unscaled CPDERs Women	CPDERFacs Men	CPDERFacs Women	CPDRedFacs Men	CPDRedFacs Women
0 1.5	6.80%	5.00%	35.53%	42.04%	0.75	0.233	(same)	0.205	0.149	0.108	0.079
1.5 5.5	23.71%	24.49%	67.24%	77.02%	3.5	0.800		0.703	0.512	0.420	0.306
5.5 15.5	38.48%	46.67%	94.60%	96.61%	10.5	1.542		1.355	0.987	0.916	0.668
15.5 25.5	24.63%	20.72%	99.02%	98.92%	20.5	2.101		1.846	1.345	1.339	0.975
25.5 35.5	3.84%	1.84%	99.83%	96.12%	30.5	2.457		2.160	1.573	1.623	1.182
35.5 +	2.54%	1.28%	97.83%	94.80%	*40.5*	2.720		2.390	1.741	1.837	1.338
Wtd. Av. CPD	12.1703	11.1222	11.5738	10.6429		1.4798639	1.442646	1.30044	0.9236	0.89825	0.63142
	on days smoked		over all days			Wtd. Av. unscaled		Wtd. Av. CPDERFac (normalized to Smoker RR)			

QuitParms (table) — Quit (cessation) rates by age & sex — Holford 2015: 1980 cohort, modeled (see spreadsheet), adjusted from 3.53% to reach 4.5% mean from Mendez 2016

	Men	Women	
Quit rate at age 18	2.51%	2.52%	
Linear Slope (%/y)	0.0442%	0.0437%	
Age Exponential Starts	60	50	
Quit rate at this age	4.30%	3.98%	
Ann. Age Multiplier	1.036	1.031	
Weighted Average	2.51%	2.52%	2.51%

	Low	Base	High
QuitRtMult 1 — Quit rate multiplier for sensitivity analysis	0.75	1	1.25

Death Rate Inputs

DRMult	1.2		Multiplier to adjust all death rates (1=no change)		To agree with US Census Bureau projecti	1 | 1.2 | 1.4	

| | | |

Total population ≥18 years old (millions)	173.6	356.9
Cigarette-attributable deaths since 2015 (1000s)		
CC-only case	13934.1	23364.9
With new product	272.2	3010.4
Avoided	13661.9	20354.5
Life-years gained since 2015		
vs. CC-only (1000s)	117.3	3496.7
Per avoided cigarette-attributable death	0.0	0.2

	2015	2020	2025	2050	2075	2100
Total population ≥18 years old (millions)	1.5	26.4	51.2	173.6	288.1	356.9
Smoking prevalence:						
CC	13.00%	15.85%	12.64%	4.47%	1.63%	0.60%
VLN	0.00%	0.00%	1.07%	1.40%	0.55%	0.21%
Total current	**13.00%**	**15.85%**	**13.70%**	**5.87%**	**2.19%**	**0.81%**
Former	4.75%	1.20%	2.05%	4.87%	5.26%	3.56%
Never (remainder)	82.25%	82.95%	84.25%	89.26%	92.55%	95.62%
Cumulative results from 2015:						
Total adult deaths (millions)	0.0	0.0	0.0	2.0	11.9	67.4
Cig.-attributable deaths (1000s)	0.0	0.0	0.0	272.2	1180.7	3010.4
Avoided cig.-att. deaths (1000s)	0.0	0.0	0.0	16.2	77.3	149.6
Life-years gained (1000s)	0.0	0.0	0.0	117.3	1159.5	3496.7
Cig.-attributable morbidity ($billions)	0.0	0.0	0.0	8.4	40.4	78.2

Morbidity at: 0.52288 million $/avoided cig-attrib. death

	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075	2080	2085	2090	2095	2100
Total pop. ≥18 years old (millions)	1.5	26.4	51.2	76.1	100.9	125.4	149.6	173.6	197.4	220.9	244.0	266.5	288.1	308.2	326.1	340.6	350.8	356.9
Smoking prevalence:																		
CC	13.00%	15.85%	12.64%	9.82%	7.98%	6.56%	5.42%	4.47%	3.69%	3.03%	2.48%	2.02%	1.63%	1.32%	1.07%	0.87%	0.72%	0.60%
VLN	0.00%	0.00%	1.07%	1.90%	1.97%	1.82%	1.62%	1.40%	1.19%	1.00%	0.83%	0.68%	0.55%	0.45%	0.36%	0.30%	0.25%	0.21%
Total current	**13.00%**	**15.85%**	**13.70%**	**11.72%**	**9.95%**	**8.38%**	**7.03%**	**5.87%**	**4.88%**	**4.03%**	**3.31%**	**2.70%**	**2.19%**	**1.77%**	**1.43%**	**1.17%**	**0.97%**	**0.81%**
Former	4.75%	1.20%	2.05%	2.86%	3.55%	4.11%	4.54%	4.87%	5.11%	5.26%	5.33%	5.33%	5.26%	5.11%	4.86%	4.51%	4.07%	3.56%
Never (remainder)	82.25%	82.95%	84.25%	85.43%	86.50%	87.51%	88.43%	89.26%	90.01%	90.71%	91.36%	91.97%	92.55%	93.12%	93.70%	94.31%	94.96%	95.62%
Total current smoker breakdown																		
Men 18-24	7.51%	9.43%	5.61%	3.24%	2.09%	1.44%	1.04%	0.77%	0.58%	0.44%	0.34%	0.27%	0.21%	0.17%	0.14%	0.11%	0.09%	0.08%
Women 18-24	5.49%	6.42%	3.70%	2.06%	1.28%	0.86%	0.59%	0.42%	0.31%	0.23%	0.17%	0.13%	0.10%	0.08%	0.06%	0.05%	0.04%	0.03%
Men 25-64	0.00%	0.00%	2.61%	3.84%	3.95%	3.68%	3.28%	2.86%	2.46%	2.08%	1.67%	1.32%	1.05%	0.84%	0.68%	0.56%	0.47%	0.40%
Women 25-64	0.00%	0.00%	1.79%	2.58%	2.61%	2.40%	2.12%	1.82%	1.54%	1.28%	0.99%	0.75%	0.58%	0.45%	0.35%	0.28%	0.22%	0.18%
Men 65+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.08%	0.14%	0.15%	0.14%	0.12%	0.11%	0.09%	0.08%
Women 65+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%	0.09%	0.10%	0.09%	0.08%	0.06%	0.05%	0.04%
Cumulative results from 2015:																		
Total adult deaths (millions)	0.0	0.0	0.0	0.0	0.1	0.5	1.1	2.0	3.1	4.4	6.2	8.6	11.9	16.6	23.6	34.0	48.6	67.4
Cig.-attributable deaths (1000s)	0.0	0.0	0.0	0.0	16.2	77.7	167.5	272.2	390.1	534.5	712.0	928.5	1180.7	1460.3	1775.9	2146.1	2569.2	3010.4

Avoided cig.-att. deaths (1000s)	0.0	0.0	0.0	0.0	0.8	4.2	9.6	16.2	23.8	33.5	45.7	60.6	77.3	94.7	111.7	127.1	139.7	149.6
Life-years gained (1000s)	0.0	0.0	0.0	0.0	1.4	14.5	50.8	117.3	218.7	363.1	561.1	824.0	1159.5	1566.5	2033.5	2535.5	3035.5	3496.7
Avoided cigarette-attributable morbidity ($billions)	0.0	0.0	0.0	0.0	0.4	2.2	5.0	8.4	12.5	17.5	23.9	31.7	40.4	49.5	58.4	66.5	73.1	78.2

25	35	45	55	85
2040	2050	2060	2070	2100
83.5767	115.727	147.265	177.657	237.944
6.56%	4.47%	3.03%	2.02%	0.60%
7.01%	4.78%	3.24%	2.16%	0.65%
8.38%	**5.87%**	**4.03%**	**2.70%**	**0.81%**
4.11%	4.87%	5.26%	5.33%	3.56%
87.51%	89.26%	90.71%	91.97%	95.62%
0.06668	0.12608	0.20017	0.35941	2.6922
0.01005	0.01442	0.02095	0.03112	0.05821
0.08%	0.11%	0.14%	0.20%	1.13%
0.10001	0.18912	0.30026	0.53911	4.03831
4.17046	15.9442	32.8206	58.2532	87.8294
4.19414	16.1594	33.5332	60.5654	149.601
14.5376	117.269	363.075	824.038	3496.72
21.77%	23.78%	24.75%	25.22%	25.48%
12.49%	10.74%	9.29%	8.03%	4.38%
#######	#######	#######	#######	#######
#######	#######	#######	#######	#######
#######	#######	#######	#######	#######
#######	#######	#######	#######	#######
0.00%	0.00%	0.00%	#######	#######
#######	#######	#######	#######	#######
#######	#######	#######	#######	#######
0.00%	0.00%	0.00%	#######	#######
10.26%	7.27%	5.07%	3.47%	1.14%
6.51%	4.47%	3.00%	1.94%	0.50%

Population Dynamics Model--2015 18-24 Year-Old Cohort

Input | Input formula (OK to change) | Button output

CC only, 9/2018 (same as Both model except no M_IntroYr)

Based on: Both

Name	Value	Units	Description	Link	Source, Comments
Population Inputs					
Year0	2015		First forecast year		Changing requires updating data below.
Pop0	**31.1541**	million	Initial US adult (≥18) population in first forecast year		2015 US Census estimates (see spreadsheet). Used only to scale calculated proportions to total counts.
Pop0Dists	(table)	%	Initial proportion of total population with each age & sex		same

	Age	Men	Women	Men/Total
PropMAt18	18	**0.06911**	**0.06612**	0.51108
	19	**0.06999**	**0.06658**	
	24	**0.07753**	**0.07427**	
	25	0	0	
	64	0	0	
	65	0	0	
	100 +	0	0	
PropM	0.51291	0.51291	0.48709	

NewPop	**0.00%**	%/y	Annual new 18-year-olds plus additional net migration		Model of 2017 US Census projections (see spreadsheet). (Annual new 18-year-olds = initial pop. x 18yo proportion.)
NewPG1	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 1	https://ww	Model of 2017 US Census projections (see spreadsheet)
NewPY2	2035		First year of Period 2		same
NewPG2	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 2		same
Cigarette Initiation, Use Rate, and Cessation Inputs					
InitRts	(table)	%	Proportion initiating cigarettes (modeled at 18 years old)		2015 NHIS maximum prevalence over 18-25 yrs old.
InitRtAnMults	(table)	%	Annual multiplier for proportion initiating cigarettes		2015-2017 NHIS max. prevalence change rate

Men	Women	Wtd. av.
22.20%	15.39%	18.88%
96.97%	96.28%	96.63%

	Value	Units	Description	Low	Base	High	Source, Comments
InitRtMult	1		Initiation rate multiplier for sensitivity analysis	1.25	1	0.75	
IStats	(table)	%	Smoking status proportions in initial population				2015 NHIS
YrQuitSlp	0.515		Slope of years since quitting vs. (age-18)--former smkrs.				2017 NHIS (see spreadsheet). For initial population only (simulated after that). No sex difference seen.
CPDERSlope	0.35			0.7	0.35	0.175	
CPDProps	(table)	%	Avg. proportions in CPD (on days smoked) categories				2017 NHIS, on days smoked.
CPDDayFracs	(table)	%	Average fraction of days smoked (unused)				2017 NHIS, mean # days smoked in last 30 days / 30
CPDERFacs	(table)		ER (RR-1) factors to adjust for CPD				Simple model based on Thun 2013 (Table S3), Thun 1997, and Bjartveit 2005. See formulas and separate spreadsheet.
CPDRedFacs	(table)		ER factors to adjust for reduced CPD				Same as CPDERFacs except at CPD reduced by M_CPDRed
QuitParms	(table)		Quit (cessation) rates by age & sex				Holford 2015: 1980 cohort, modeled (see spreadsheet), adjusted from 3.53% to reach 4.5% mean from Mendez 2016
	Weighted Average		2.64% 2.65% 2.65%	Low	Base	High	
QuitRtMult	1		Quit rate multiplier for sensitivity analysis	0.75	1	1.25	
Death Rate Inputs							
DRMult	1.2		Multiplier to adjust all death rates (1=no change)	1	1.2	1.4	To agree with US Census Bureau projectio
DRAnMult	0.99		Annual mortality rate multiplier	0.98	0.99	1	
NSDRs, RRs	(table)	/100,000/y	Annual mortality rate and Relative Risk (RR)				http://ww Thun 2013 Table S2 (5 contemporary cohorts, 2000-2010)
	Wtd. Av.		627.906 608.02 2.30044 1.9236 1629.85 1315.9				0.4867949 0.5132051
			Should = Wtd. Av. CPDERFacs + 1				
ERChgs	(table)	1/y	ER change rate with years after quitting				Exponential declines toward ER=0, based on results in Mendez 2001 (see spreadsheet)
New Product (MRTP) Inputs							
M_IntroYr			Year VLN product is introduced				Set >= 1st year, or blank (none).
M_CtoM	**7.1%**	%/yr	C-I: Peak annual rate CC smokers switch to VLN				
M_CtoMYAM	1		C-Im: Young adult (<=24) multiplier for rate CC smokers switch				
M_CtoMYr	**5**	yr	Years until peak rate that CC smokers switch - linear growth				>=0
M_MtoS	50%	%	I-S: Proportion of initial VLN smokers sustaining use beyond 1 year				Cf. dropout rate by 20 wk in Hatsukami 2018: 32% total, 4% for product dissatisfaction (immediate red. group)
M_StoC	**10%**	%/yr	S-C: Annual rate sustaining VLN smokers relapse to CCs				(Can be correlated with above)
M_CPDRedF	80%	%	CPDf: Proportion of VLN smokers reducing CPD				Hatsukami 2018 (approximated)
M_CPDRed	50%	%	CPDr: Av. reduction in CPD among VLN smokers reducing CPD				Hatsukami 2018 (approximated)
M_MtoFRel	118%	%	S-Fm: Quit rate for VLN smokers as % of CC quit rate				
M_ERR	100%	%	ERR: prop. of CC smoker Excess Risk experienced by VLN smokers				

Results

Run through year 2100

Last run took 3.98 seconds (12/9/2018 9:04:48 PM).

☐ Create workbook with detailed results (slow)

Year #:	0	1	2	3	4	5	6	7	8	9	15	25	35	45	55	85

		Year:	*2015*	2016	2017	2018	2019	2020	2021	2022	2023	2024	2030	2040	2050	2060	2070	2100
1	Total adult population relative to that of 2015		1	1	1	1	1	1	1	1	1	1	0.99385	0.9694	0.94685	0.90899	0.82959	0.04013
2	C: conventional cig. smoker proportion		13.05%	12.70%	12.35%	12.01%	11.67%	11.34%	11.01%	10.68%	10.36%	10.05%	8.21%	5.55%	3.52%	1.91%	0.77%	0.00%
3	C+M: CC + 1st-year New Product proportion		13.05%	12.70%	12.35%	12.01%	11.67%	11.34%	11.01%	10.68%	10.36%	10.05%	8.21%	5.55%	3.52%	1.91%	0.77%	0.00%
4	C+M+S: total smoker proportion		**13.05%**	**12.70%**	**12.35%**	**12.01%**	**11.67%**	**11.34%**	**11.01%**	**10.68%**	**10.36%**	**10.05%**	**8.21%**	**5.55%**	**3.52%**	**1.91%**	**0.77%**	**0.00%**
5	F: former smoker proportion		4.76%	5.11%	5.46%	5.81%	6.14%	6.48%	6.81%	7.13%	7.45%	7.77%	9.52%	11.90%	13.69%	14.91%	15.47%	10.99%
6	N: never-smoker proportion		82.18%	82.18%	82.18%	82.18%	82.18%	82.18%	82.18%	82.18%	82.18%	82.18%	82.27%	82.55%	82.78%	83.19%	83.77%	89.00%
7	D: annual deaths as proportion of initial population	0.95987	0	0	0	0	0	0	0	0	0	0	0.00198	0.00229	0.00245	0.00491	0.01046	0.01019
41	Tobacco-attributable deaths relative to initial population	0.0371	0	0	0	0	0	0	0	0	0	0	0.00031	0.00027	0.00031	0.00051	0.00055	0.00011
	Annual US adult death rate		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.20%	0.24%	0.26%	0.54%	1.26%	25.39%
	Annual US adult deaths (millions)		0	0	0	0	0	0	0	0	0	0	0.06168	0.07148	0.07618	0.15311	0.32585	0.31738
	Avoided deaths through each year vs. CC Only (1000s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Avoided tobacco-attributable deaths through each year vs. CC Only (1000s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Life-years gained through each year vs. CC only (1000s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

1.4844

Population Dynamics Model--2015 18-24 Year-Old Cohort

Input | Input formula (OK to change) | Button output

Both products, 9/2018

Based on:

Name	Value	Units	Description	Link	Source, Comments
Population Inputs					
Year0	2015		First forecast year		Changing requires updating data below.
Pop0	**31.1541**	million	Initial US adult (≥18) population in first forecast year		2015 US Census estimates (see spreadsheet). Used only to scale calculated proportions to total counts.
Pop0Dists	(table)	%	Initial proportion of total population with each age & sex		same
PropMAt18	Age 18		Men **0.06911** Women **0.06612** Men/Total 0.51108		
	19		**0.06999** **0.06658**		
	100 +		0 0		
PropM	0.51291		0.51291 0.48709		
NewPop	**0.00%**	%/y	Annual new 18-year-olds plus additional net migration		Model of 2017 US Census projections (see spreadsheet)
NewPG1	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 1	https://ww	Model of 2017 US Census projections (see spreadsheet)
NewPY2	2035		First year of Period 2		same
NewPG2	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 2		same
Cigarette Initiation, Use Rate, and Cessation Inputs					
InitRts	(table)	%	Proportion initiating cigarettes (modeled at 18 years old)		2015 NHIS maximum prevalence over 18-25 yrs old.
InitRtAnMults	(table)	%	Annual multiplier for proportion initiating cigarettes		2015-2017 NHIS max. prevalence change rate
			Men 22.20% Women 15.39% Wtd. av. 18.88%		
			96.97% 96.28% 96.63%		Low 1.25 Base 1 High 0.75
InitRtMult	1		Initiation rate multiplier for sensitivity analysis		
IStats	(table)	%	Smoking status proportions in initial population		2015 NHIS
YrQuitSlp	0.515		Slope of years since quitting vs. (age-18)--former smkrs.		2017 NHIS (see spreadsheet). For initial population only (simulated after that). No sex difference seen.
CPDERSlope	0.35				0.7 0.35 0.175
CPDProps	(table)	%	Avg. proportions in CPD (on days smoked) categories		2017 NHIS, on days smoked.
CPDDayFracs	(table)	%	Average fraction of days smoked (unused)		2017 NHIS, mean # days smoked in last 30 days / 30
CPDERFacs	(table)		ER (RR-1) factors to adjust for CPD		Simple model based on Thun 2013 (Table S3), Thun 1997, and Bjartveit 2005. See formulas and separate spreadsheet.
CPDRedFacs	(table)		ER factors to adjust for reduced CPD		Same as CPDERFacs except at CPD reduced by M_CPDRed

CPD from to	CPDProps Men	CPDProps Women	CPDDayFracs Men	CPDDayFracs Women	CPD Midpt.	Unscaled CPDERs Men	Unscaled CPDERs Women	CPDERFacs Men	CPDERFacs Women	CPDRedFacs Men	CPDRedFacs Women
0 1.5	6.80%	5.00%	35.53%	42.04%	0.75	0.233	(same)	0.205	0.149	0.108	0.079
1.5 5.5	23.71%	24.49%	67.24%	77.02%	3.5	0.800		0.703	0.512	0.420	0.306
5.5 15.5	38.48%	46.67%	94.60%	96.61%	10.5	1.542		1.355	0.987	0.916	0.668
15.5 25.5	24.63%	20.72%	99.02%	98.92%	20.5	2.101		1.846	1.345	1.339	0.975
25.5 35.5	3.84%	1.84%	99.83%	96.12%	30.5	2.457		2.160	1.573	1.623	1.182
35.5 +	2.54%	1.28%	97.83%	94.80%	*40.5*	2.720		2.390	1.741	1.837	1.338
Wtd. Av. CPD	12.1703	11.1222	11.5738	10.6429		1.4798639	1.442646	1.30044	0.9236	0.89825	0.63142
	on days smoked		over all days			Wtd. Av. unscaled		Wtd. Av. CPDERFac (normalized to Smoker RR)			

QuitParms	(table)		Quit (cessation) rates by age & sex	Holford 2015: 1980 cohort, modeled (see spreadsheet), adjusted from 3.53% to reach 4.5% mean from Mendez 2016

	Men	Women	
Quit rate at age 18	2.51%	2.52%	
Linear Slope (%/y)	0.0442%	0.0437%	
Age Exponential Starts	60	50	
Quit rate at this age	4.30%	3.98%	
Ann. Age Multiplier	1.036	1.031	
Weighted Average	2.64%	2.65%	2.65%

Low 0.75 Base 1 High 1.25

QuitRtMult: 1 — Quit rate multiplier for sensitivity analysis

Death Rate Inputs				
DRMult	1.2		Multiplier to adjust all death rates (1=no change)	To agree with US Census Bureau projecti: 1 1.2 1.4
DRAnMult	0.99		Annual mortality rate multiplier	0.98 0.99 1
NSDRs, RRs	(table)	/100,000/y	Annual mortality rate and Relative Risk (RR)	http://ww Thun 2013 Table S2 (5 contemporary cohorts, 2000-2010)

Age from to	Never-Smoker Rate/10^5 Men	Never-Smoker Rate/10^5 Women	Smoker RR Men	Smoker RR Women	Smoker Rate/10^5 Men	Smoker Rate/10^5 Women		Proportion of Pop. Men	Proportion of Pop. Women
18 34	0	0	1	1	0	0	<35: simple assumptions since no data	**0.15464**	**0.14945**
35 54	250	195	2.55	1.79	637.5	349.05	http://ww USDHHS 2014 Table 12.3: RR for 35-54 age gr	**0.16745**	**0.17058**
55 59	299	265	3.69	2.66	1102	705		**0.04276**	**0.04524**
60 64	530	361	3.39	2.96	1795	1069		**0.03678**	**0.04019**

65	69	826	577	3.49	3.12	2880	1799	0.03067	0.03422
70	74	1356	913	3.26	3.05	4424	2789	0.02139	0.025
75	79	2323	1552	2.62	2.65	6078	4119	0.01459	0.01824
80	84	4340	2902	2.37	2.28	10278	6629	0.00975	0.01369
85	89	8108	5426	2.14	1.97	17380.3	10668.5	0.00582	0.00978
90	94	15149	10146	1.94	1.69	29390.3	17169.6	0.00238	0.00509
95	99	28302	18972	1.76	1.46	49699.5	27632.3	0.00052	0.00148
100	+	52875.2	35474.8	1.59	1.25	84042.8	44470.6	6.1E-05	0.00025
Wtd. Av.		627.906	608.02	2.30044	1.9236	1629.85	1315.9	0.4867949	0.5132051

Should = Wtd. Av. CPDERFacs + 1

ERChgs (table) 1/y — ER change rate with years after quitting — Exponential declines toward ER=0, based on results in Mendez 2001 (see spreadsheet)

New Product (MRTP) Inputs

			Low	Base	High	
M_IntroYr	**2021**	Year VLN product is introduced				Set >= 1st year, or blank (none).
M_CtoM	**7.1%** %/yr	C-I: Peak annual rate CC smokers switch to VLN				
M_CtoMYAM	1	C-Im: Young adult (<=24) multiplier for rate CC smokers switch				
M_CtoMYr	**5** yr	Years until peak rate that CC smokers switch - linear growth				>=0
M_MtoS	50% %	I-S: Proportion of initial VLN smokers sustaining use beyond 1 year				Cf. dropout rate by 20 wk in Hatsukami 2018: 32% total, 4% for product dissatisfaction (immediate red. group)
M_StoC	**10%** %/yr	S-C: Annual rate sustaining VLN smokers relapse to CCs				(Can be correlated with above)
M_CPDRedF	80% %	CPDf: Proportion of VLN smokers reducing CPD				Hatsukami 2018 (approximated)
M_CPDRed	50% %	CPDr: Av. reduction in CPD among VLN smokers reducing CPD				Hatsukami 2018 (approximated)
M_MtoFRel	**118%** %	S-Fm: Quit rate for VLN smokers as % of CC quit rate				
M_ERR	100% %	ERR: prop. of CC smoker Excess Risk experienced by VLN smokers				

Results

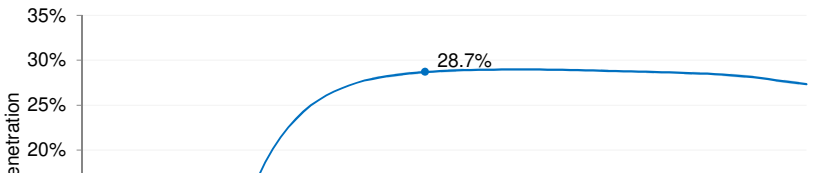
Run through year 2100

Last run took 3.98 seconds (12/9/2018 9:04:55 PM). ☐ Create workbook with detailed results (slow)

				Year #:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
				Year:	*2015*	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1	Total adult population relative to that of 2015				1	1	1	1	1	1	1	1	1	1	1	0.99956	0.99871	0.99746	0.99585	0.99388
2	C: conventional cig. smoker proportion				13.05%	12.70%	12.35%	12.01%	11.67%	11.34%	11.01%	10.53%	10.00%	9.43%	8.84%	8.23%	7.75%	7.30%	6.90%	6.52%
3	C+M: CC + 1st-year New Product proportion				13.05%	12.70%	12.35%	12.01%	11.67%	11.34%	11.01%	10.68%	10.29%	9.84%	9.35%	8.84%	8.31%	7.83%	7.40%	7.00%
4	C+M+S: total smoker proportion				**13.05%**	**12.70%**	**12.35%**	**12.01%**	**11.67%**	**11.34%**	**11.01%**	**10.68%**	**10.36%**	**10.04%**	**9.73%**	**9.42%**	**9.10%**	**8.79%**	**8.48%**	**8.17%**
5	F: former smoker proportion				4.76%	5.11%	5.46%	5.81%	6.14%	6.48%	6.81%	7.13%	7.46%	7.77%	8.09%	8.39%	8.70%	8.99%	9.28%	9.56%
6	N: never-smoker proportion				82.18%	82.18%	82.18%	82.18%	82.18%	82.18%	82.18%	82.18%	82.18%	82.18%	82.18%	82.19%	82.20%	82.22%	82.24%	82.27%
7	D: annual deaths as proportion of initial population				0	0	0	0	0	0	0	0	0	0	0	0.00044	0.00085	0.00125	0.00162	0.00197
41	Tobacco-attributable deaths relative to initial population				0	0	0	0	0	0	0	0	0	0	0	7.4E-05	0.00014	0.0002	0.00025	0.0003
	Annual US adult death rate				0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.04%	0.09%	0.12%	0.16%	0.20%
	Annual US adult deaths (millions)				0	0	0	0	0	0	0	0	0	0	0	0.01365	0.0266	0.03879	0.05038	0.06135
	Avoided deaths through each year vs. CC Only (1000s)			0	0	0	0	0	0	0	0	0	0	0	0	0.03965	0.14239	0.3152	0.56313	0.88705
	Avoided tobacco-attributable deaths through each year vs. CC Only (1000s)			0	0	0	0	0	0	0	0	0	0	0	0	0.03965	0.14249	0.31566	0.56439	0.88971
	Life-years gained through each year vs. CC only (1000s)			0	0	0	0	0	0	0	0	0	0	0	0	0.03965	0.18205	0.49724	1.06038	1.94743
For plots:																				
	Market penetration ((M+S)/(C+M+S))				0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.42%	3.51%	6.14%	9.19%	12.56%	14.89%	16.91%	18.65%	20.14%
	Smoker + former smoker proportion				17.82%	17.82%	17.82%	17.82%	17.82%	17.82%	17.82%	17.82%	17.82%	17.82%	17.82%	17.81%	17.80%	17.78%	17.76%	17.73%
	Population breakdown	M			51.29%	51.29%	51.29%	51.29%	51.29%	51.29%	51.29%	51.29%	51.29%	51.29%	51.29%	51.26%	51.21%	51.13%	51.03%	50.91%
		F			48.71%	48.71%	48.71%	48.71%	48.71%	48.71%	48.71%	48.71%	48.71%	48.71%	48.71%	48.69%	48.66%	48.61%	48.55%	48.47%
		M	18-24		51.29%	43.54%	35.89%	28.42%	21.09%	13.91%	6.91%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		M	25-64		0.00%	7.75%	15.40%	22.87%	30.20%	37.38%	44.38%	51.29%	51.29%	51.29%	51.29%	51.26%	51.21%	51.13%	51.03%	50.91%
		M	65+		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		F	18-24		48.71%	41.28%	34.04%	27.00%	20.07%	13.27%	6.61%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		F	25-64		0.00%	7.43%	14.67%	21.71%	28.64%	35.44%	42.10%	48.71%	48.71%	48.71%	48.71%	48.69%	48.66%	48.61%	48.55%	48.47%
		F	65+		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Smoker breakdown	M			15.02%	14.61%	14.21%	13.82%	13.43%	13.05%	12.67%	12.29%	11.92%	11.56%	11.20%	10.84%	10.47%	10.11%	9.74%	9.38%
		F			10.98%	10.69%	10.39%	10.10%	9.82%	9.54%	9.26%	8.98%	8.71%	8.45%	8.18%	7.92%	7.66%	7.40%	7.15%	6.90%

Summary Tables

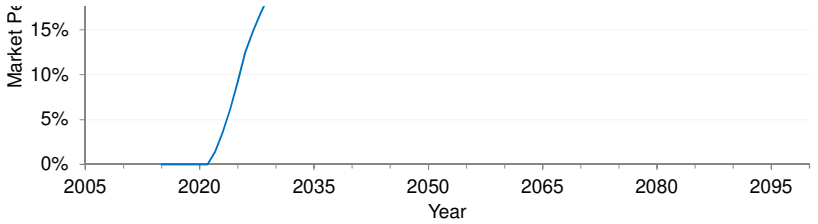
	2050	2100
Total population ≥18 years old (millions)	29.5	1.3
Cigarette-attributable deaths since 2015 (1000s)		
CC-only case	13934.1	23364.9
With new product	205.6	1127.5
Avoided	13728.5	22237.4
Life-years gained since 2015		
vs. CC-only (1000s)	108.5	840.0



Per avoided cigarette-attributable death	0.0	0.0				

	2015	2020	2025	2050	2075	2100
Total population ≥18 years old (millions)	31.2	31.2	31.2	29.5	23.6	1.3
Smoking prevalence:						
CC	13.05%	11.34%	8.84%	2.42%	0.27%	0.00%
VLN	0.00%	0.00%	0.89%	0.97%	0.11%	0.00%
Total current	**13.05%**	**11.34%**	**9.73%**	**3.39%**	**0.38%**	**0.00%**
Former	4.76%	6.48%	8.09%	13.85%	15.60%	11.06%
Never (remainder)	82.18%	82.18%	82.18%	82.76%	84.02%	88.94%
Cumulative results from 2015:						
Total adult deaths (millions)	0.0	0.0	0.0	1.6	7.6	29.9
Cig.-attributable deaths (1000s)	0.0	0.0	0.0	205.6	595.1	1127.5
Avoided cig.-att. deaths (1000s)	0.0	0.0	0.0	9.5	27.6	28.4
Life-years gained (1000s)	0.0	0.0	0.0	108.5	547.9	840.0
Cig.-attributable morbidity ($billions)	0.0	0.0	0.0	5.0	14.4	14.8

Morbidity at: 0.52288 million $/avoided cig-attrib. death



	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075	2080	2085	2090	2095	2100
Total pop. ≥18 years old (millions)	31.2	31.2	31.2	31.0	30.6	30.2	29.9	29.5	29.0	28.3	27.3	25.9	23.6	20.1	15.1	9.2	4.0	1.3
Smoking prevalence:																		
CC	13.05%	11.34%	8.84%	6.52%	5.04%	3.96%	3.13%	2.42%	1.81%	1.28%	0.83%	0.50%	0.27%	0.13%	0.05%	0.02%	0.01%	0.00%
VLN	0.00%	0.00%	0.89%	1.65%	1.68%	1.48%	1.23%	0.97%	0.73%	0.52%	0.34%	0.20%	0.11%	0.05%	0.02%	0.01%	0.00%	0.00%
Total current	**13.05%**	**11.34%**	**9.73%**	**8.17%**	**6.71%**	**5.44%**	**4.35%**	**3.39%**	**2.54%**	**1.80%**	**1.17%**	**0.70%**	**0.38%**	**0.18%**	**0.07%**	**0.03%**	**0.01%**	**0.00%**
Former	4.76%	6.48%	8.09%	9.56%	10.87%	12.02%	13.01%	13.85%	14.54%	15.06%	15.42%	15.60%	15.60%	15.33%	14.69%	13.65%	12.33%	11.06%
Never (remainder)	82.18%	82.18%	82.18%	82.27%	82.42%	82.54%	82.64%	82.76%	82.92%	83.14%	83.40%	83.70%	84.02%	84.49%	85.24%	86.33%	87.66%	88.94%
Total current smoker breakdown																		
Men 18-24	7.70%	1.83%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Women 18-24	5.35%	1.27%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Men 25-64	0.00%	4.87%	5.74%	4.81%	3.92%	3.15%	2.51%	1.95%	1.47%	0.33%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Women 25-64	0.00%	3.37%	3.99%	3.36%	2.79%	2.29%	1.85%	1.44%	1.07%	0.23%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Men 65+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.72%	0.68%	0.41%	0.21%	0.10%	0.04%	0.01%	0.00%	0.00%
Women 65+	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.52%	0.49%	0.30%	0.16%	0.08%	0.04%	0.02%	0.01%	0.00%
Cumulative results from 2015:																		
Total adult deaths (millions)	0.0	0.0	0.0	0.2	0.6	0.9	1.3	1.6	2.1	2.8	3.8	5.3	7.6	11.1	16.0	21.9	27.2	29.9
Cig.-attributable deaths (1000s)	0.0	0.0	0.0	30.2	85.1	129.6	164.4	205.6	263.3	335.2	420.4	507.4	595.1	705.0	846.8	991.1	1090.7	1127.5
Avoided cig.-att. deaths (1000s)	0.0	0.0	0.0	0.9	3.2	5.3	7.2	9.5	12.8	16.8	21.0	24.7	27.6	29.4	29.8	29.3	28.7	28.4
Life-years gained (1000s)	0.0	0.0	0.0	1.9	13.0	35.2	67.0	108.5	164.0	236.7	328.0	434.4	547.9	657.0	746.9	805.3	832.1	840.0
Avoided cigarette-attributable morbidity ($billions)	0.0	0.0	0.0	0.5	1.7	2.8	3.8	5.0	6.7	8.8	11.0	12.9	14.4	15.4	15.6	15.3	15.0	14.8

25	35	45	55	85
2040	2050	2060	2070	2100
0.96957	0.94715	0.90951	0.8303	0.04016
3.96%	2.42%	1.28%	0.50%	0.00%
4.24%	2.59%	1.37%	0.54%	0.00%
5.44%	**3.39%**	**1.80%**	**0.70%**	**0.00%**
12.02%	13.85%	15.06%	15.60%	11.06%
82.54%	82.76%	83.14%	83.70%	88.94%
0.00228	0.00243	0.00489	0.01045	0.0102
0.00026	0.0003	0.00048	0.00053	0.00011
0.24%	0.26%	0.54%	1.26%	25.39%
0.07108	0.07567	0.15239	0.32549	0.31763
5.25751	9.2506	16.0234	22.1456	0.86658
5.32724	9.47541	16.7541	24.7316	28.3965
35.2265	108.492	236.744	434.447	840.019
27.21%	28.68%	28.96%	28.89%	27.32%
17.46%	17.24%	16.86%	16.30%	11.06%
49.44%	48.12%	45.84%	41.04%	0.78%
47.52%	46.60%	45.11%	41.99%	3.23%
0.00%	0.00%	0.00%	0.00%	0.00%
49.44%	48.12%	12.70%	0.00%	0.00%
0.00%	0.00%	33.14%	41.04%	0.78%
0.00%	0.00%	0.00%	0.00%	0.00%
47.52%	46.60%	12.46%	0.00%	0.00%
0.00%	0.00%	32.66%	41.99%	3.23%
6.18%	3.85%	2.08%	0.82%	0.00%
4.68%	2.92%	1.51%	0.59%	0.00%

Population Dynamics Model--2015 25-64 Year-Old Cohort

Input | Input formula (OK to change) | Button output

CC only, 9/2018 (same as Both model except no M_IntroYr)

Based on: Both

Name	Value	Units	Description	Link	Source, Comments
Population Inputs					
Year0	2015		First forecast year		Changing requires updating data below.
Pop0	**168.529**	million	Initial US adult (≥18) population in first forecast year		2015 US Census estimates (see spreadsheet). Used only to scale calculated proportions to total counts.
Pop0Dists	(table)	%	Initial proportion of total population with each age & sex		same

Age	Men	Women	Men/Total
PropMAt18 18	0	0	*0.5*
19	0	0	
24	0	0	
25	**0.01428**	**0.01374**	
64	**0.00994**	**0.01101**	
65	0	0	
100 +	0	0	
PropM 0.49481	0.49481	0.50519	

NewPop	**0.000%**	%/y	Annual new 18-year-olds plus additional net migration		Model of 2017 US Census projections (see spreadsheet). (Annual new 18-year-olds = initial pop. x 18yo proportion.)
NewPG1	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 1	https://ww	Model of 2017 US Census projections (see spreadsheet)
NewPY2	2035		First year of Period 2		same
NewPG2	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 2		same
Cigarette Initiation, Use Rate, and Cessation Inputs					
InitRts	(table)	%	Proportion initiating cigarettes (modeled at 18 years old)		2015 NHIS maximum prevalence over 18-25 yrs old.
InitRtAnMults	(table)	%	Annual multiplier for proportion initiating cigarettes		2015-2017 NHIS max. prevalence change rate

Men	Women	Wtd. av.
22.20%	15.39%	18.76%
96.97%	96.28%	96.62%

	Low	Base	High
InitRtMult 1	1.25	1	0.75

Initiation rate multiplier for sensitivity analysis

IStats	(table)	%	Smoking status proportions in initial population	2015 NHIS
YrQuitSlp	0.515		Slope of years since quitting vs. (age-18)--former smkrs.	2017 NHIS (see spreadsheet). For initial population only (simulated after that). No sex difference seen.

	Low	Base	High
CPDERSlope 0.35	0.7	0.35	0.175

CPDProps	(table)	%	Avg. proportions in CPD (on days smoked) categories
CPDDayFracs	(table)	%	Average fraction of days smoked (unused)
CPDERFacs	(table)		ER (RR-1) factors to adjust for CPD
CPDRedFacs	(table)		ER factors to adjust for reduced CPD

2017 NHIS, on days smoked.

2017 NHIS, mean # days smoked in last 30 days / 30

Simple model based on Thun 2013 (Table S3), Thun 1997, and Bjartveit 2005. See formulas and separate spreadsheet.

Same as CPDERFacs except at CPD reduced by M_CPDRed

CPD from to	CPDProps Men	CPDProps Women	CPDDayFracs Men	CPDDayFracs Women	CPD Midpt.	Unscaled CPDERs Men	Unscaled CPDERs Women	CPDERFacs Men	CPDERFacs Women	CPDRedFacs Men	CPDRedFacs Women
0 1.5	6.80%	5.00%	35.53%	42.04%	0.75	0.233	(same)	0.205	0.149	0.108	0.079
1.5 5.5	23.71%	24.49%	67.24%	77.02%	3.5	0.800		0.703	0.512	0.420	0.306
5.5 15.5	38.48%	46.67%	94.60%	96.61%	10.5	1.542		1.355	0.987	0.916	0.668
15.5 25.5	24.63%	20.72%	99.02%	98.92%	20.5	2.101		1.846	1.345	1.339	0.975
25.5 35.5	3.84%	1.84%	99.83%	96.12%	30.5	2.457		2.160	1.573	1.623	1.182
35.5 +	2.54%	1.28%	97.83%	94.80%	*40.5*	2.720		2.390	1.741	1.837	1.338
Wtd. Av. CPD	12.1703	11.1222	11.5738	10.6429		1.4798639	1.442646	1.30044	0.9236	0.89825	0.63142
	on days smoked		over all days			Wtd. Av. unscaled		Wtd. Av. CPDERFac (normalized to Smoker RR)			

QuitParms	(table)		Quit (cessation) rates by age & sex		Holford 2015: 1980 cohort, modeled (see spreadsheet), adjusted from 3.53% to reach 4.5% mean from Mendez 2016
	Weighted Average		3.67% 3.95% 3.81%		

	Low	Base	High
QuitRtMult 1	0.75	1	1.25

Quit rate multiplier for sensitivity analysis

Death Rate Inputs					
DRMult	1.2		Multiplier to adjust all death rates (1=no change)		To agree with US Census Bureau projecti
DRAnMult	0.99		Annual mortality rate multiplier		

Low	Base	High
1	1.2	1.4
0.98	0.99	1

NSDRs, RRs	(table)	/100,000/y	Annual mortality rate and Relative Risk (RR)	http://ww	Thun 2013 Table S2 (5 contemporary cohorts, 2000-2010)

Wtd. Av.	627.906	608.02	2.30044	1.9236	1629.85	1315.9	0.4867949 0.5132051

Should = Wtd. Av. CPDERFacs + 1

ERChgs	(table)	1/y	ER change rate with years after quitting		Exponential declines toward ER=0, based on results in Mendez 2001 (see spreadsheet)
New Product (MRTP) Inputs					

	Low	Base	High
M_IntroYr			

Year VLN product is introduced

Set >= 1st year, or blank (none).

M_CtoM	**7.1%**	%/yr	C-I: Peak annual rate CC smokers switch to VLN	

M_CtoMYAM	1		C-Im: Young adult (<=24) multiplier for rate CC smokers switch	
M_CtoMYr	**5**	yr	Years until peak rate that CC smokers switch - linear growth	>=0
M_MtoS	50%	%	I-S: Proportion of initial VLN smokers sustaining use beyond 1 year	Cf. dropout rate by 20 wk in Hatsukami 2018: 32% total, 4% for product dissatisfaction (immediate red. group)
M_StoC	**10%**	%/yr	S-C: Annual rate sustaining VLN smokers relapse to CCs	(Can be correlated with above)
M_CPDRedF	80%	%	CPDf: Proportion of VLN smokers reducing CPD	Hatsukami 2018 (approximated)
M_CPDRed	50%	%	CPDr: Av. reduction in CPD among VLN smokers reducing CPD	Hatsukami 2018 (approximated)
M_MtoFRel	118%	%	S-Fm: Quit rate for VLN smokers as % of CC quit rate	
M_ERR	100%	%	ERR: prop. of CC smoker Excess Risk experienced by VLN smokers	

Results

Run through year 2100

Last run took 3.98 seconds (12/9/2018 9:05:02 PM).

☐ Create workbook with detailed results (slow)

		Year #:	0	1	2	3	4	5	6	7	8	9	15	25	35	45	55	85
		Year:	*2015*	2016	2017	2018	2019	2020	2021	2022	2023	2024	2030	2040	2050	2060	2070	2100
1	Total adult population relative to that of 2015		1	0.99635	0.99248	0.9884	0.98412	0.97964	0.97486	0.96979	0.96444	0.95883	0.91913	0.81596	0.64185	0.43362	0.24419	0.00139
2	C: conventional cig. smoker proportion		17.38%	16.64%	15.91%	15.20%	14.51%	13.84%	13.18%	12.54%	11.92%	11.31%	8.10%	4.34%	2.20%	1.00%	0.34%	0.00%
3	C+M: CC + 1st-year New Product proportion		17.38%	16.64%	15.91%	15.20%	14.51%	13.84%	13.18%	12.54%	11.92%	11.31%	8.10%	4.34%	2.20%	1.00%	0.34%	0.00%
4	C+M+S: total smoker proportion		**17.38%**	**16.64%**	**15.91%**	**15.20%**	**14.51%**	**13.84%**	**13.18%**	**12.54%**	**11.92%**	**11.31%**	**8.10%**	**4.34%**	**2.20%**	**1.00%**	**0.34%**	**0.00%**
5	F: former smoker proportion		19.90%	20.57%	21.22%	21.85%	22.46%	23.05%	23.62%	24.16%	24.68%	25.19%	27.75%	30.42%	31.69%	32.41%	32.33%	23.61%
6	N: never-smoker proportion		62.72%	62.79%	62.86%	62.94%	63.03%	63.11%	63.20%	63.30%	63.40%	63.50%	64.15%	65.24%	66.10%	66.60%	67.32%	76.39%
7	D: annual deaths as proportion of initial population	0.99861	0	0.00365	0.00387	0.00408	0.00428	0.00448	0.00478	0.00507	0.00535	0.00561	0.00731	0.0131	0.02011	0.02043	0.01776	0.00033
41	Tobacco-attributable deaths relative to initial population	0.08749	0	0.00112	0.00118	0.00124	0.00129	0.00133	0.00139	0.00145	0.0015	0.00154	0.00161	0.00165	0.00152	0.00116	0.00086	5.6E-06
	Annual US adult death rate		0.00%	0.37%	0.39%	0.41%	0.44%	0.46%	0.49%	0.52%	0.55%	0.59%	0.80%	1.61%	3.13%	4.71%	7.27%	23.62%
	Annual US adult deaths (millions)		0	0.61466	0.6523	0.68808	0.72172	0.75446	0.80597	0.85473	0.90122	0.94588	1.2324	2.20787	3.38985	3.44232	2.99272	0.05531
	Avoided deaths through each year vs. CC Only (1000s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Avoided tobacco-attributable deaths through each year vs. CC Only (1000s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Life-years gained through each year vs. CC only (1000s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Population Dynamics Model--2015 25-64 Year-Old Cohort

Input | Input formula (OK to change) | Button output

Both products, 9/2018

Based on:

Name	Value	Units	Description	Link	Source, Comments
Population Inputs					
Year0	2015		First forecast year		Changing requires updating data below.
Pop0	**168.529**	million	Initial US adult (≥18) population in first forecast year		2015 US Census estimates (see spreadsheet). Used only to scale calculated proportions to total counts.
Pop0Dists	(table)	%	Initial proportion of total population with each age & sex		same

	Age	Men	Women	Men/Total
PropMAt18	18	0	0	*0.5*
	19	0	0	
	100 +	0	0	
PropM		0.49481	0.50519	

NewPop	**0.000%**	%/y	Annual new 18-year-olds plus additional net migration	Model of 2017 US Census projections (see spreadsheet)
NewPG1	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 1	https://ww Model of 2017 US Census projections (see spreadsheet)
NewPY2	2035		First year of Period 2	same
NewPG2	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 2	same

Cigarette Initiation, Use Rate, and Cessation Inputs

InitRts	(table)	%	Proportion initiating cigarettes (modeled at 18 years old)	2015 NHIS maximum prevalence over 18-25 yrs old.
InitRtAnMults	(table)	%	Annual multiplier for proportion initiating cigarettes	2015-2017 NHIS max. prevalence change rate

Men	Women	Wtd. av.
22.20%	15.39%	18.76%
96.97%	96.28%	96.62%

	Low	Base	High
InitRtMult	1.25	1	0.75

Initiation rate multiplier for sensitivity analysis

IStats	(table)	%	Smoking status proportions in initial population	2015 NHIS
YrQuitSlp	0.515		Slope of years since quitting vs. (age-18)--former smkrs.	2017 NHIS (see spreadsheet). For initial population only (simulated after that). No sex difference seen.

	Low	Base	High
CPDERSlope	0.7	0.35	0.175

CPDProps	(table)	%	Avg. proportions in CPD (on days smoked) categories	2017 NHIS, on days smoked.
CPDDayFracs	(table)	%	Average fraction of days smoked (unused)	2017 NHIS, mean # days smoked in last 30 days / 30
CPDERFacs	(table)		ER (RR-1) factors to adjust for CPD	Simple model based on Thun 2013 (Table S3), Thun 1997, and Bjartveit 2005. See formulas and separate spreadsheet.
CPDRedFacs	(table)		ER factors to adjust for reduced CPD	Same as CPDERFacs except at CPD reduced by M_CPDRed

	CPDProps		CPDDayFracs			Unscaled CPDERs		CPDERFacs		CPDRedFacs	
CPD from to	Men	Women	Men	Women	CPD Midpt.	Men	Women	Men	Women	Men	Women
0 1.5	6.80%	5.00%	35.53%	42.04%	0.75	0.233	(same)	0.205	0.149	0.108	0.079
1.5 5.5	23.71%	24.49%	67.24%	77.02%	3.5	0.800		0.703	0.512	0.420	0.306
5.5 15.5	38.48%	46.67%	94.60%	96.61%	10.5	1.542		1.355	0.987	0.916	0.668
15.5 25.5	24.63%	20.72%	99.02%	98.92%	20.5	2.101		1.846	1.345	1.339	0.975
25.5 35.5	3.84%	1.84%	99.83%	96.12%	30.5	2.457		2.160	1.573	1.623	1.182
35.5 +	2.54%	1.28%	97.83%	94.80%	*40.5*	2.720		2.390	1.741	1.837	1.338
Wtd. Av. CPD	12.1703	11.1222	11.5738	10.6429		1.4798639	1.442646	1.30044	0.9236	0.89825	0.63142
	on days smoked		over all days			Wtd. Av. unscaled		Wtd. Av. CPDERFac (normalized to Smoker RR)			

QuitParms	(table)		Quit (cessation) rates by age & sex	Holford 2015: 1980 cohort, modeled (see spreadsheet), adjusted from 3.53% to reach 4.5% mean from Mendez 2016

	Weighted Average	3.67%	3.95%	3.81%

	Low	Base	High
QuitRtMult	0.75	1	1.25

Quit rate multiplier for sensitivity analysis

Death Rate Inputs

DRMult	1.2		Multiplier to adjust all death rates (1=no change)	To agree with US Census Bureau projecti	
DRAnMult	0.99		Annual mortality rate multiplier		
NSDRs, RRs	(table)	/100,000/y	Annual mortality rate and Relative Risk (RR)	http://ww	Thun 2013 Table S2 (5 contemporary cohorts, 2000-2010)

	Low	Base	High
DRMult	1	1.2	1.4
DRAnMult	0.98	0.99	1

	Never-Smoker Rate/10^5		Smoker RR		Smoker Rate/10^5			Proportion of Pop.	
Age from to	Men	Women	Men	Women	Men	Women		Men	Women
18 34	0	0	1	1	0	0	<35: simple assumptions since no data	**0.15464**	**0.14945**
35 54	250	195	2.55	1.79	637.5	349.05	http://ww USDHHS 2014 Table 12.3: RR for 35-54 age gr	**0.16745**	**0.17058**
55 59	299	265	3.69	2.66	1102	705		**0.04276**	**0.04524**
60 64	530	361	3.39	2.96	1795	1069		**0.03678**	**0.04019**
65 69	826	577	3.49	3.12	2880	1799		**0.03067**	**0.03422**
70 74	1356	913	3.26	3.05	4424	2789		**0.02139**	**0.025**
75 79	2323	1552	2.62	2.65	6078	4119		**0.01459**	**0.01824**
80 84	4340	2902	2.37	2.28	10278	6629		**0.00975**	**0.01369**
85 89	8108	5426	2.14	1.97	17380.3	10668.5		**0.00582**	**0.00978**
90 94	15149	10146	1.94	1.69	29390.3	17169.6		**0.00238**	**0.00509**

95 99	28302	18972	1.76	1.46	49699.5	27632.3	
100 +	52875.2	35474.8	1.59	1.25	84042.8	44470.6	
Wtd. Av.	627.906	608.02	2.30044	1.9236	1629.85	1315.9	

Should = Wtd. Av. CPDERFacs + 1

0.00052	**0.00148**
6.1E-05	**0.00025**
0.4867949	0.5132051

ERChgs (table) 1/y — ER change rate with years after quitting

Exponential declines toward ER=0, based on results in Mendez 2001 (see spreadsheet)

New Product (MRTP) Inputs

			Low	Base	High
M_IntroYr	**2021**	Year VLN product is introduced	Set >= 1st year, or blank (none).		
M_CtoM	**7.1%** %/yr	C-I: Peak annual rate CC smokers switch to VLN			
M_CtoMYAM	1	C-Im: Young adult (<=24) multiplier for rate CC smokers switch			
M_CtoMYr	**5** yr	Years until peak rate that CC smokers switch - linear growth	>=0		
M_MtoS	50% %	I-S: Proportion of initial VLN smokers sustaining use beyond 1 year	Cf. dropout rate by 20 wk in Hatsukami 2018: 32% total, 4% for product dissatisfaction (immediate red. group)		
M_StoC	**10%** %/yr	S-C: Annual rate sustaining VLN smokers relapse to CCs	(Can be correlated with above)		
M_CPDRedF	80% %	CPDf: Proportion of VLN smokers reducing CPD	Hatsukami 2018 (approximated)		
M_CPDRed	50% %	CPDr: Av. reduction in CPD among VLN smokers reducing CPD	Hatsukami 2018 (approximated)		
M_MtoFRel	**118%** %	S-Fm: Quit rate for VLN smokers as % of CC quit rate			
M_ERR	100% %	ERR: prop. of CC smoker Excess Risk experienced by VLN smokers			

Results

Run through year 2100

Last run took 4.02 seconds (12/9/2018 9:05:08 PM).

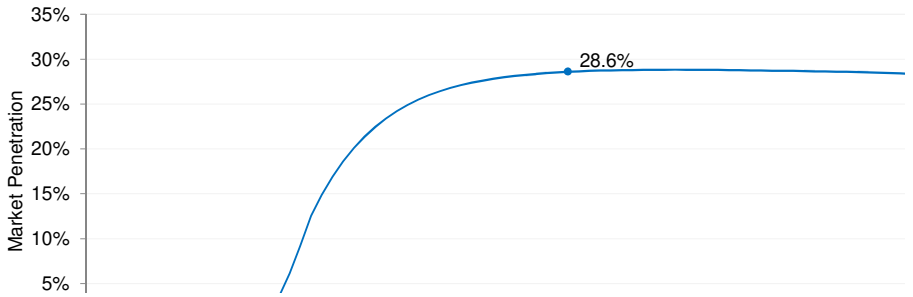
☐ Create workbook with detailed results (slow)

				Year #:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
				Year:	*2015*	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1	Total adult population relative to that of 2015				1	0.99635	0.99248	0.9884	0.98412	0.97964	0.97486	0.96979	0.96444	0.95884	0.95298	0.94681	0.94034	0.9336	0.92658	0.91931
2	C: conventional cig. smoker proportion				17.38%	16.64%	15.91%	15.20%	14.51%	13.84%	13.18%	12.36%	11.50%	10.62%	9.73%	8.87%	8.17%	7.53%	6.96%	6.44%
3	C+M: CC + 1st-year New Product proportion				17.38%	16.64%	15.91%	15.20%	14.51%	13.84%	13.18%	12.54%	11.83%	11.08%	10.31%	9.53%	8.76%	8.08%	7.46%	6.90%
4	C+M+S: total smoker proportion				**17.38%**	**16.64%**	**15.91%**	**15.20%**	**14.51%**	**13.84%**	**13.18%**	**12.54%**	**11.92%**	**11.31%**	**10.72%**	**10.15%**	**9.60%**	**9.06%**	**8.55%**	**8.06%**
5	F: former smoker proportion				19.90%	20.57%	21.22%	21.85%	22.46%	23.05%	23.62%	24.16%	24.69%	25.19%	25.68%	26.14%	26.59%	27.02%	27.42%	27.81%
6	N: never-smoker proportion				62.72%	62.79%	62.86%	62.94%	63.03%	63.11%	63.20%	63.30%	63.40%	63.50%	63.60%	63.71%	63.81%	63.92%	64.03%	64.13%
7	D: annual deaths as proportion of initial population				0	0.00365	0.00387	0.00408	0.00428	0.00448	0.00478	0.00507	0.00534	0.0056	0.00586	0.00617	0.00647	0.00675	0.00701	0.00728
41	Tobacco-attributable deaths relative to initial population				0	0.00112	0.00118	0.00124	0.00129	0.00133	0.00139	0.00145	0.00149	0.00153	0.00156	0.00157	0.00158	0.00158	0.00158	0.00158
	Annual US adult death rate				0.00%	0.37%	0.39%	0.41%	0.44%	0.46%	0.49%	0.52%	0.55%	0.58%	0.61%	0.65%	0.69%	0.72%	0.76%	0.79%
	Annual US adult deaths (millions)				0	0.61466	0.6523	0.68808	0.72172	0.75446	0.80597	0.85473	0.90062	0.94442	0.98713	1.04003	1.08965	1.13697	1.18209	1.22631
	Avoided deaths through each year vs. CC Only (1000s)			0	0	0	0	0	0	0	0	0	0	0.60086	2.06539	4.58507	8.25224	13.0817	18.5358	24.4001	30.4964
	Avoided tobacco-attributable deaths through each year vs. CC Only (1000s)			0	0	0	0	0	0	0	0	0	0	0.60086	2.06963	4.6044	8.3079	13.2079	18.7815	24.8246	31.1676
	Life-years gained through each year vs. CC only (1000s)			0	0	0	0	0	0	0	0	0	1.9E-11	0.60086	2.66625	7.25132	15.5036	28.5852	47.1211	71.5212	102.018
For plots:																					
	Market penetration ((M+S)/(C+M+S))				0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.42%	3.51%	6.13%	9.19%	12.55%	14.88%	16.90%	18.63%	20.11%
	Smoker + former smoker proportion				37.28%	37.21%	37.14%	37.06%	36.97%	36.89%	36.80%	36.70%	36.60%	36.50%	36.40%	36.29%	36.19%	36.08%	35.97%	35.87%
	Population breakdown	M			49.48%	49.26%	49.02%	48.76%	48.50%	48.23%	47.93%	47.62%	47.30%	46.96%	46.60%	46.23%	45.84%	45.44%	45.03%	44.60%
		F			50.52%	50.38%	50.23%	50.08%	49.91%	49.74%	49.55%	49.36%	49.15%	48.93%	48.70%	48.45%	48.19%	47.92%	47.63%	47.33%
		M	18-24		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		M	25-64		49.48%	48.28%	47.05%	45.79%	44.50%	43.18%	41.85%	40.49%	39.12%	37.75%	36.34%	34.96%	33.60%	32.25%	30.91%	29.60%
		M	65+		0.00%	0.98%	1.97%	2.97%	4.00%	5.05%	6.08%	7.13%	8.18%	9.21%	10.26%	11.27%	12.24%	13.19%	14.11%	15.00%
		F	18-24		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		F	25-64		50.52%	49.29%	48.04%	46.75%	45.42%	44.06%	42.69%	41.30%	39.89%	38.49%	37.06%	35.65%	34.26%	32.87%	31.50%	30.16%
		F	65+		0.00%	1.09%	2.20%	3.33%	4.49%	5.68%	6.86%	8.06%	9.25%	10.43%	11.64%	12.81%	13.93%	15.04%	16.13%	17.17%
	Smoker breakdown	M			18.87%	18.06%	17.27%	16.50%	15.75%	15.02%	14.30%	13.61%	12.93%	12.27%	11.63%	11.01%	10.41%	9.84%	9.29%	8.76%
		F			15.92%	15.25%	14.59%	13.94%	13.31%	12.69%	12.09%	11.51%	10.94%	10.39%	9.85%	9.33%	8.82%	8.33%	7.86%	7.40%

Summary Tables

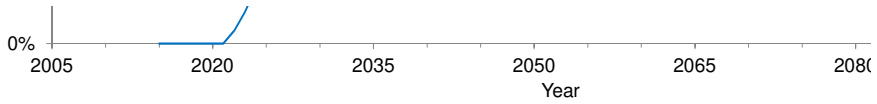
	2050	2100
Total population ≥18 years old (millions)	108.3	0.2
Cigarette-attributable deaths since 2015 (1000s)		
CC-only case	13934.1	23364.9
With new product	8998.2	14588.7
Avoided	4935.9	8776.2
Life-years gained since 2015		
vs. CC-only (1000s)	1630.1	3654.4
Per avoided cigarette-attributable death	0.3	0.4

	2015	2020	2025	2050	2075	2100
Total population ≥18 years old (millions)	168.5	165.1	160.6	108.3	27.3	0.2
Smoking prevalence:						
CC	17.38%	13.84%	9.73%	1.51%	0.11%	0.00%



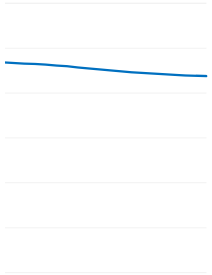
VLN	0.00%	0.00%	0.98%	0.60%	0.04%	0.00%
Total current	**17.38%**	**13.84%**	**10.72%**	**2.11%**	**0.15%**	**0.00%**
Former	19.90%	23.05%	25.68%	31.85%	31.89%	23.68%
Never (remainder)	62.72%	63.11%	63.60%	66.04%	67.96%	76.32%
Cumulative results from 2015:						
Total adult deaths (millions)	0.0	3.4	7.9	60.3	141.2	168.3
Cig.-attributable deaths (1000s)	0.0	1035.6	2287.1	8998.2	13503.8	14588.7
Avoided cig.-att. deaths (1000s)	0.0	0.0	4.6	128.6	159.1	156.4
Life-years gained (1000s)	0.0	0.0	7.3	1630.1	3418.8	3654.4
Cig.-attributable morbidity ($billions)	0.0	0.0	2.4	67.2	83.2	81.8

Morbidity at: 0.52288 million $/avoided cig-attrib. death



	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075	2080	2085	2090	2095	2100
Total pop. ≥18 years old (millions)	168.5	165.1	160.6	154.9	147.6	137.6	124.4	108.3	90.6	73.2	56.6	41.2	27.3	15.6	7.1	2.4	0.7	0.2
Smoking prevalence:																		
CC	17.38%	13.84%	9.73%	6.44%	4.43%	3.10%	2.17%	1.51%	1.02%	0.66%	0.40%	0.22%	0.11%	0.05%	0.02%	0.01%	0.00%	0.00%
VLN	0.00%	0.00%	0.98%	1.62%	1.47%	1.15%	0.85%	0.60%	0.41%	0.27%	0.16%	0.09%	0.04%	0.02%	0.01%	0.00%	0.00%	0.00%
Total current	**17.38%**	**13.84%**	**10.72%**	**8.06%**	**5.90%**	**4.25%**	**3.01%**	**2.11%**	**1.44%**	**0.93%**	**0.56%**	**0.31%**	**0.15%**	**0.07%**	**0.02%**	**0.01%**	**0.00%**	**0.00%**
Former	19.90%	23.05%	25.68%	27.81%	29.42%	30.55%	31.31%	31.85%	32.27%	32.55%	32.63%	32.45%	31.89%	30.80%	29.07%	26.75%	24.89%	23.68%
Never (remainder)	62.72%	63.11%	63.60%	64.13%	64.67%	65.20%	65.68%	66.04%	66.29%	66.52%	66.80%	67.24%	67.96%	69.14%	70.91%	73.24%	75.11%	76.32%
Total current smoker breakdown																		
Men 18-24	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Women 18-24	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Men 25-64	9.33%	6.72%	4.71%	3.22%	2.16%	1.41%	0.85%	0.39%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Women 25-64	8.04%	5.81%	4.10%	2.83%	1.91%	1.24%	0.74%	0.34%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Men 65+	0.00%	0.67%	0.97%	1.03%	0.93%	0.81%	0.73%	0.71%	0.75%	0.48%	0.29%	0.15%	0.07%	0.03%	0.01%	0.00%	0.00%	0.00%
Women 65+	0.00%	0.64%	0.93%	0.98%	0.89%	0.78%	0.70%	0.67%	0.69%	0.45%	0.28%	0.16%	0.08%	0.04%	0.02%	0.01%	0.00%	0.00%
Cumulative results from 2015:																		
Total adult deaths (millions)	0.0	3.4	7.9	13.6	21.0	30.9	44.1	60.3	77.9	95.4	111.9	127.3	141.2	152.9	161.4	166.2	167.8	168.3
Cig.-attributable deaths (1000s)	0.0	1035.6	2287.1	3617.2	4963.6	6328.8	7695.4	8998.2	10177.6	11205.1	12084.0	12843.2	13503.8	14034.4	14381.4	14539.6	14579.9	14588.7
Avoided cig.-att. deaths (1000s)	0.0	0.0	4.6	31.2	63.7	91.4	112.6	128.6	140.9	149.9	155.6	158.5	159.1	158.3	157.2	156.6	156.4	156.4
Life-years gained (1000s)	0.0	0.0	7.3	102.0	345.4	714.8	1158.8	1630.1	2093.2	2522.9	2897.4	3199.5	3418.8	3555.0	3622.2	3646.2	3652.5	3654.4
Avoided cigarette-attributable morbidity ($billions)	0.0	0.0	2.4	16.3	33.3	47.8	58.9	67.2	73.7	78.4	81.4	82.9	83.2	82.8	82.2	81.9	81.8	81.8

25	35	45	55	85
2040	2050	2060	2070	2100
0.81644	0.64241	0.43411	0.24451	0.00139
3.10%	1.51%	0.66%	0.22%	0.00%
3.32%	1.61%	0.71%	0.24%	0.00%
4.25%	**2.11%**	**0.93%**	**0.31%**	**0.00%**
30.55%	31.85%	32.55%	32.45%	23.68%
65.20%	66.04%	66.52%	67.24%	76.32%
0.01308	0.02011	0.02044	0.01778	0.00033
0.00162	0.0015	0.00115	0.00086	5.7E-06
1.60%	3.13%	4.71%	7.27%	23.62%
2.20444	3.38994	3.44435	2.99601	0.05536
81.5647	94.5611	82.1892	54.0041	0.22135
91.3787	128.6	149.897	158.519	156.368
714.813	1630.08	2522.91	3199.48	3654.38
27.12%	28.60%	28.83%	28.72%	26.88%
34.80%	33.96%	33.48%	32.76%	23.68%
38.74%	29.56%	19.41%	10.39%	0.01%
42.91%	34.68%	24.00%	14.07%	0.13%
0.00%	0.00%	0.00%	0.00%	0.00%
17.69%	6.10%	0.00%	0.00%	0.00%
21.04%	23.46%	19.41%	10.39%	0.01%
0.00%	0.00%	0.00%	0.00%	0.00%
17.98%	6.12%	0.00%	0.00%	0.00%
24.92%	28.56%	24.00%	14.07%	0.13%
4.68%	2.40%	1.08%	0.36%	0.00%
3.86%	1.87%	0.81%	0.28%	0.00%



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2095

Population Dynamics Model--2015 65+ Year-Old Cohort

Input | Input formula (OK to change) | Button output

CC only, 9/2018 (same as Both model except no M_IntroYr)

Based on: Both

Name	Value	Units	Description	Link	Source, Comments
Population Inputs					
Year0	2015		First forecast year		Changing requires updating data below.
Pop0	**47.7281**	million	Initial US adult (≥18) population in first forecast year		2015 US Census estimates (see spreadsheet). Used only to scale calculated proportions to total counts.
Pop0Dists	(table)	%	Initial proportion of total population with each age & sex		same

Age	Men	Women	Men/Total
PropMAt18 18	0	0	*0.5*
19	0	0	
24	0	0	
25	0	0	
64	0	0	
65	**0.03427**	**0.03796**	
100 +	**0.00032**	**0.0013**	
PropM 0.44144	0.44144	0.55856	

NewPop	**0.000%**	%/y	Annual new 18-year-olds plus additional net migration		Model of 2017 US Census projections (see spreadsheet). (Annual new 18-year-olds = initial pop. x 18yo proportion.)
NewPG1	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 1	https://ww	Model of 2017 US Census projections (see spreadsheet)
NewPY2	2035		First year of Period 2		same
NewPG2	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 2		same

Cigarette Initiation, Use Rate, and Cessation Inputs

InitRts	(table)	%	Proportion initiating cigarettes (modeled at 18 years old)		2015 NHIS maximum prevalence over 18-25 yrs old.
InitRtAnMults	(table)	%	Annual multiplier for proportion initiating cigarettes		2015-2017 NHIS max. prevalence change rate

	Men	Women	Wtd. av.
	22.20%	15.39%	18.40%
	96.97%	96.28%	96.58%

				Low	Base	High
InitRtMult	1		Initiation rate multiplier for sensitivity analysis	1.25	1	0.75
IStats	(table)	%	Smoking status proportions in initial population		2015 NHIS	
YrQuitSlp	0.515		Slope of years since quitting vs. (age-18)--former smkrs.		2017 NHIS (see spreadsheet). For initial population only (simulated after that). No sex difference seen.	
CPDERSlope	0.35			0.7	0.35	0.175
CPDProps	(table)	%	Avg. proportions in CPD (on days smoked) categories		2017 NHIS, on days smoked.	
CPDDayFracs	(table)	%	Average fraction of days smoked (unused)		2017 NHIS, mean # days smoked in last 30 days / 30	
CPDERFacs	(table)		ER (RR-1) factors to adjust for CPD		Simple model based on Thun 2013 (Table S3), Thun 1997, and Bjartveit 2005. See formulas and separate spreadsheet.	
CPDRedFacs	(table)		ER factors to adjust for reduced CPD		Same as CPDERFacs except at CPD reduced by M_CPDRed	
QuitParms	(table)		Quit (cessation) rates by age & sex		Holford 2015: 1980 cohort, modeled (see spreadsheet), adjusted from 3.53% to reach 4.5% mean from Mendez 2016	
	Weighted Average		7.26% 8.83% 8.14%		Low	Base	High
QuitRtMult	1		Quit rate multiplier for sensitivity analysis		0.75	1	1.25

Death Rate Inputs

DRMult	1.2		Multiplier to adjust all death rates (1=no change)	To agree with US Census Bureau projectio	1	1.2	1.4
DRAnMult	0.99		Annual mortality rate multiplier		0.98	0.99	1
NSDRs, RRs	(table)	/100,000/y	Annual mortality rate and Relative Risk (RR)	http://ww	Thun 2013 Table S2 (5 contemporary cohorts, 2000-2010)		

Wtd. Av.	627.906	608.02	2.30044	1.9236	1629.85	1315.9		0.4867949	0.5132051
			Should = Wtd. Av. CPDERFacs + 1						

ERChgs	(table)	1/y	ER change rate with years after quitting		Exponential declines toward ER=0, based on results in Mendez 2001 (see spreadsheet)		

New Product (MRTP) Inputs

				Low	Base	High
M_IntroYr			Year VLN product is introduced	Set >= 1st year, or blank (none).		
M_CtoM	**7.1%**	%/yr	C-I: Peak annual rate CC smokers switch to VLN			
M_CtoMYAM	1		C-Im: Young adult (<=24) multiplier for rate CC smokers switch			
M_CtoMYr	**5**	yr	Years until peak rate that CC smokers switch - linear growth	>=0		
M_MtoS	50%	%	I-S: Proportion of initial VLN smokers sustaining use beyond 1 year	Cf. dropout rate by 20 wk in Hatsukami 2018: 32% total, 4% for product dissatisfaction (immediate red. group)		
M_StoC	**10%**	%/yr	S-C: Annual rate sustaining VLN smokers relapse to CCs	(Can be correlated with above)		
M_CPDRedF	80%	%	CPDf: Proportion of VLN smokers reducing CPD	Hatsukami 2018 (approximated)		
M_CPDRed	50%	%	CPDr: Av. reduction in CPD among VLN smokers reducing CPD	Hatsukami 2018 (approximated)		
M_MtoFRel	118%	%	S-Fm: Quit rate for VLN smokers as % of CC quit rate			
M_ERR	100%	%	ERR: prop. of CC smoker Excess Risk experienced by VLN smokers			

Results Run through year 2100 Last run took 3.98 seconds (12/9/2018 9:05:15 PM). ☐ Create workbook with detailed results (slow)

Year #:	0	1	2	3	4	5	6	7	8	9	15	25	35	45	55	85

	Year:	*2015*	2016	2017	2018	2019	2020	2021	2022	2023	2024	2030	2040	2050	2060	2070	2100
1	Total adult population relative to that of 2015	1	0.96037	0.92176	0.88364	0.84589	0.8083	0.7713	0.73451	0.69778	0.66114	0.44549	0.14081	0.01053	0.00032	1.5E-05	1.2E-08
2	C: conventional cig. smoker proportion	8.39%	7.36%	6.48%	5.72%	5.04%	4.45%	3.92%	3.45%	3.04%	2.66%	1.14%	0.19%	0.02%	0.00%	0.00%	0.00%
3	C+M: CC + 1st-year New Product proportion	8.39%	7.36%	6.48%	5.72%	5.04%	4.45%	3.92%	3.45%	3.04%	2.66%	1.14%	0.19%	0.02%	0.00%	0.00%	0.00%
4	C+M+S: total smoker proportion	**8.39%**	**7.36%**	**6.48%**	**5.72%**	**5.04%**	**4.45%**	**3.92%**	**3.45%**	**3.04%**	**2.66%**	**1.14%**	**0.19%**	**0.02%**	**0.00%**	**0.00%**	**0.00%**
5	F: former smoker proportion	39.92%	40.58%	41.13%	41.59%	41.96%	42.27%	42.52%	42.72%	42.87%	42.97%	42.74%	38.73%	29.95%	24.07%	20.29%	13.63%
6	N: never-smoker proportion	51.70%	52.06%	52.39%	52.70%	52.99%	53.28%	53.55%	53.82%	54.09%	54.36%	56.13%	61.08%	70.03%	75.92%	79.71%	86.37%
7	D: annual deaths as proportion of initial population	1	0	0.03963	0.03861	0.03812	0.03775	0.03759	0.037	0.03679	0.03674	0.03664	0.0356	0.02501	0.00517	0.00012	5.1E-06	2.6E-09
41	Tobacco-attributable deaths relative to initial population	0.09049	0	0.00624	0.00566	0.00525	0.00491	0.00464	0.00433	0.00409	0.00389	0.0037	0.00288	0.00158	0.00016	1.9E-06	6.5E-08	2E-11
	Annual US adult death rate	0.00%	4.13%	4.19%	4.31%	4.46%	4.65%	4.80%	5.01%	5.26%	5.54%	7.99%	17.76%	49.14%	38.33%	33.04%	22.34%
	Annual US adult deaths (millions)	0	1.89151	1.84293	1.81939	1.80161	1.7939	1.76588	1.75594	1.75341	1.74866	1.69911	1.19346	0.24692	0.00577	0.00024	1.3E-07
	Avoided deaths through each year vs. CC Only (1000s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Avoided tobacco-attributable deaths through each year vs. CC Only (1000s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Life-years gained through each year vs. CC only (1000s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Population Dynamics Model--2015 65+ Year-Old Cohort

Input | Input formula (OK to change) | Button output

Both products, 9/2018

Based on:

Name	Value	Units	Description	Link	Source, Comments
Population Inputs					
Year0	2015		First forecast year		Changing requires updating data below.
Pop0	**47.7281**	million	Initial US adult (≥18) population in first forecast year		2015 US Census estimates (see spreadsheet). Used only to scale calculated proportions to total counts.
Pop0Dists	(table)	%	Initial proportion of total population with each age & sex		same

Age	Men	Women	Men/Total
18	0	0	*0.5*
19	0	0	
100 +	**0.00032**	**0.0013**	

PropM	0.44144		0.44144	0.55856	
NewPop	**0.000%**	%/y	Annual new 18-year-olds plus additional net migration		Model of 2017 US Census projections (see spreadsheet)
NewPG1	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 1	https://ww	Model of 2017 US Census projections (see spreadsheet)
NewPY2	2035		First year of Period 2		same
NewPG2	0.000%	%/y	Annual growth rate (multiplicative) in this pop. in Period 2		same

Cigarette Initiation, Use Rate, and Cessation Inputs

InitRts	(table)	%	Proportion initiating cigarettes (modeled at 18 years old)		2015 NHIS maximum prevalence over 18-25 yrs old.
InitRtAnMults	(table)	%	Annual multiplier for proportion initiating cigarettes		2015-2017 NHIS max. prevalence change rate

Men	Women	Wtd. av.
22.20%	15.39%	18.40%
96.97%	96.28%	96.58%

				Low	Base	High
InitRtMult	1		Initiation rate multiplier for sensitivity analysis	1.25	1	0.75
IStats	(table)	%	Smoking status proportions in initial population			2015 NHIS
YrQuitSlp	0.515		Slope of years since quitting vs. (age-18)--former smkrs.			2017 NHIS (see spreadsheet). For initial population only (simulated after that). No sex difference seen.
CPDERSlope	0.35			0.7	0.35	0.175
CPDProps	(table)	%	Avg. proportions in CPD (on days smoked) categories			2017 NHIS, on days smoked.
CPDDayFracs	(table)	%	Average fraction of days smoked (unused)			2017 NHIS, mean # days smoked in last 30 days / 30
CPDERFacs	(table)		ER (RR-1) factors to adjust for CPD			Simple model based on Thun 2013 (Table S3), Thun 1997, and Bjartveit 2005. See formulas and separate spreadsheet.
CPDRedFacs	(table)		ER factors to adjust for reduced CPD			Same as CPDERFacs except at CPD reduced by M_CPDRed

CPD from to	CPDProps Men	CPDProps Women	CPDDayFracs Men	CPDDayFracs Women	CPD Midpt.	Unscaled CPDERs Men	Unscaled CPDERs Women	CPDERFacs Men	CPDERFacs Women	CPDRedFacs Men	CPDRedFacs Women
0 1.5	6.80%	5.00%	35.53%	42.04%	0.75	0.233	(same)	0.205	0.149	0.108	0.079
1.5 5.5	23.71%	24.49%	67.24%	77.02%	3.5	0.800		0.703	0.512	0.420	0.306
5.5 15.5	38.48%	46.67%	94.60%	96.61%	10.5	1.542		1.355	0.987	0.916	0.668
15.5 25.5	24.63%	20.72%	99.02%	98.92%	20.5	2.101		1.846	1.345	1.339	0.975
25.5 35.5	3.84%	1.84%	99.83%	96.12%	30.5	2.457		2.160	1.573	1.623	1.182
35.5 +	2.54%	1.28%	97.83%	94.80%	*40.5*	2.720		2.390	1.741	1.837	1.338
Wtd. Av. CPD	12.1703	11.1222	11.5738	10.6429		1.4798639	1.442646	1.30044	0.9236	0.89825	0.63142
	on days smoked		over all days			Wtd. Av. unscaled		Wtd. Av. CPDERFac (normalized to Smoker RR)			

QuitParms	(table)		Quit (cessation) rates by age & sex			Holford 2015: 1980 cohort, modeled (see spreadsheet), adjusted from 3.53% to reach 4.5% mean from Mendez 2016
	Weighted Average		7.26%	8.83%	8.14%	
QuitRtMult	1		Quit rate multiplier for sensitivity analysis			

	Low	Base	High
	0.75	1	1.25

Death Rate Inputs

DRMult	1.2		Multiplier to adjust all death rates (1=no change)		To agree with US Census Bureau projecti	
DRAnMult	0.99		Annual mortality rate multiplier			
NSDRs, RRs	(table)	/100,000/y	Annual mortality rate and Relative Risk (RR)	http://ww	Thun 2013 Table S2 (5 contemporary cohorts, 2000-2010)	

	Low	Base	High
	1	1.2	1.4
	0.98	0.99	1

Age from to	Never-Smoker Rate/10^5 Men	Never-Smoker Rate/10^5 Women	Smoker RR Men	Smoker RR Women	Smoker Rate/10^5 Men	Smoker Rate/10^5 Women		Proportion of Pop. Men	Proportion of Pop. Women
18 34	0	0	1	1	0	0	<35: simple assumptions since no data	**0.15464**	**0.14945**
35 54	250	195	2.55	1.79	637.5	349.05	http://ww USDHHS 2014 Table 12.3: RR for 35-54 age gr	**0.16745**	**0.17058**
55 59	299	265	3.69	2.66	1102	705		**0.04276**	**0.04524**
60 64	530	361	3.39	2.96	1795	1069		**0.03678**	**0.04019**
65 69	826	577	3.49	3.12	2880	1799		**0.03067**	**0.03422**
70 74	1356	913	3.26	3.05	4424	2789		**0.02139**	**0.025**
75 79	2323	1552	2.62	2.65	6078	4119		**0.01459**	**0.01824**
80 84	4340	2902	2.37	2.28	10278	6629		**0.00975**	**0.01369**
85 89	8108	5426	2.14	1.97	17380.3	10668.5		**0.00582**	**0.00978**
90 94	15149	10146	1.94	1.69	29390.3	17169.6		**0.00238**	**0.00509**

95	99	28302	18972	1.76	1.46	49699.5	27632.3		0.00052	0.00148
100	+	52875.2	35474.8	1.59	1.25	84042.8	44470.6		6.1E-05	0.00025
Wtd. Av.		627.906	608.02	2.30044	1.9236	1629.85	1315.9		0.4867949	0.5132051

Should = Wtd. Av. CPDERFacs + 1

ERChgs (table) 1/y — ER change rate with years after quitting

Exponential declines toward ER=0, based on results in Mendez 2001 (see spreadsheet)

New Product (MRTP) Inputs

				Low	Base	High
M_IntroYr	**2021**		Year VLN product is introduced	Set >= 1st year, or blank (none).		
M_CtoM	**7.1%**	%/yr	C-I: Peak annual rate CC smokers switch to VLN			
M_CtoMYAM	1		C-Im: Young adult (<=24) multiplier for rate CC smokers switch			
M_CtoMYr	**5**	yr	Years until peak rate that CC smokers switch - linear growth	>=0		
M_MtoS	50%	%	I-S: Proportion of initial VLN smokers sustaining use beyond 1 year	Cf. dropout rate by 20 wk in Hatsukami 2018: 32% total, 4% for product dissatisfaction (immediate red. group)		
M_StoC	**10%**	%/yr	S-C: Annual rate sustaining VLN smokers relapse to CCs	(Can be correlated with above)		
M_CPDRedF	80%	%	CPDf: Proportion of VLN smokers reducing CPD	Hatsukami 2018 (approximated)		
M_CPDRed	50%	%	CPDr: Av. reduction in CPD among VLN smokers reducing CPD	Hatsukami 2018 (approximated)		
M_MtoFRel	**118%**	%	S-Fm: Quit rate for VLN smokers as % of CC quit rate			
M_ERR	100%	%	ERR: prop. of CC smoker Excess Risk experienced by VLN smokers			

Results

Run through year 2100

Last run took 3.81 seconds (12/9/2018 9:05:23 PM).

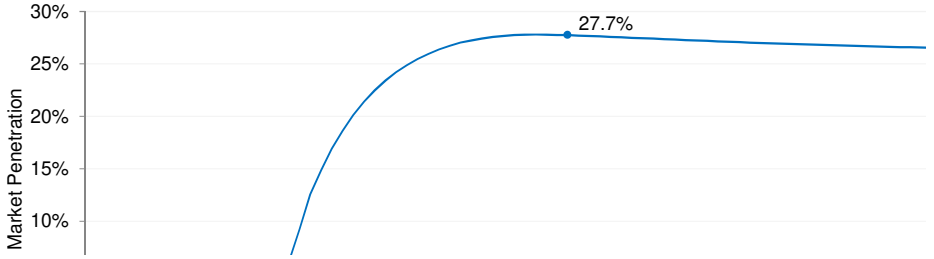
☐ Create workbook with detailed results (slow)

				Year #:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
				Year:	*2015*	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1	Total adult population relative to that of 2015				1	0.96037	0.92176	0.88364	0.84589	0.8083	0.7713	0.73451	0.69778	0.66115	0.6245	0.58847	0.55262	0.51682	0.48117	0.44558
2	C: conventional cig. smoker proportion				8.39%	7.36%	6.48%	5.72%	5.04%	4.45%	3.92%	3.41%	2.93%	2.50%	2.12%	1.78%	1.50%	1.27%	1.07%	0.90%
3	C+M: CC + 1st-year New Product proportion				8.39%	7.36%	6.48%	5.72%	5.04%	4.45%	3.92%	3.45%	3.02%	2.61%	2.24%	1.91%	1.61%	1.37%	1.15%	0.97%
4	C+M+S: total smoker proportion				**8.39%**	**7.36%**	**6.48%**	**5.72%**	**5.04%**	**4.45%**	**3.92%**	**3.45%**	**3.04%**	**2.66%**	**2.33%**	**2.03%**	**1.77%**	**1.53%**	**1.32%**	**1.13%**
5	F: former smoker proportion				39.92%	40.58%	41.13%	41.59%	41.96%	42.27%	42.52%	42.72%	42.87%	42.98%	43.04%	43.06%	43.05%	42.99%	42.89%	42.75%
6	N: never-smoker proportion				51.70%	52.06%	52.39%	52.70%	52.99%	53.28%	53.55%	53.82%	54.09%	54.36%	54.63%	54.90%	55.18%	55.48%	55.78%	56.12%
7	D: annual deaths as proportion of initial population				0	0.03963	0.03861	0.03812	0.03775	0.03759	0.037	0.03679	0.03673	0.03663	0.03665	0.03603	0.03585	0.0358	0.03565	0.03559
41	Cigarette-attributable deaths relative to initial population				0	0.00624	0.00566	0.00525	0.00491	0.00464	0.00433	0.00409	0.00389	0.00369	0.00353	0.00333	0.00319	0.00308	0.00297	0.00287
	Annual US adult death rate				0.00%	4.13%	4.19%	4.31%	4.46%	4.65%	4.80%	5.01%	5.26%	5.54%	5.87%	6.12%	6.49%	6.93%	7.41%	7.99%
	Annual US adult deaths (millions)				0	1.89151	1.84293	1.81939	1.80161	1.7939	1.76588	1.75594	1.7532	1.74825	1.7492	1.71984	1.71115	1.70863	1.70144	1.69878
	Avoided deaths through each year vs. CC Only (1000s)			0	0	0	0	0	0	0	0	0	0	0.20568	0.61277	1.18293	1.8443	2.54527	3.15098	3.62523	3.95449
	Avoided cigarette-attributable deaths through each year vs. CC Only (1000s)			0	0	0	0	0	0	0	0	0	0	0.20568	0.62386	1.22769	1.95481	2.76194	3.5213	4.19573	4.76927
	Life-years gained through each year vs. CC only (1000s)			0	0	0	0	0	0	0	0	0	0	0.20568	0.81845	2.00139	3.84568	6.39095	9.54193	13.1672	17.1216
For plots:																					
	Market penetration ((M+S)/(C+M+S))				0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.42%	3.51%	6.14%	9.19%	12.56%	14.89%	16.90%	18.63%	20.12%
	Smoker + former smoker proportion				48.30%	47.94%	47.61%	47.30%	47.01%	46.72%	46.45%	46.18%	45.91%	45.64%	45.37%	45.10%	44.82%	44.52%	44.22%	43.88%
	Population breakdown	M			44.14%	42.11%	40.17%	38.28%	36.43%	34.60%	32.82%	31.06%	29.31%	27.57%	25.84%	24.15%	22.48%	20.81%	19.16%	17.52%
		F			55.86%	53.93%	52.01%	50.08%	48.16%	46.23%	44.31%	42.40%	40.47%	38.54%	36.61%	34.70%	32.78%	30.87%	28.96%	27.04%
		M	18-24		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		M	25-64		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		M	65+		44.14%	42.11%	40.17%	38.28%	36.43%	34.60%	32.82%	31.06%	29.31%	27.57%	25.84%	24.15%	22.48%	20.81%	19.16%	17.52%
		F	18-24		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		F	25-64		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		F	65+		55.86%	53.93%	52.01%	50.08%	48.16%	46.23%	44.31%	42.40%	40.47%	38.54%	36.61%	34.70%	32.78%	30.87%	28.96%	27.04%
	Smoker breakdown	M			9.70%	8.46%	7.42%	6.53%	5.75%	5.05%	4.44%	3.90%	3.42%	2.99%	2.60%	2.26%	1.96%	1.69%	1.44%	1.23%
		F			7.35%	6.50%	5.75%	5.09%	4.51%	4.00%	3.54%	3.13%	2.76%	2.43%	2.14%	1.87%	1.64%	1.43%	1.24%	1.07%

Summary Tables

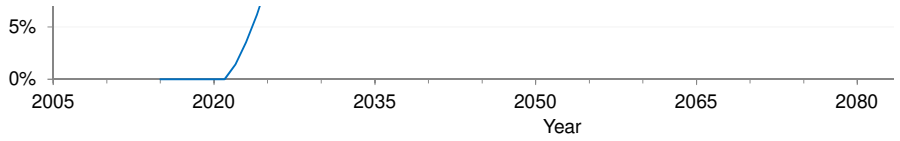
	2050	2100
Total population ≥18 years old (millions)	0.5	0.0
Cigarette-attributable deaths since 2015 (1000s)		
CC-only case	13934.1	23364.9
With new product	4302.1	4313.4
Avoided	9632.1	19051.5
Life-years gained since 2015		
vs. CC-only (1000s)	54.8	55.0
Per avoided cigarette-attributable death	0.0	0.0

	2015	2020	2025	2050	2075	2100
Total population ≥18 years old (millions)	47.7	38.6	29.8	0.5	0.0	0.0
Smoking prevalence:						
CC	8.39%	4.45%	2.12%	0.01%	0.00%	0.00%



VLN	0.00%	0.00%	0.21%	0.01%	0.00%	0.00%
Total current	**8.39%**	**4.45%**	**2.33%**	**0.02%**	**0.00%**	**0.00%**
Former	39.92%	42.27%	43.04%	29.97%	18.77%	13.64%
Never (remainder)	51.70%	53.28%	54.63%	70.01%	81.23%	86.36%
Cumulative results from 2015:						
Total adult deaths (millions)	0.0	9.1	17.9	47.2	47.7	47.7
Cig.-attributable deaths (1000s)	0.0	1274.6	2207.0	4302.1	4313.4	4313.4
Avoided cig.-att. deaths (1000s)	0.0	0.0	1.2	5.4	5.4	5.4
Life-years gained (1000s)	0.0	0.0	2.0	54.8	55.0	55.0
Cig.-attributable morbidity ($billions)	0.0	0.0	0.6	2.8	2.8	2.8

Morbidity at: 0.52288 million $/avoided cig-attrib. death



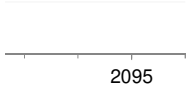
	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075	2080	2085	2090	2095	2100
Total pop. ≥18 years old (millions)	47.7	38.6	29.8	21.3	13.3	6.7	2.4	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Smoking prevalence:																		
CC	8.39%	4.45%	2.12%	0.90%	0.37%	0.14%	0.05%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
VLN	0.00%	0.00%	0.21%	0.23%	0.12%	0.05%	0.02%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Total current	**8.39%**	**4.45%**	**2.33%**	**1.13%**	**0.49%**	**0.19%**	**0.06%**	**0.02%**	**0.01%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
Former	39.92%	42.27%	43.04%	42.75%	41.38%	38.75%	34.79%	29.97%	26.45%	24.09%	22.06%	20.30%	18.77%	17.45%	16.30%	15.29%	14.41%	13.64%
Never (remainder)	51.70%	53.28%	54.63%	56.12%	58.13%	61.06%	65.15%	70.01%	73.54%	75.91%	77.94%	79.70%	81.23%	82.55%	83.70%	84.71%	85.59%	86.36%
Total current smoker breakdown																		
Men 18-24	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Women 18-24	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Men 25-64	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Women 25-64	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Men 65+	4.28%	2.16%	1.08%	0.48%	0.18%	0.05%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Women 65+	4.10%	2.29%	1.25%	0.65%	0.31%	0.14%	0.05%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Cumulative results from 2015:																		
Total adult deaths (millions)	0.0	9.1	17.9	26.5	34.4	41.0	45.3	47.2	47.6	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7
Cig.-attributable deaths (1000s)	0.0	1274.6	2207.0	2943.8	3548.1	3990.3	4227.8	4302.1	4312.0	4313.2	4313.4	4313.4	4313.4	4313.4	4313.4	4313.4	4313.4	4313.4
Avoided cig.-att. deaths (1000s)	0.0	0.0	1.2	4.8	5.9	5.7	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
Life-years gained (1000s)	0.0	0.0	2.0	17.1	36.7	49.0	53.7	54.8	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0
Avoided cigarette-attributable morbidity ($billions)	0.0	0.0	0.6	2.5	3.1	3.0	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8

Multiple age groups:

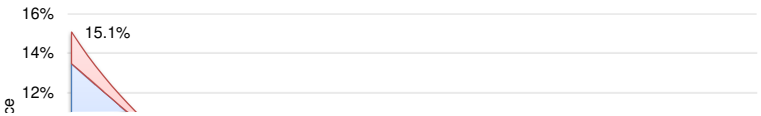
Avoided Cigarette-Attributable Deaths (1000s)																	
New pop. including net migration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ages 18-24 in 2015	0	0	0	0	0	0	0	0	0	0	0	0.03965	0.14249	0.31566	0.56439	0.88971	
Ages 25-64 in 2015	0	0	0	0	0	0	0	0	0.60086	2.06963	4.6044	8.3079	13.2079	18.7815	24.8246	31.1676	
Ages 65+ in 2015	0	0	0	0	0	0	0	0	0.20568	0.62386	1.22769	1.95481	2.76194	3.5213	4.19573	4.76927	

All ages *(check against Both sheet)*	0	0	0	0	0	0	0	0	0.80654	2.69349	5.83209	10.3024	16.1124	22.6184	29.5847	36.8266
Life-Years Gained																
New pop. including net migration	0	0	0	0	0	0	0	0	0	0	1.1E-11	1.1E-11	1.1E-11	2.1E-11	1.1E-11	2.1E-11
Ages 18-24 in 2015	0	0	0	0	0	0	0	0	0	0	0	0.03965	0.18205	0.49724	1.06038	1.94743
Ages 25-64 in 2015	0	0	0	0	0	0	0	1.9E-11	0.60086	2.66625	7.25132	15.5036	28.5852	47.1211	71.5212	102.018
Ages 65+ in 2015	0	0	0	0	0	0	0	0	0.20568	0.81845	2.00139	3.84568	6.39095	9.54193	13.1672	17.1216
All ages *(check against Both sheet)*	0	0	0	0	0	0	0	1.9E-11	0.80654	3.4847	9.25271	19.3889	35.1582	57.1602	85.7487	121.087
Smoking Prevalence																
New pop. including net migration	0.08%	0.44%	0.76%	1.07%	1.34%	1.60%	1.83%	2.05%	2.24%	2.42%	2.57%	2.72%	2.84%	2.96%	3.06%	3.15%
Ages 18-24 in 2015	1.63%	1.57%	1.52%	1.46%	1.41%	1.35%	1.30%	1.25%	1.20%	1.16%	1.11%	1.07%	1.02%	0.98%	0.94%	0.89%
Ages 25-64 in 2015	11.77%	11.11%	10.48%	9.88%	9.30%	8.75%	8.21%	7.71%	7.22%	6.75%	6.31%	5.89%	5.49%	5.11%	4.75%	4.41%
Ages 65+ in 2015	1.61%	1.34%	1.12%	0.94%	0.79%	0.66%	0.55%	0.46%	0.38%	0.31%	0.25%	0.21%	0.17%	0.14%	0.11%	0.08%
All ages *(check against Both sheet)*	15.09%	14.46%	13.89%	13.35%	12.84%	12.36%	11.90%	11.46%	11.04%	10.64%	10.25%	9.88%	9.52%	9.18%	8.85%	8.53%

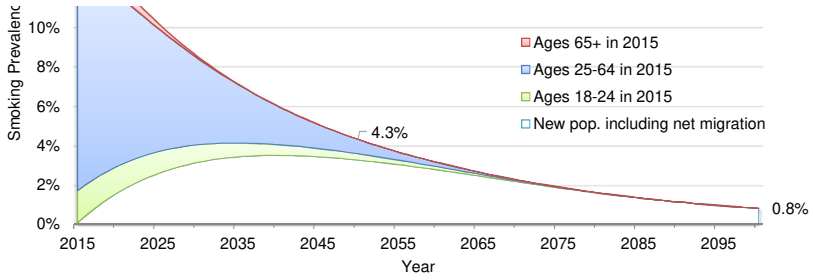
25	35	45	55	85
2040	2050	2060	2070	2100
0.14084	0.01053	0.00032	1.5E-05	1.2E-08
0.14%	0.01%	0.00%	0.00%	0.00%
0.15%	0.01%	0.00%	0.00%	0.00%
0.19%	**0.02%**	**0.00%**	**0.00%**	**0.00%**
38.75%	29.97%	24.09%	20.30%	13.64%
61.06%	70.01%	75.91%	79.70%	86.36%
0.02501	0.00517	0.00012	5.1E-06	2.6E-09
0.00159	0.00016	1.9E-06	6.5E-08	2E-11
17.76%	49.14%	38.33%	33.04%	22.34%
1.19382	0.24697	0.00577	0.00024	1.3E-07
1.73137	0.09061	0.00219	9.3E-05	4.9E-08
5.70815	5.3763	5.36849	5.36838	5.36837
49.014	54.8107	54.9928	54.9982	54.9985
27.01%	27.74%	27.31%	26.92%	26.27%
38.94%	29.99%	24.09%	20.30%	13.64%
4.30%	0.11%	0.00%	0.00%	0.00%
9.78%	0.94%	0.03%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%	0.00%
4.30%	0.11%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%	0.00%
9.78%	0.94%	0.03%	0.00%	0.00%
0.17%	0.01%	0.00%	0.00%	0.00%
0.19%	0.02%	0.00%	0.00%	0.00%

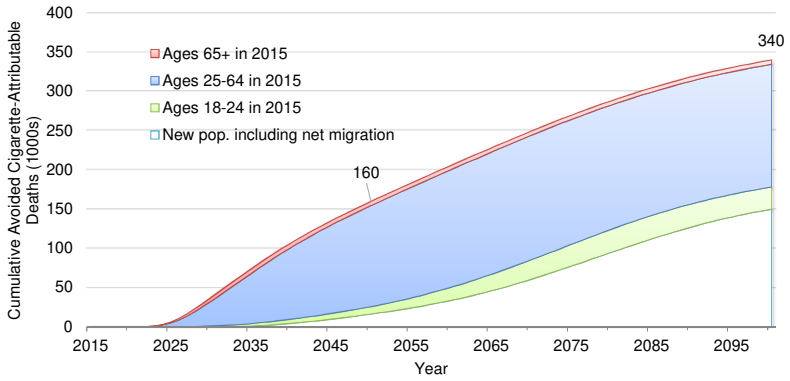


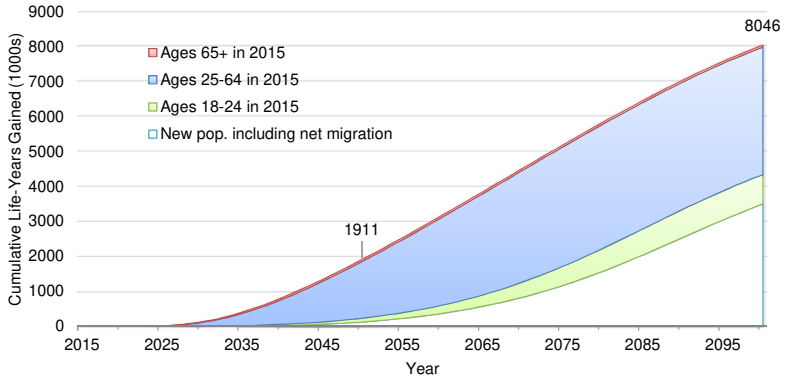
4.19414	16.1594	33.5332	60.5654	149.601	0.44035
5.32724	9.47541	16.7541	24.7316	28.3965	0.08358
91.3787	128.6	149.897	158.519	156.368	0.46027
5.70815	5.3763	5.36849	5.36838	5.36837	0.0158



106.608	159.611	205.553	249.184	**339.734**	
14.5376	117.269	363.075	824.038	3496.72	0.43458
35.2265	108.492	236.744	434.447	840.019	0.1044
714.813	1630.08	2522.91	3199.48	3654.38	0.45418
49.014	54.8107	54.9928	54.9982	54.9985	0.00684
813.591	1910.65	3177.72	4512.96	8046.12	
3.50%	3.27%	2.76%	2.15%	0.81%	
0.55%	0.32%	0.16%	0.05%	0.00%	
1.95%	0.73%	0.21%	0.04%	0.00%	
0.00%	0.00%	0.00%	0.00%	0.00%	
6.01%	4.32%	3.13%	2.25%	0.81%	
				4666.77	







Probabilistic Analysis with (Quasi) Random Draws for Selected Inputs

Runs models in previous two sheets up to 500 times with different inputs. Caution: extremely slow; set up previous sheets carefully & test with 2 or so runs.
Note: the final run left in the model sheets is case #1 using the median inputs specified below (possibly different from the model sheet inputs).

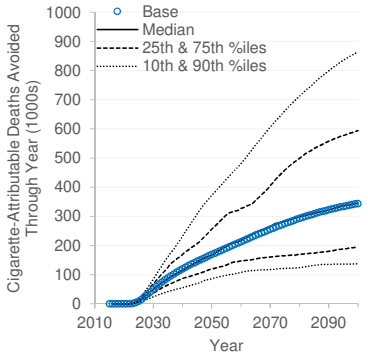
◉ Normal (truncated at 0)
○ Logormal

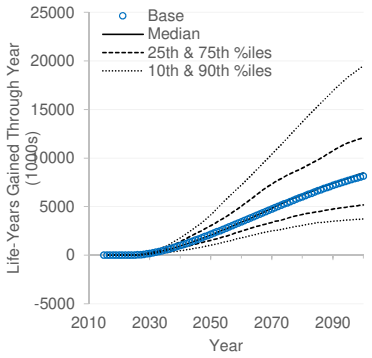
100 times (rows) Last runs took 948.55 seconds (9/10/2018 6:13:28 PM).

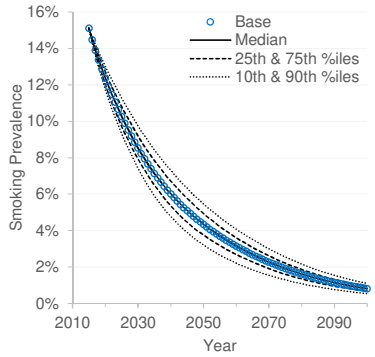
Values for Uncertain Inputs

	InitRtMult	CPDERSlop	QuitRtMult	DRMult	DRAnMult	**M_CtoM**	M_MtoS	M_StoC	M_CPDRed	M_CPDRed	M_MtoFRel	M_ERR
Median	1	0.35	1	1.2	0.99	0.12	0.5	0.25	*0.99999*	0.4	1.18	1
90%ile	1.25	0.6	1.25	1.4	1	0.14	0.75	0.5	1	0.5	1.5	1.1
Run\Var.#												
Base = 1	**1**	**0.35**	**1**	**1.2**	**0.99**	**0.12**	**0.5**	**0.25**	**1**	**0.4**	***1.18***	**1**
2	1.1316	0.2184	1.1316	1.0947	0.9953	0.1095	0.6316	0.1184	1	0.4526	*1.012*	1.0526
3	0.8684	0.4816	0.8684	1.3053	0.9847	0.1305	0.3684	0.3816	1	0.3474	*1.348*	0.9474
4	0.9378	0.2878	1.0622	1.0205	0.999	0.138	0.2756	0.3122	1	0.4898	*1.1*	1.0249
5	1.2244	0.5744	0.7756	1.2497	0.9875	0.115	0.5622	0.0256	1	0.3751	*1.467*	0.9102
6	1.0622	0.1256	0.9378	1.1503	0.981	0.125	0.7244	0.4744	1	0.3102	*1*	0.9751
7	0.7756	0.4122	1.2244	1.3795	0.9925	0.102	0.4378	0.1878	1	0.4249	*1.26*	1.0898
8	0.8269	0.2547	0.9047	1.2763	0.9912	0.1062	0.2007	0.5493	1	0.2803	*1.302*	1.0692
9	1.0953	0.5231	1.1731	1.0616	0.978	0.1276	0.5307	0.2193	1	0.4123	*1*	0.9619
10	1.2993	0.0507	1.0307	1.4394	0.9862	0.1175	0.6731	0.3453	1	0.4692	*1.563*	0.8803
100	0.9576	0.2232	0.9003	1.1908	0.9877	0.124	0.0284	0.3768	1	0.4399	*1.676*	0.8934
200	0.8407	0.2938	1.2715	1.223	0.997	0.1208	0	0.116	1	0.4855	*1.217*	0.9977
300	0.9328	0.0191	1.1607	1.1176	0.9784	0.1221	0.5067	0.3274	1	0.4769	*1.086*	0.9488
400	0.7539	0.26	1.1096	1.3419	1.0008	0.1326	0.1419	0.7417	1	0.4709	*1.034*	1.1263
500	0.9703	0.0538	1.3689	1.2686	0.9907	0.1125	0.1608	0.1196	1	0.3779	*1.341*	1.0968

	Smoking Prevalence			Cigarette-Attributable Deaths Av			Life-Years Gained Through Year (1000s)		
	2015	2050	2100	2015	2050	2100	2015	2050	2100
	0.151	**0.0433**	**0.0081**	**0**	**168.7**	**343.68**	**0**	**2148.4**	**8125.3**
	0.151	0.0453	0.0088	0	206.67	293.17	0	2706.1	8491.5
	0.151	0.0421	0.0077	0	163.38	378.81	0	2011.9	8415
	0.151	0.0404	0.0076	0	153.03	257.46	0	2052.5	6382.8
	0.151	0.0538	0.0103	0	448.12	1403.5	0	4822.9	29316
	0.151	0.0481	0.0092	0	123.14	150.45	0	1804	4852.8
	0.151	0.0307	0.0053	0	125.42	293.99	0	1483.5	6300.5
	0.151	0.0404	0.0074	0	67.571	190.32	0	754.58	3739.8
	0.151	0.0419	0.0075	0	121.95	144.36	0	1789.5	4956.5
	0.151	0.0496	0.0094	0	348.68	835.59	0	4391.7	19662
	0.151	0.0438	0.0082	0	165.62	422.83	0	2006.2	9047.5



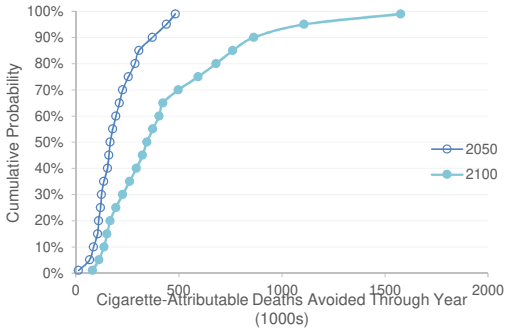




Year	2020	2040	2060	2080	2100
Total Smoking Prevalence					
10th Percentile	11.7%	4.8%	2.2%	1.1%	0.5%
Mean	12.4%	6.0%	3.2%	1.6%	0.8%

Mean	0.151	0.0435	0.0082	200.46	449.98	2424.5 10237
10%	0.151	0.0321	0.0054	86.06	136.76	1033.8 3738.7
25%	0.151	0.0375	0.0067	120.03	194.01	1536.3 5164.5
50%	0.151	0.0435	0.0082	167.16	345.02	2068.9 8459.4
75%	0.151	0.0494	0.0094	255.35	593.82	3024.4 12141
90%	0.151	0.0546	0.011	371.51	863.86	4149.9 19486

1%	13.181	81.173
5%	66.528	111.84
10%	86.06	136.76
15%	105.7	151.05
20%	110.34	167.36
25%	120.03	194.01
30%	125.25	227.17
35%	135.7	261.22
40%	153.62	293.95
45%	161.01	323.62
50%	167.16	345.02
55%	178.93	373.46
60%	194.8	404.7
65%	211.63	422.18
70%	227.42	498
75%	255.35	593.82
80%	287.06	680.92
85%	306.45	761.99
90%	371.51	863.86
95%	439.2	1108
99%	483.26	1577.3



90th Percentile	13.0%	7.3%	4.1%	2.2%	1.1%
Tobacco-Related Deaths Averted Through Year (1000s)					
10th Percentile	0.0	55.0	107.5	124.1	136.8
Mean	0.0	134.3	262.3	376.2	450.0
90th Percentile	0.0	232.0	480.9	712.6	863.9
Life-Years Gained Through Year (1000s)					
10th Percentile	0.0	412.5	1720.4	3013.1	3708.3
Mean	0.0	950.9	3843.8	7226.3	######
90th Percentile	0.0	1591.8	6924.0	######	######