

POTENTIAL IMPACT OF E-CIGARETTES ON LIFE-YEARS LOST FROM CONVENTIONAL SMOKING IN UKRAINE, A REPLICATION STUDY

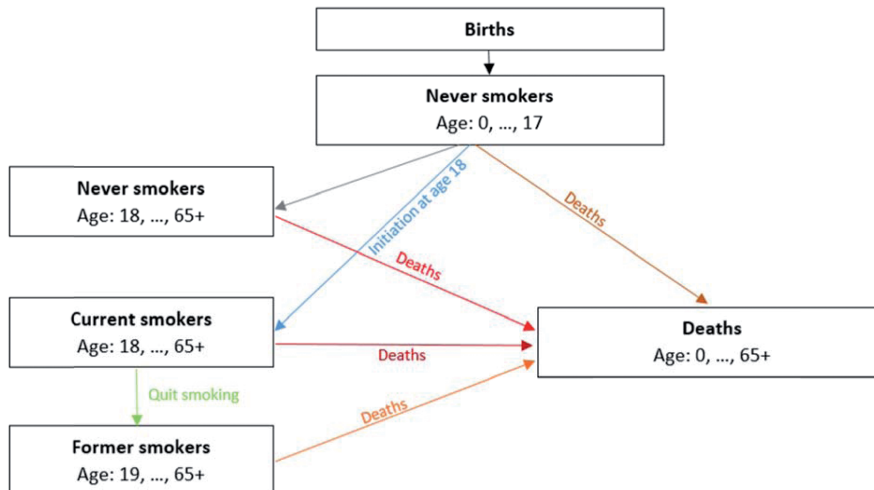
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Model specification

Schematic representation of the background simulation model



Dynamic relationships in the simulation model and main variables

$$P(s, 0, t) = P(s, 0, t - 1),$$

$$N(s, 0, t) = P(s, 0, t),$$

$$N(s, a, t) = N(s, a - 1, t - 1) * (1 - \mu_N(s, a - 1)) \text{ for } a \neq 18,$$

$$N(s, 18, t) = N(s, 17, t - 1) * (1 - \mu_N(s, 17)) * (1 - \gamma(s)),$$

$$S(s, a, t) = 0 \text{ for } a < 18,$$

$$S(s, 18, t) = N(s, 17, t - 1) * (1 - \mu_N(s, 17)) * \gamma(s),$$

$$S(s, a, t) = S(s, a - 1, t - 1) * (1 - \mu_S(s, a - 1)) * (1 - \rho(s)) \text{ for } a > 18,$$

$F(s, a, t) = 0$ for $a < 19$,

$F(s, a, t) = F(s, a - 1, t - 1) * (1 - \mu_F(s, a - 1)) + S(s, a - 1, t - 1) * \mu_S(s, a - 1) * \rho(s, a - 1)$ for $a \geq 19$,

$\pi(t) = \frac{\sum_{a=18}^{90} S(\text{Women}, a, t) + \sum_{a=18}^{90} S(\text{Men}, a, t)}{\sum_{a=18}^{90} N(\text{Women}, a, t) + \sum_{a=18}^{90} N(\text{Men}, a, t)}$, where:

$P(s, a, t)$ is the population of sex s , age a , in year t ,

$N(s, a, t)$, $S(s, a, t)$ and $F(s, a, t)$ are the population of never-smokers, current smokers, and former smokers of sex s , age a , in year t ,

$\mu_N(s, a)$, $\mu_S(s, a)$ and $\mu_F(s, a)$ are death rates of never-smokers, smokers, and former smokers of sex s , age a ,

$\rho(s)$ is the smoking cessation rate of smokers of sex s ,

$\gamma(s)$ is the smoking initiation rate of smokers of sex s ,

$\pi(t)$ is the smoking prevalence in year t .

S Table 1. Sex- and age-specific population in Ukraine, 2017

Age	Men	Women
0	203,793	190,833
1	211,045	197,600
2	237,929	224,336
3	242,802	228,506
4	251,201	236,030
5	242,467	227,967
6	239,738	225,856
7	247,603	232,042
8	246,238	231,335
9	226,623	214,511
10	220,944	210,020
11	205,363	193,450
12	205,461	194,569
13	196,045	185,932
14	188,298	176,999
15	180,859	170,565
16	185,990	175,922
17	188,144	178,590
18	199,959	191,425
19	210,527	199,650
20	229,118	216,485
21	239,503	225,537
22	249,094	234,150
23	262,233	248,188
24	280,918	266,346
25	299,374	284,191
26	313,398	298,552
27	326,497	312,544
28	345,782	332,446
29	356,606	343,069
30	377,087	365,195
31	364,603	355,062
32	372,641	363,038

Source: State Statistics Service of Ukraine

Age	Men	Women
33	376,464	368,133
34	342,549	334,493
35	327,960	327,331
36	334,798	334,485
37	314,568	316,292
38	309,988	315,973
39	297,602	307,015
40	312,866	323,495
41	303,838	319,180
42	294,323	311,309
43	286,146	303,723
44	293,019	314,366
45	290,310	310,935
46	286,619	308,488
47	260,553	285,635
48	262,840	290,464
49	256,572	288,226
50	262,022	297,829
51	256,251	296,576
52	264,837	311,045
53	279,060	333,552
54	282,185	342,221
55	290,839	354,529
56	297,343	367,794
57	278,088	352,696
58	271,496	350,322
59	254,987	335,932
60	248,445	334,890
61	226,389	312,671
62	227,425	321,405
63	202,048	293,211
64	205,987	305,914
65+	2,298,280	4,569,254

S Table 2. Sex- and age-specific smoking prevalence in Ukraine, 2017

Age	Men			Women		
	Never smokers (%)	Current smokers (%)	Former smokers (%)	Never smokers (%)	Current smokers (%)	Former smokers (%)
18	77	9	14	92	6	3
19	52	39	9	97	1	2
20	62	38	0	80	20	0
21	49	33	17	60	7	33
22	53	36	11	77	4	19

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S Table 2.

Age	Men			Women		
	Never smokers (%)	Current smokers (%)	Former smokers (%)	Never smokers (%)	Current smokers (%)	Former smokers (%)
23	45	41	15	62	14	24
24	49	32	18	84	13	3
25	21	64	15	78	19	3
26	32	60	8	62	14	24
27	36	49	15	75	18	7
28	45	41	14	60	28	12
29	30	55	15	59	25	16
30	39	39	22	77	13	10
31	39	45	16	64	11	25
32	44	49	7	63	11	26
33	27	60	12	81	13	6
34	37	51	13	60	12	28
35	30	51	20	69	12	19
36	32	46	21	73	17	10
37	33	47	20	74	24	1
38	27	52	21	68	18	13
39	18	54	28	84	10	6
40	25	50	26	77	7	15
41	34	45	22	69	20	11
42	26	56	19	70	11	19
43	26	49	24	80	7	12
44	20	43	37	73	16	12
45	32	43	25	77	16	7
46	24	56	21	73	12	14
47	23	51	27	68	14	18
48	37	43	21	92	2	7
49	22	43	34	88	10	2
50	40	36	24	78	14	8
51	35	37	28	84	8	8
52	22	54	24	88	12	0
53	26	48	26	88	8	4
54	29	51	20	79	11	9
55	25	49	26	85	2	13
56	37	34	29	86	5	8
57	26	40	34	79	12	8
58	31	43	26	86	8	6
59	34	38	28	81	5	13
60	41	40	19	93	6	1
61	17	38	45	92	3	5
62	53	14	33	90	2	8
63	30	41	29	94	2	3
64	33	40	27	87	3	10
65+	41	16	43	97	1	2

Source: Authors' calculations based on GATS 2017 (4)

S Table 3. Population for the baseline year by age, sex, and smoking status

Age	Men			Women		
	Never smokers	Current smokers	Former smokers	Never smokers	Current smokers	Former smokers
0	203,793	0	0	190,833	0	0
1	211,045	0	0	197,600	0	0
2	237,929	0	0	224,336	0	0
3	242,802	0	0	228,506	0	0
4	251,201	0	0	236,030	0	0
5	242,467	0	0	227,967	0	0
6	239,738	0	0	225,856	0	0
7	247,603	0	0	232,042	0	0
8	246,238	0	0	231,335	0	0
9	226,623	0	0	214,511	0	0
10	220,944	0	0	210,020	0	0
11	205,363	0	0	193,450	0	0
12	205,461	0	0	194,569	0	0
13	196,045	0	0	185,932	0	0
14	188,298	0	0	176,999	0	0
15	180,859	0	0	170,565	0	0
16	185,990	0	0	175,922	0	0
17	188,144	0	0	178,590	0	0
18	153,158	18,388	28,413	175,686	10,739	4,999
19	109,768	82,786	17,973	193,930	1,707	4,013
20	141,758	87,360	0	173,445	43,040	0
21	117,482	80,196	41,825	135,938	15,150	74,449
22	131,917	88,582	28,595	181,453	8,971	43,726
23	117,228	106,611	38,395	153,106	34,777	60,305
24	138,577	91,294	51,047	223,326	35,504	7,516
25	61,457	192,808	45,108	220,727	54,574	8,890
26	99,831	187,521	26,045	185,828	42,366	70,358
27	118,496	159,505	48,496	235,191	56,607	20,747
28	156,924	140,982	47,876	200,778	93,038	38,630
29	107,261	194,464	54,880	201,183	85,844	56,042
30	146,278	146,329	84,480	281,133	48,431	35,631
31	141,765	163,733	59,105	225,850	39,932	89,280
32	162,446	184,054	26,142	227,714	39,957	95,367
33	103,347	226,444	46,673	299,616	46,142	22,375
34	125,440	173,975	43,135	202,245	38,907	93,341
35	97,858	166,032	64,070	224,769	38,942	63,619
36	108,352	154,800	71,646	245,206	56,983	32,296
37	103,003	148,160	63,404	234,895	77,454	3,943
38	84,378	162,043	63,567	215,328	58,347	42,298
39	53,219	160,417	83,966	257,430	30,984	18,601
40	77,253	155,348	80,265	250,045	23,609	49,841
41	102,203	136,231	65,404	220,845	64,681	33,653
42	75,597	164,143	54,583	218,116	34,983	58,210
43	74,900	141,512	69,734	244,465	22,143	37,115

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S Table 3.

Age	Men			Women		
	Never smokers	Current smokers	Former smokers	Never smokers	Current smokers	Former smokers
44	59,465	124,896	108,658	228,151	49,966	36,249
45	93,716	125,230	71,363	239,630	50,178	21,127
46	68,108	159,221	59,289	226,196	38,306	43,986
47	59,605	131,776	69,172	194,554	39,589	51,491
48	96,642	112,153	54,045	266,861	4,488	19,115
49	57,649	111,587	87,336	254,130	27,598	6,497
50	106,102	93,930	61,990	232,990	40,549	24,291
51	89,353	94,625	72,273	249,711	23,133	23,733
52	57,799	142,735	64,303	274,071	36,940	34
53	73,107	134,678	71,275	292,485	28,238	12,828
54	81,675	144,111	56,399	271,917	37,839	32,465
55	73,420	141,454	75,965	301,766	7,948	44,816
56	109,712	102,532	85,099	317,357	19,614	30,823
57	72,299	110,657	95,133	279,784	43,233	29,679
58	84,498	117,749	69,249	302,254	27,978	20,090
59	86,947	96,274	71,767	273,637	18,409	43,886
60	101,346	100,403	46,696	312,412	19,027	3,450
61	38,427	86,615	101,347	288,645	8,740	15,286
62	121,671	31,801	73,953	287,960	6,689	26,756
63	61,577	82,609	57,862	276,539	7,203	9,469
64	68,390	82,971	54,626	266,090	10,205	29,619
65+	941,578	360,828	995,873	4,428,489	55,480	85,284

Source: Authors' calculations based on GATS 2017 (4) and population statistics from the State Statistics Service of Ukraine

S Table 4. Relative risk to adult mortality from smoking-related diseases, adults 35 years of age and older

Disease category	ICD-10 code	Men				Women			
		Current smokers		Former smokers		Current smokers		Former smokers	
		35-64	65+	35-64	65+	35-64	65+	35-64	65+
Malignant neoplasms									
Lip, oral cavity, pharynx	C00-C14	10.89	10.89	3.4	3.4	5.08	5.08	2.29	2.29
Esophagus	C15	6.76	6.76	4.46	4.46	7.75	7.75	2.79	2.79
Stomach	C16	1.96	1.96	1.47	1.47	1.36	1.36	1.32	1.32
Pancreas	C25	2.31	2.31	1.15	1.15	2.25	2.25	1.55	1.55
Larynx	C32	14.6	14.6	6.34	6.34	13.02	13.02	5.16	5.16
Trachea, lung, bronchus	C33-C34	23.26	23.26	8.7	8.7	12.69	12.69	4.53	4.53
Cervix uteri	C53	N/A	N/A	N/A	N/A	1.59	1.59	1.14	1.14
Kidney and renal pelvis	C64-C65	2.72	2.72	1.73	1.73	1.29	1.29	1.05	1.05
Urinary bladder	C67	3.27	3.27	2.09	2.09	2.22	2.22	1.89	1.89
Acute myeloid leukemia	C92.0	1.86	1.86	1.33	1.33	1.13	1.13	1.38	1.38
Cardiovascular diseases									
Coronary heart disease	I20-I25	2.8	1.51	1.64	1.21	3.08	1.6	1.32	1.2
Other heart diseases	I00-I09, I26-I28, I29-I51	1.78	1.78	1.22	1.22	1.49	1.49	1.14	1.14
Cerebrovascular disease	I60-I69	3.27	1.63	1.04	1.04	4	1.49	1.3	1.03
Atherosclerosis	I70	2.44	2.44	1.33	1.33	1.83	1.83	1	1
Aortic aneurysm	I71	6.21	6.21	3.07	3.07	7.07	7.07	2.07	2.07
Other arterial diseases	I72-I78	2.07	2.07	1.01	1.01	2.17	2.17	1.12	1.12
Respiratory diseases									
Influenza, pneumonia	J10-J11, J12-J18	1.75	1.75	1.36	1.36	2.17	2.17	1.1	1.1
Bronchitis, emphysema	J40-J42, J43	17.1	17.1	15.64	15.64	12.04	12.04	11.77	11.77
Chronic airway obstructions	J44	10.58	10.58	6.8	6.8	13.08	13.08	6.78	6.78

Based on Cancer Prevention Study II, United States

Source: National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health (34)

ICD – International Classification of Diseases

S Table 5. Sex- and age-specific death rates by smoking status (per 1,000 people)

Age	Men			Women		
	Never smokers	Current smokers	Former smokers	Never smokers	Current smokers	Former smokers
35	4.3	5.3	4.6	1.6	2.1	1.7
36	4.3	5.4	4.6	1.6	2.0	1.7
37	4.3	5.3	4.6	1.5	2.0	1.6
38	4.3	5.3	4.6	1.6	2.0	1.7
39	4.3	5.2	4.6	1.6	2.1	1.7
40	5.6	7.6	6.2	2.2	3.3	2.4
41	5.7	7.7	6.3	2.1	3.0	2.3
42	5.6	7.4	6.1	2.1	3.1	2.3
43	5.6	7.6	6.2	2.2	3.3	2.4
44	5.6	7.7	6.2	2.1	3.1	2.3
45	7.2	11.0	8.3	2.9	4.4	3.2
46	7.0	10.5	8.1	2.9	4.5	3.2
47	7.1	10.6	8.1	2.9	4.4	3.2
48	7.2	11.1	8.4	3.1	5.3	3.5
49	7.2	10.9	8.3	2.9	4.8	3.3
50	9.6	17.2	11.9	3.8	6.6	4.4
51	9.5	16.9	11.7	3.9	7.2	4.6
52	9.0	15.3	10.9	3.9	6.9	4.5
53	9.2	15.7	11.2	3.9	7.2	4.6
54	9.1	15.6	11.1	3.8	6.8	4.4
55	12.1	23.6	15.7	5.8	12.3	7.1
56	12.8	26.3	16.9	5.7	11.8	6.9
57	12.4	24.8	16.2	5.4	10.6	6.4
58	12.4	24.6	16.1	5.6	11.4	6.7
59	12.6	25.6	16.6	5.6	11.6	6.8
60	17.5	40.3	24.7	9.0	21.4	11.3
61	17.0	38.3	23.5	9.2	22.4	11.7
62	20.4	52.2	30.3	9.2	22.4	11.7
63	17.2	39.0	24.0	9.3	22.8	11.9
64	17.3	39.5	24.2	9.1	21.7	11.4
65+	58.6	99.1	73.2	52.7	84.7	62.4

Source: Authors' calculations based on relative risks and sex-, age-, and disease-specific mortality data from the State Statistics Service of Ukraine

S Table 6. *LYL due to smoking across 80 years*

	LYL (millions)	LYL as a share of the cumulative life years of adult population (%)	LYL as a share of the cumulative life years of current smokers (%)
Total	69.8	3.1	20.9
Men	58.4	5.7	20.5
Women	11.3	0.9	23.3

LYS – life-years saved; LYL – life-years lost

S Table 7. *Estimated smoking initiation rates in 2010 and 2017*

Year	Men (95% CI)	Women (95% CI)	Total (95% CI)
2010	51.3 (45.1–57.4)	18.1 (13.0–24.6)	34.1 (29.7–38.7)
2017	33.3 (26.8–40.4)	10 (5.5–17.6)	22.5 (18.2–27.4)

Source: Authors' calculations based on GATS 2010 and 2017 (4)

S Table 8 is inserted in a separate file**S Table 9.** *Sensitivity analysis – summary of all e-cigarette scenario simulations (lower bound estimates of smoking cessation and initiation rates)*

	Minimum value	Maximum value	Median value
LYS (millions)	-1.147	12.923	2.702
LYS by vaping as a share of LYL due to smoking (%)	-1.5	16.8	3.5
Number of scenarios with positive LYS	184		

LYS – life-years saved; LYL – life-years lost

S Table 10. *Sensitivity analysis – summary of all e-cigarette scenario simulations (upper bound estimates of smoking cessation and initiation rates)*

	Minimum value	Maximum value	Median value
LYS (millions)	-1.317	9.933	2.091
LYS by vaping as a share of LYL due to smoking (%)	-2.1	15.8	3.3
Number of scenarios with positive LYS	178		

S Table 11 is inserted in a separate file**S Table 12** is inserted in a separate file**S Table 13.** *Sensitivity analysis – effects of vaping on mortality and smoking cessation (cumulative over 80 years) in selected e-cigarette scenarios (lower bound estimates of smoking cessation and initiation rates)*

Vaping risk (%)	Annual cessation rate increase due to vaping (%)	Vaping reduces smoking initiation by 10%		
		LYS (million)	LYS as a share of LYL due to smoking (%)	E-quitters as a share in all quitters (%)
5	25	2.592	3.4	18.5
	50	4.267	5.5	31.2
10	25	2.438	3.2	18.4
	50	3.972	5.1	31.0

LYS – life-years saved; LYL – life-years lost; E-quitters – individuals who successfully quit smoking due to vaping

S Table 14. Sensitivity analysis – effects of vaping on mortality and smoking cessation (cumulative over 80 years) in selected e-cigarette scenarios (upper bound estimates of smoking cessation and initiation rates)

Vaping risk (%)	Annual cessation rate increase due to vaping (%)	Vaping reducing smoking initiation by 10%		
		LYS (million)	LYS as a share of LYL due to smoking (%)	E-quitters as a share in all quitters (%)
5	25	2.544	4.1	19.5
	50	3.892	6.2	32.6
10	25	2.135	3.4	19.4
	50	3.177	5.1	32.4

LYS – life-years saved; LYL – life-years lost; E-quitters – individuals who successfully quit smoking due to vaping