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Estimating the structure by age and sex of the US sexually active population

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ABSTRACT

A model combines demographic data provided by the United States Census Bureau for 2021 with survey data on sexual activity from the Centers for Disease Control and Prevention to estimate the structure by age and sex of the sexually active population in the United States. It also provides the proportions of newly sexually active people by age and sex. The model is based on percentages of sexually active people by age and sex, and on an ordinary differential equation formalizing a “learning process” for the years 2009 to 2019. The data produced fit well with the empirical data for each age and sex.

KEYWORDS

Age and sex structure; newly sexually active; ordinary differential equations; population model; sexually active

JEL CLASSIFICATION

C63

1. Introduction

The United States Census Bureau¹ states that “data on the age and sex composition of the population can be found from a variety of sources. These sources are listed in the Surveys/Programs area with brief descriptions to help you decide which data source would best suit your needs.” However, none of these surveys include questions about sexual activity. The Centers for Disease Control and Prevention (2010), which conducted a survey on sexual behavior, sexual attraction, and sexual identity in the United States, found that 14.2% of women aged 18 to 44 and 5.1% of men aged 15 to 44 had ever had a homosexual relationship from 2006 to 2010. These percentages were 17.6% and 5.1% again from 2011 to 2015 (Chandra, Copen, and Mosher, 2013). These data do not, however, inform us on the size of the groups whose percentages are reported.

2. A two-sex model yielding the distribution of the sexually active population by age and sex

We consider the sexually active population in the United States to consist of all individuals aged 15 and over who have had oral, vaginal, or anal sexual

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¹www.census.gov/topics/population/age-and-sex/data/tables.html.

contact. It consists of $F(t)$ women and $M(t)$ men at time t , where $t = 0$ refers to the year 2009.

We combine survey data on sexually active people by age and sex with census data to estimate the distribution of the sexually active population of the United States by age and sex for the years 2009 to 2019.

We use the percentages of sexually active people by age and sex from 2011 to 2015 as established by Abma and Martinez (2017) for 15–20-year-olds, Fortenberry (2014) for 21–29-year-olds, and Gorshow (2018) for 30–39 year-olds. We use the percentages of sexually active people by age and sex from 2006 to 2008 as established by Chandra et al. (2011) for 40–44-year-olds. We assume that people who have not had sex by age 45 will never have sex.

We calculate the percentage of newly sexually active individuals for an age and sex group as the difference between the percentage of sexually active individuals for that age group and sex and the percentage of sexually active individuals for that sex in the previous age group. [Table 1](#) presents the data.

We assume that the percentages of newly sexually active people by age and sex for the over-20s have not changed over the 2009–2019 period.

[Table 2](#) shows the percentages of sexually active and newly sexually active people in the United States, by age and sex, for the period 2015–2019.

The percentages in [Table 2](#) for ages 15–20 are taken from the National Center for Health Statistics 2020 cited by Martinez and Abma (2020) on sexual activity and contraceptive use among adolescents, and based on data collected from 2015 to 2017. We have updated the entries of [Table 1](#) for these ages, while keeping the data for ages older than 20 unchanged.

The percentages published by Abma and Martinez (2017) for people aged 15 to 20 for the years 2011 to 2015 differ from those published by Martinez and Abma (2020) for the years 2015 to 2017. Therefore, for the year 2015, we use the means of the percentages in [Tables 1 and 2](#) for each of those ages.

To obtain the distribution of the total numbers of sexually active individuals by age and sex for each year, we multiplied the percentages of sexually active

Table 1. Percentages of sexually active individuals in the United States by age and sex from 2010 to 2015.

Age	Sexually active women (%)	Sexually active men (%)	Newly sexually active women (%)	Newly sexually active men (%)
15	11.0	16.0	11.0	16.0
16	25.0	27.0	14.0	11.0
17	42.0	41.0	17.0	14.0
18	55.0	55.0	13.0	14.0
19	69.0	68.0	14.0	13.0
20	75.0	75.0	6.0	7.0
21–24	87.7	85.7	12.7	10.7
25–29	95.2	95.6	7.5	9.9
30–34	97.6	96.7	2.4	0.1
35–39	98.5	98.4	0.9	1.7
40–44	99.6	98.7	1.1	0.3
45+	99.6	98.7	0.0	0.0

Table 2. Percentage of sexually active individuals in the United States by age and sex from 2015 to 2019.

Age	Sexually active women (%)	Sexually active men (%)	Newly sexually active women (%)	Newly sexually active men (%)
15	21.0	20.0	21.0	20.0
16	37.0	34.0	16.0	14.0
17	53.0	48.0	16.0	14.0
18	65.0	62.0	12.0	14.0
19	74.0	70.0	9.0	8.0
20	79.0	77.0	5.0	7.0
21–24	87.7	85.7	8.7	8.7
25–29	95.2	95.6	7.5	9.9
30–34	97.6	96.7	2.4	1.1
35–39	98.5	98.4	0.9	1.7
40–44	99.6	98.7	1.1	0.3
45+	99.6	98.7	0.0	0.0

women and men by age from [Tables 1 and 2](#) by the corresponding age and sex group sizes from the United States Census Bureau. As an example, [Table 3](#) shows the calculations of the age distribution of sexually active women in 2015.

[Table 4](#) presents the results for each year from 2009 to 2019 for both sexes. [Table 5](#) obtained in the same way presents the population sizes of newly sexually active by age and sex, using the percentages of newly sexually active by age and sex in 2015 instead of those of sexually active.

For finer age resolution, [Figure 1](#) presents the estimated distribution of the sexually active US population into one-year age groups for the year 2020, based on data provided by the United States Census Bureau.² We then multiply these sizes by the corresponding percentages of sexually active people summarized in [Table 2](#). We assume that people aged 90+ are not sexually active. [Tables 6 and 7](#) present the results.

Table 3. Estimated total number (in millions) of sexually active women by age in the United States in 2015.

Age	Sexually active women (%)	Population size	Sexually active population, $F(2015)$ (in millions)
15	16.0	2.08	0.33
16	31.0	2.05	0.63
17	47.5	2.05	0.97
18	60.0	1.97	1.18
19	71.5	1.97	1.41
20	77.0	2.04	1.57
21–24	87.7	8.98	7.87
25–29	95.2	1.88	1.36
30–34	97.6	1.70	1.44
35–39	98.5	1.09	9.94
40–44	99.6	1.21	1.17
45+	99.6	68.37	68.10
Total	93.6	131.37	122.97

²www2.census.gov/programs-surveys/popest/datasets/2020-2022/national/asrh/nc-est2022-agesex-res.csv.

Table 4. Estimated US sexually active population by sex and age (in millions), from 2009 to 2019.

	Age, in years											
	15	16	17	18	19	20	21–24	25–29	30–34	35–39	40–44	45+
Women												
in 2009	0.23	0.53	0.90	1.09	1.37	4.82	7.28	9.89	9.46	10.12	10.51	61.61
in 2010	0.23	0.53	0.89	1.10	1.38	1.63	7.43	10.02	9.63	9.84	10.35	55.34
in 2011	0.22	0.52	0.89	1.10	1.38	1.60	7.63	9.96	9.89	9.57	10.37	56.30
in 2012	0.22	0.51	0.87	1.12	1.41	1.60	7.68	9.96	10.05	9.57	10.49	65.19
in 2013	0.22	0.51	0.86	1.06	1.34	1.61	7.78	10.00	10.22	9.61	10.45	66.09
in 2014	0.22	0.51	0.86	1.05	1.32	1.65	7.75	10.14	10.34	9.70	10.30	66.99
in 2015	0.33	0.63	0.97	1.18	1.41	1.57	7.87	10.36	10.44	9.94	10.17	68.09
in 2016	0.43	0.77	1.09	1.24	1.41	3.01	6.20	10.59	10.31	9.95	9.68	67.39
in 2017	0.42	0.76	1.11	1.25	1.42	1.59	7.64	10.77	10.33	10.10	9.52	68.05
in 2018	0.43	0.75	1.10	1.27	1.44	1.66	7.54	10.91	10.41	10.31	9.59	61.40
in 2019	0.43	0.76	1.08	1.28	1.46	1.56	7.51	10.91	10.52	10.41	9.66	69.39
Men												
in 2009	0.35	0.61	0.93	0.36	0.44	1.61	7.09	10.39	9.162	10.01	10.19	53.88
in 2010	0.35	0.60	0.92	1.14	1.41	1.66	7.11	10.45	9.34	9.74	10.04	62.02
in 2011	0.34	0.59	0.91	1.13	1.40	1.69	7.23	10.44	9.63	9.39	10.04	62.77
in 2012	0.34	0.58	0.90	1.15	1.42	1.77	7.39	9.97	9.60	9.27	10.12	57.23
in 2013	0.34	0.57	0.88	1.10	1.36	1.59	7.73	10.16	9.75	9.31	10.03	58.10
in 2014	0.34	0.58	0.88	1.12	1.38	1.63	7.78	10.35	9.93	9.40	9.91	59.02
in 2015	0.39	0.65	0.95	1.16	1.37	1.71	7.68	10.44	10.00	9.47	9.50	59.01
in 2016	0.43	0.74	1.03	1.24	1.40	1.82	7.48	10.72	10.10	9.68	9.36	59.97
in 2017	0.42	0.73	1.05	1.23	1.39	1.67	7.47	10.84	10.25	9.90	9.17	60.59
in 2018	0.42	0.72	1.04	1.25	1.41	1.70	7.30	11.09	10.35	10.18	9.22	68.89
in 2019	0.41	0.70	0.98	1.22	1.38	1.52	7.34	10.91	10.52	10.41	9.66	69.39

Table 5. Estimated total number (in millions) of newly sexually active women by age in the United States in 2015.

Age	Newly sexually women (%)	Sexually active population (in millions)		Newly sexually active population (in millions)
		Age	Newly sexually women (%)	
15	16.0		2.08	0.33
16	15.0		2.05	0.31
17	16.5		2.05	0.34
18	12.5		1.97	0.25
19	11.5		1.97	0.23
20	5.5		2.04	0.11
1–24	10.7		8.98	0.96
25–29	7.5		1.88	0.82
30–34	2.4		1.70	0.26
35–39	0.9		1.09	0.09
40–44	1.1		1.21	0.11
45+	0.0		68.37	0.00
Total			131.37	3.80

The model for the total numbers of sexually active women and men is given by the “learning curve” (Stewart, 2012) yielded by the ordinary differential equations:

$$F'(t) = \Lambda_f - \xi_f F(t), \quad (1)$$

$$M'(t) = \Lambda_m - \xi_m M(t), \quad (2)$$

where ξ_f is the per-head exit rate from the set of sexually active women, ξ_m the per-head exit rate from the set of sexually active men, Λ_f the total number of

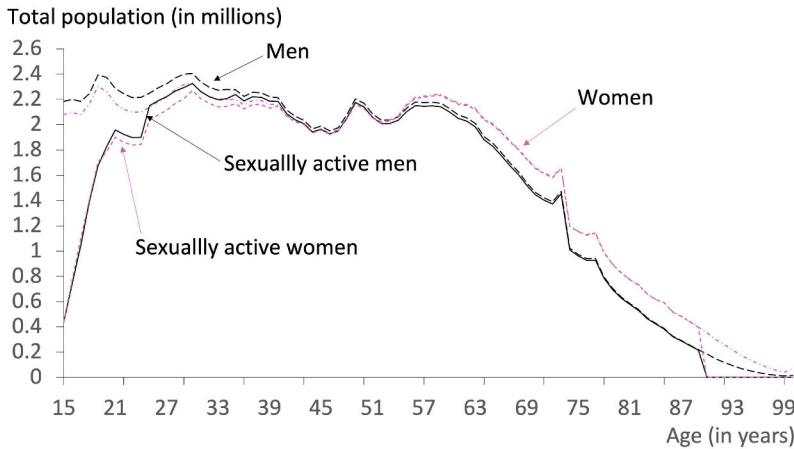


Figure 1. Estimated US sexually active population in 2020 by sex and 1-year age groups.

newly sexually active women per time unit, and Λ_m the total number of newly sexually active men per time unit.

The differential equation

$$P'(t) = \Lambda - \xi P(t) \quad (3)$$

accounts for the variation of the size $P(t)$ at time t of the population size under the assumption of a constant immigration rate Λ and a per-head mortality/loss rate ξ . The solutions are called “learning curves” (Stewart, 2012), as they summarize the knowledge accumulated on the subject of study at time t . The parameter Λ represents the rate of knowledge acquisition and the parameter ξ the unit rate of knowledge loss. [Figure 2](#) shows several learning curves with different unit loss rates that start at the same level and end at the same maximum level.

The solutions

$$F(t) = F(0)e^{-\xi_f t} + \frac{\Lambda_f}{\xi_f} (1 - e^{-\xi_f t}), \quad (4)$$

$$M(t) = M(0)e^{-\xi_m t} + \frac{\Lambda_m}{\xi_m} (1 - e^{-\xi_m t}) \quad (5)$$

to Eq. (1) and (2) allow not only to estimate the six parameters best fitting the empirical data, but also to estimate the size of the sexually active US men’s and women’s populations at times for which no estimates are available.

Table 6. Estimated total number of sexually active women by age in the United States in the year 2020.

Age (years)	Population size of women of women	% of sexually active women women	Total number of sexually active women	Age (years)	Population size women women	% of sexually active active women	Total number of sexually active women
15	2,081,574	21.0	437,131	53	2,037,054	99.6	2,028,906
16	2,095,709	37.0	775,412	54	2,070,574	99.6	2,062,292
17	2,079,063	53.0	1,101,903	55	2,162,074	99.6	2,153,426
18	2,164,749	65.0	1,407,087	56	2,216,832	99.6	2,207,965
19	2,303,416	74.0	1,704,528	57	2,224,981	99.6	2,216,081
20	2,262,510	79.0	1,787,383	58	2,236,686	99.6	2,227,739
21	2,167,816	87.7	1,901,175	59	2,238,503	99.6	2,229,549
22	2,121,331	87.7	1,860,407	60	2,203,394	99.6	2,194,580
23	2,098,272	87.7	1,840,185	61	2,171,824	99.6	2,163,137
24	2,100,720	87.7	1,842,331	62	2,159,774	99.6	2,151,135
25	2,137,469	95.2	2,034,870	63	2,129,827	99.6	2,121,308
26	2,181,646	95.2	2,076,927	64	2,046,673	99.6	2,038,486
27	2,218,911	95.2	2,112,403	65	2,006,950	99.6	1,998,922
28	2,277,063	95.2	2,167,764	66	1,946,294	99.6	1,938,509
29	2,316,595	95.2	2,205,398	67	1,874,144	99.6	1,866,647
30	2,327,046	97.6	2,271,197	68	1,809,387	99.6	1,802,149
31	2,259,863	97.6	2,205,626	69	1,733,179	99.6	1,726,246
32	2,221,501	97.6	2,168,185	70	1,659,444	99.6	1,652,806
33	2,193,003	97.6	2,140,371	71	1,620,667	99.6	1,614,184
34	2,196,517	97.6	2,143,801	72	1,586,916	99.6	1,580,568
35	2,199,043	98.5	2,166,057	73	1,663,125	99.6	1,656,473
36	2,157,312	98.5	2,124,952	74	1,198,751	99.6	1,193,956
37	2,191,717	98.5	2,158,841	75	1,157,144	99.6	1,152,515
38	2,191,650	98.5	2,158,775	76	1,131,158	99.6	1,126,633
39	2,162,976	98.5	2,130,531	77	1,146,968	99.6	1,142,380
40	2,156,356	99.6	2,147,731	78	990,550	99.6	986,588
41	2,074,536	99.6	2,066,238	79	898,173	99.6	894,580
42	2,029,737	99.6	2,021,618	80	830,770	99.6	827,447
43	2,010,258	99.6	2,002,217	81	776,887	99.6	773,779
44	1,942,483	99.6	1,934,713	82	735,370	99.6	732,429
45	1,966,775	99.6	1,958,908	83	664,331	99.6	661,674
46	1,931,637	99.6	1,923,910	84	620,435	99.6	617,953
47	1,960,306	99.6	1,952,465	85	594,931	99.6	592,551
48	2,051,999	99.6	2,043,791	86	520,669	99.6	518,586
49	2,169,649	99.6	2,160,970	87	483,345	99.6	481,412
50	2,137,641	99.6	2,129,090	88	441,779	99.6	440,012
51	2,061,583	99.6	2,053,337	89	397,663	99.6	396,072
52	2,021,503	99.6	2,013,417	all	166,986,403	76.4	127,501,324

2.1. Estimation of the total numbers Λ_f and Λ_m of newly sexually active women and men per time unit, and per-head exit rates ξ_f and ξ_m from the set of sexually active women and men

Summing the data in the last column of [Table 5](#) over all age groups provides the total number of newly sexually active women for the year 2015, shown in the last entry of [Table 5](#). We similarly estimated the total numbers of newly sexually active women and men for each year from 2009 to 2019. The means by sex from 2009 to 2019 are estimates of the constants Λ_f in Eq. (4) and Λ_m in Eq. (5):

$$\Lambda_f = 3,777,794 \text{ women per year and } \Lambda_m = 3,872,800 \text{ men per year.} \quad (6)$$

Table 7. Estimated total number of sexually active men by age in the United States in the year 2020.

Age (years)	Population size of men	% of sexually active men	Total number of sexually active men	Age (years)	Population size of men	% of sexually active men	Total number of sexually active men
15	2,184,583	20.0	436,917	53	2,036,002	98.7	2,009,534
16	2,200,309	34.0	748,105	54	2,062,609	98.7	2,035,795
17	2,184,631	48.0	1,048,623	55	2,131,630	98.7	2,103,919
18	2,245,840	62.0	1,392,421	56	2,178,759	98.7	2,150,435
19	2,392,919	70.0	1,675,043	57	2,173,446	98.7	2,145,191
20	2,373,155	77.0	1,827,329	58	2,177,520	98.7	2,149,212
21	2,285,791	85.7	1,958,923	59	2,168,325	98.7	2,140,137
22	2,243,080	85.7	1,922,320	60	2,127,531	98.7	2,099,873
23	2,214,035	85.7	1,897,428	61	2,077,966	98.7	2,050,952
24	2,216,241	85.7	1,899,319	62	2,054,261	98.7	2,027,556
25	2,248,655	95.6	2,149,714	63	2,008,919	98.7	1,982,803
26	2,290,911	95.6	2,190,111	64	1,906,485	98.7	1,881,701
27	2,324,140	95.6	2,221,878	65	1,854,078	98.7	1,829,975
28	2,369,658	95.6	2,265,393	66	1,779,636	98.7	1,756,501
29	2,399,118	95.6	2,293,557	67	1,698,320	98.7	1,676,242
30	2,404,762	96.7	2,325,405	68	1,628,676	98.7	1,607,503
31	2,337,447	96.7	2,260,311	69	1,538,979	98.7	1,518,972
32	2,295,358	96.7	2,219,611	70	1,464,230	98.7	1,445,195
33	2,273,346	96.7	2,198,326	71	1,421,278	98.7	1,402,801
34	2,279,687	96.7	2,204,457	72	1,390,894	98.7	1,372,812
35	2,275,725	98.4	2,239,313	73	1,472,748	98.7	1,453,602
36	2,224,239	98.4	2,188,651	74	1,023,912	98.7	1,010,601
37	2,256,585	98.4	2,220,480	75	973,938	98.7	961,277
38	2,252,958	98.4	2,216,911	76	940,255	98.7	928,032
39	2,221,044	98.4	2,185,507	77	941,978	98.7	929,732
40	2,210,852	98.7	2,182,111	78	797,030	98.7	786,669
41	2,113,973	98.7	2,086,491	79	705,755	98.7	696,580
42	2,064,935	98.7	2,038,091	80	636,905	98.7	628,625
43	2,034,660	98.7	2,008,209	81	586,081	98.7	578,462
44	1,967,042	98.7	1,941,470	82	537,853	98.7	530,861
45	1,989,738	98.7	1,963,871	83	472,166	98.7	466,028
46	1,951,437	98.7	1,926,068	84	427,986	98.7	422,422
47	1,975,790	98.7	1,950,105	85	386,715	98.7	381,688
48	2,075,037	98.7	2,048,062	86	326,411	98.7	322,168
49	2,203,883	98.7	2,175,233	87	292,545	98.7	288,742
50	2,168,887	98.7	2,140,691	88	254,672	98.7	251,361
51	2,084,076	98.7	2,056,983	89	219,123	98.7	216,274
52	2,036,555	98.7	2,010,080	All	164,525,109	74.7	122,953,752

We used these estimates to fit $F(0)$, ξ_f , $M(0)$, and ξ_m from each of the learning curves for both sexes in Eq. (4) and (5) to the sizes of the sexually active population by sex for the years 2009 to 2019. Figure 3 shows the fit by learning curves from Eq. (4) and (5) to the total numbers of sexually active women and men in the U.S. for the years 2009 to 2019, using demographic data and the data of Table 4.

The fit is good, as the maximum annual deviation is between 0.5% and 0.6%, with the values

$$F(0) = 113,860,000 \text{ women}, \quad \Lambda_f = 3,777,794 \text{ women per year}, \\ \xi_f = 0.0196 \text{ per year}, \quad (7)$$

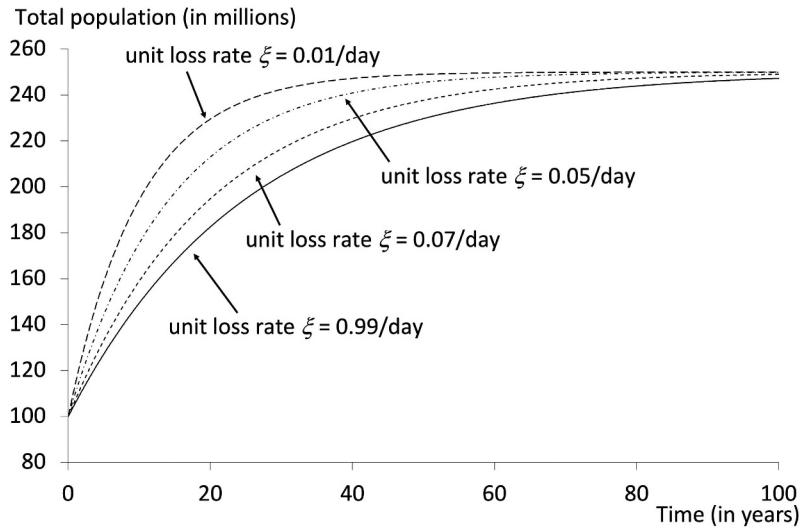


Figure 2. Examples of learning curves for various values of the loss rate ξ .

$$M(0) = 106,500,000 \text{ men}, \Lambda_m = 3,872,800 \text{ men per year}, \\ \xi_m = 0.0238 \text{ per year.} \quad (8)$$

We finally used

$$\Lambda = \Lambda_f + \Lambda_m \quad (9)$$

for the recruitment rate for a learning curve model of the US unstructured sexually active population, $N(t) = F(t) + M(t)$. Specifically,

$$N'(t) = \Lambda - \xi N(t), \text{ with solution } N(t) = N(0)e^{-\xi t} + \frac{\Lambda}{\xi} (1 - e^{-\xi t}). \quad (10)$$

We fitted $N(0)$ and the parameter ξ in Eq. (10) to the total number of sexually active people in the United States for the years 2009 to 2019. Figure 4 shows the learning curve fit of the estimated sexually active population in the United States for the years 2009 to 2019 to the data estimated in Table 4.

The maximum annual deviation is 0.4%, which is very good, with the values

$$N(0) = 220,360,000 \text{ individuals, } \Lambda = 7,650,594 \text{ individuals per year,} \\ \xi = 0.0215 \text{ per year.} \quad (11)$$

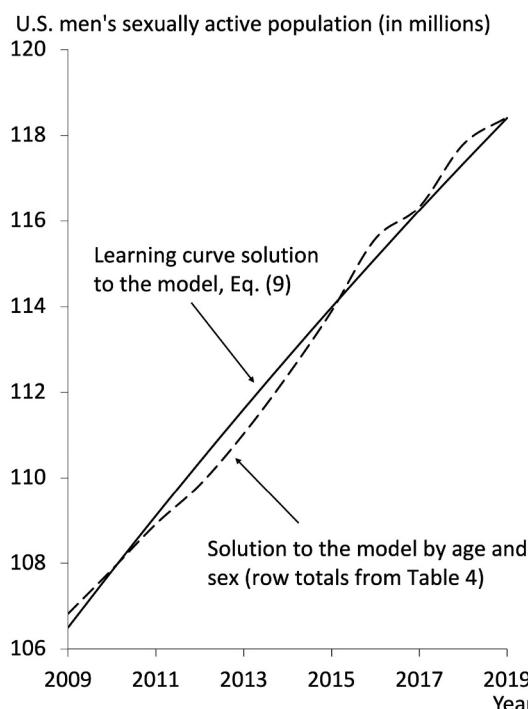
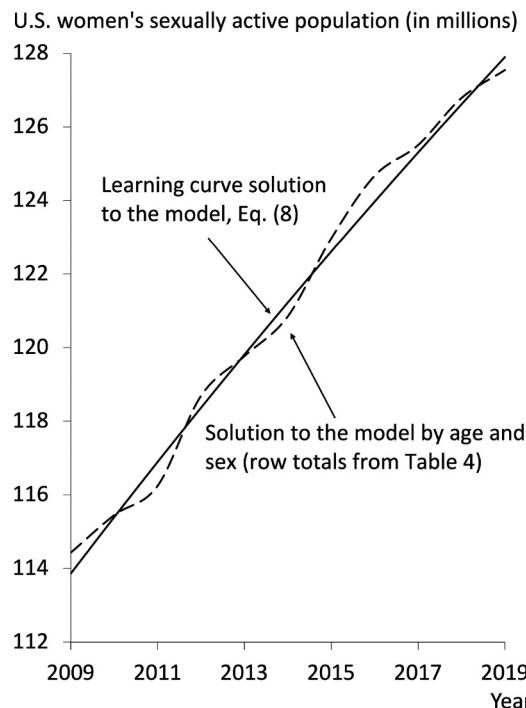


Figure 3. Learning curve fitting for US sexually active women's (top) and men's (bottom) populations.

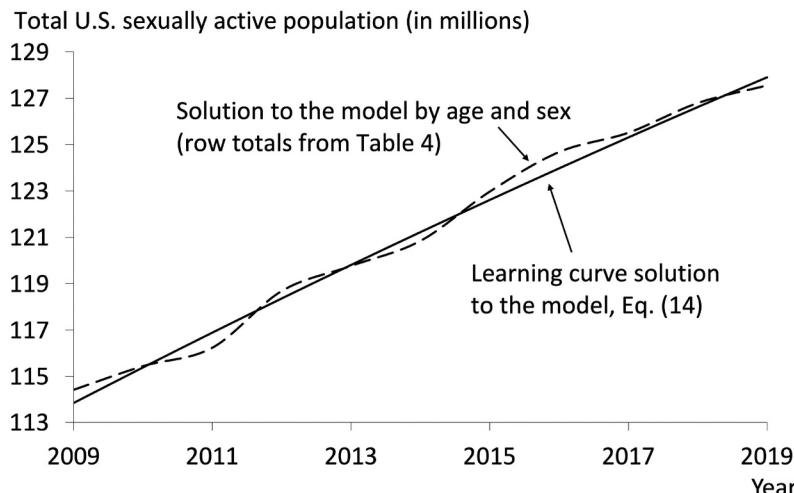


Figure 4. Learning curve fitting for the sexually active population, $N(t) = N(0)e^{-\xi t} + \frac{\Delta}{\xi}(1 - e^{-\xi t})$.

3. Conclusion

We have estimated the structure by age and sex of the sexually active population of the United States. Such an estimate may prove useful in the epidemiology of sexually transmitted infections.

The estimation is based on percentages of sexually active people by age and sex, and on learning-curve ordinary differential equations. It provides estimates of the annual rates by sex of entry into sexual partnership and the rates by sex of exit from the sexually active population for the years 2009 to 2019.

The accuracy of the model depends on the quality of the available percentages of sexually active people by sex and age, which were used to estimate the rates of the newly sexually active population for each sex.

Disclosure statement

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References

Abma, J. C. and Martinez, G. M. (2017). Sexual activity and contraceptive use among teenagers in the United States, 2011–2015. *National Health Statistics Reports*, 104: 1–23.

Centers for Disease Control and Prevention. (2010). *Teenagers in the United States: sexual activity, contraceptive use, and childbearing, national survey of family growth 2006–2008*. Retrieved December 14, 2023, from https://www.cdc.gov/nchs/data/series/sr_23/sr23_030.pdf

Chandra, A., Copen, C. E., and Mosher, W. D. (2013). Sexual behavior, sexual attraction, and sexual identity in the United States: Data from the 2006–2010 national survey of family growth, in *International Handbooks of Population, International Handbook on the Demography of Sexuality, Volume VI*, A. K. Baumle (ed). Dordrecht: Springer Science and Business Media, 45–66.

Chandra, A., Mosher, W. D., Copen, C., and Sionean, C. (2011). Sexual behavior, sexual attraction, and sexual identity in the United States: Data from the 2006–2008 National Survey of Family Growth. *National Health Statistics Reports*, (36): 1–36.

Fortenberry, J. (2014). On late-in-life virginity loss. *The Atlantic*. Retrieved June 30, 2023, from <https://www.theatlantic.com/health/archive/2014/03/on-late-in-life-virginity-loss/284412/>

Gorshow, L. (2018). Helpful advice for a 30-year-old virgin. *Love to Know*. <https://www.lovetoknow.com/life/relationships/30-year-old-virgin>

Martinez, G. M. and Abma, J. C. (2020). Sexual activity and contraceptive use among teenagers aged 15–19 in the United States, 2015–2017. *National Health Statistics Data Brief*, 366: 1–8.

Stewart, J. (2012). *Calculus: Early Transcendentals*. Belmont, CA: Brooks/Cole, Cengage Learning.