Supplementary Online Content

**Drug overdose deaths among non-Hispanic Black men
in the US: Age-specific projections through 2025**

Rebecca Arden Harris, MD MSc

This supplemental material has been provided to give readers additional information about the work.

I – Comparison of Population Projections

Table S1 compares the US Census Bureau's 2025 population projections for Non-Hispanic Black men with our 2025 projections, by age group. While the two projections are similar, there are some differences. The differences are likely due to the fact that the base year of the Census Bureau's 2025 projections predates the 2020 Census (projection accuracy decays over time). The Census Bureau's projections also predate the pandemic and the recent escalation in the rate of overdose deaths.

To get a sense of accuracy, it is useful to compare the Census Bureau's 2020 projections for Non-Hispanic Black men with the Census Bureau's 2020 actual counts. By age group, the Census Bureau's 2020 projections undercounted men aged 19-30 by 6%, men aged 31-47 by 4%, and men aged 48-64 by 1%. (Figure S1 shows the differences across the age continuum.) Certainly, the undercount of 48-64 year-olds would have been larger but for the pandemic. The Census Bureau reports that new projections are currently in development.

Table S1. US Census Bureau projections* compared to current projections, rounded to 1,000

	Ages 19-30	Ages 31-47	Ages 48-64
2025 population (Census Bureau projections)	3,686,000	5,090,000	3,887,000
2025 population (current projections)	3,830,000	5,123,000	3,743,000
increase/decrease from CB projections	-144,000	-33,000	144,000
% increase/decrease from CB projections	-4%	<1%	4%

* U.S. Census Bureau. National Population Projections: United States by Age, Gender, Ethnicity and Race for years 2014-2060. Accessed at http://wonder.cdc.gov/population-projections-2014-2060.html on Oct 2, 2022

Figure S1. Census Bureau's 2020 population counts vs. Census Bureau's 2020 projections
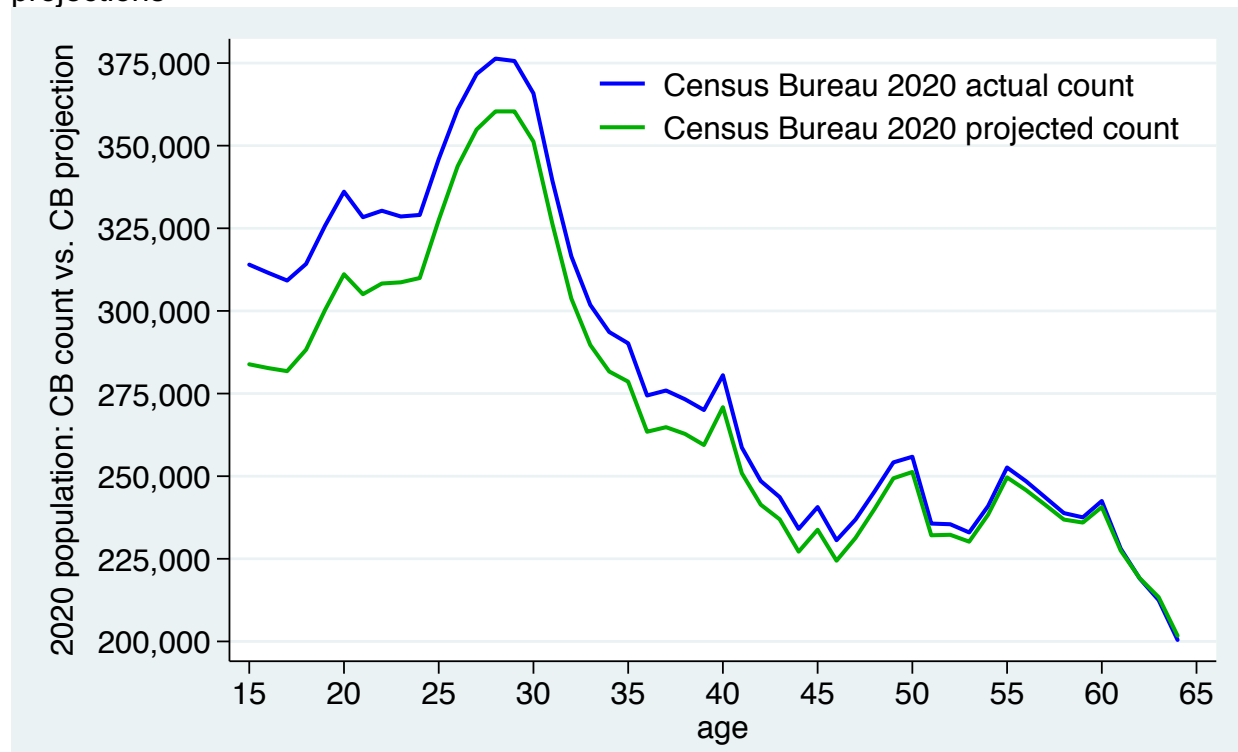
Source: U.S. Census Bureau. National Population Projections: United States by Age, Gender, Ethnicity and Race for years 2014-2060. Accessed at http://wonder.cdc.gov/population-projections-2014-2060.html on Oct 2, 2022

II – CDC WONDER mortality data, ICD-10 codes, smoothing, statistical software

1. Total drug overdose mortality counts for the 2015-2020 period were obtained from the CDC WONDER platform. Data are from the Multiple Cause of Death Files, 1999-2020, which include both population counts and counts of overdose fatalities. Accessed at http://wonder.cdc.gov/mcd-icd10.html.

2. Provisional 2021 overdose mortality rates were obtained from the CDC WONDER platform, Provisional Multiple Cause of Death file.
Accessed at http://wonder.cdc.gov/mcd-icd10-provisional.html.

3. Rates were calculated as total drug overdose deaths per 100,000 population, according to mid-year population. The exception was 2021 where the CDC used the 2020 census count.

4. Drug overdose deaths were identified by the following ICD-10 codes:

   X40 (Accidental poisoning by and exposure to nonopioid analgesics, antipyretics and antirheumatics)

   X41 (Accidental poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified)

   X42 (Accidental poisoning by and exposure to narcotics and psychodysleptics [hallucinogens], not elsewhere classified)

   X43 (Accidental poisoning by and exposure to other drugs acting on the autonomic nervous system)

   X44 (Accidental poisoning by and exposure to other and unspecified drugs, medicaments and biological substances)

   X60 (Intentional self-poisoning by and exposure to nonopioid analgesics, antipyretics and antirheumatics)

   X61 (Intentional self-poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified)

   X62 (Intentional self-poisoning by and exposure to narcotics and psychodysleptics [hallucinogens], not elsewhere classified)

   X63 (Intentional self-poisoning by and exposure to other drugs acting on the autonomic nervous system)

   X64 (Intentional self-poisoning by and exposure to other and unspecified drugs, medicaments and biological substances)

X85 (Assault by drugs, medicaments and biological substances)

Y10 (Poisoning by and exposure to nonopioid analgesics, antipyretics and antirheumatics, undetermined intent)

Y11 (Poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified, undetermined intent)

Y12 (Poisoning by and exposure to narcotics and psychodysleptics [hallucinogens], not elsewhere classified, undetermined intent)

Y13 (Poisoning by and exposure to other drugs acting on the autonomic nervous system, undetermined intent)

Y14 (Poisoning by and exposure to other and unspecified drugs, medicaments and biological substances, undetermined intent)

5. Population and mortality curves were smoothed using Tukey's nonparametric 3RSSH3 procedure. See John W. Tukey. Exploratory Data Analysis. Addison-Wesley, 1977.

6. Statistical analyses were conducted using Stata software version 17.2 (StataCorp, College Station, Texas, USA).

III – Interrupted time series analysis (ITSA) of drug overdose deaths, before and after the COVID-19 onset, to project 2025 deaths by age group

To provide an alternative to the naïve forecast, we used interrupted time series analysis (ITSA) to model the overdose death trends before and after the onset of COVID-19 in March/April 2020. We used ITSA because there was an abrupt increase in overdose deaths in March/April 2020, and this change in level has persisted. ITSA is designed to analyze both change in level and change in trend lines (slopes). Using the ITSA estimates, we extrapolated trend lines for the three age groups (Black men 19-30, 31-47, and 48-64) through December 2025. We used Stata version 16 (StataCorp) procedure ITSA to estimate the regression parameters. We used the Akaike information criterion (AIC) to adjust for autocorrelation in the time series.

The standard ITSA regression model takes the form:

$$Y_t = B_0 + B_1 T_t + B_2 X_t + B_3 X_t T_t + e_t$$

where

Y_t is the outcome variable measured at each time point t

T_t is the time since the start of the study

X_t is a dummy variable representing the intervention (pre-intervention periods 0, otherwise 1)

$X_t T_t$ is an interaction term

B_0 is the intercept

B_1 is the slope prior to COVID-19 onset in March/April 2020

B_2 is the change in the level of the outcome variable immediately following the onset of COVID-19

B_3 is the difference between the pre- and post-intervention slopes of the outcome, and

e_t is the error term.

Below we display the pre- and post-COVID-19-onset data series (Figures S2-S4) and report the ITSA parameter estimates with Newey-West standard errors. We focus on the shift in the level of fatal drug overdoses that occurred with COVID-19 and the change in slope after the onset of the pandemic. Our model extrapolates the post-onset intercept and slope through 2025.

Ages 19-30

Figure S2. Trends in overdose deaths before and after the onset of COVID-19 among Black men ages 19 to 30. Red trend lines are ITSA estimates and blue data points are overdose death counts obtained from the CDC Wonder database.
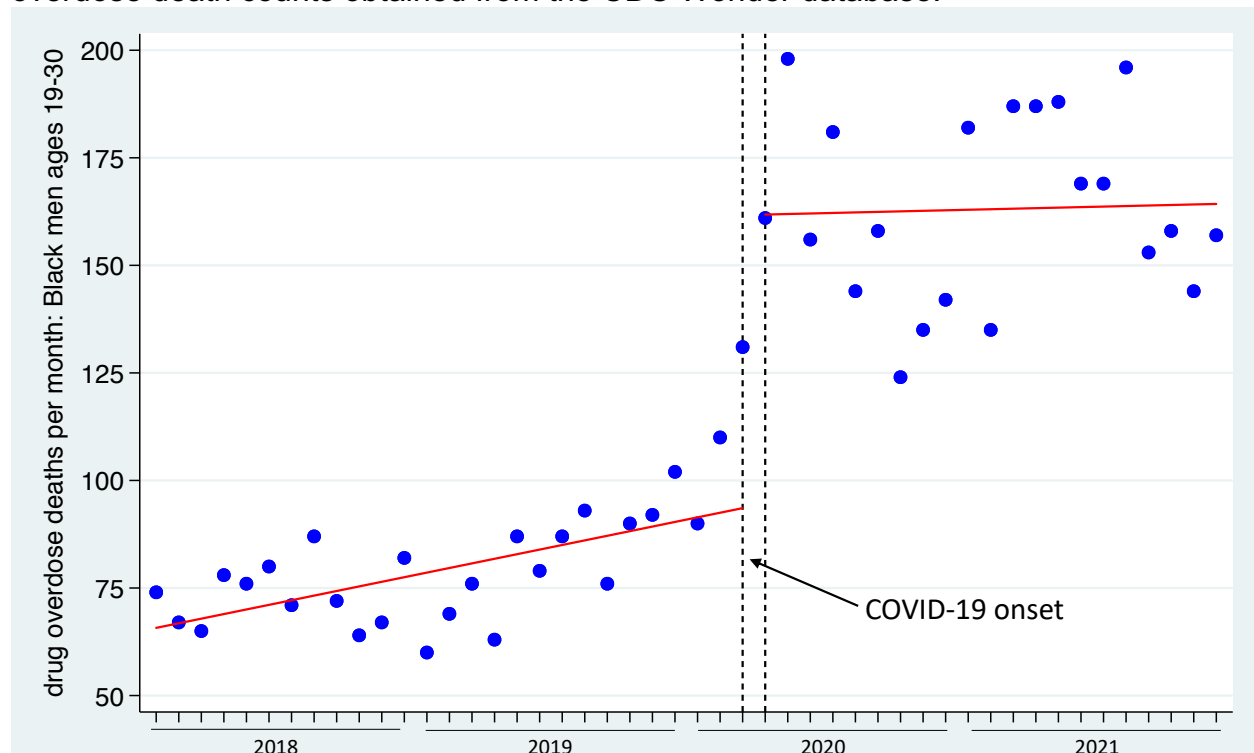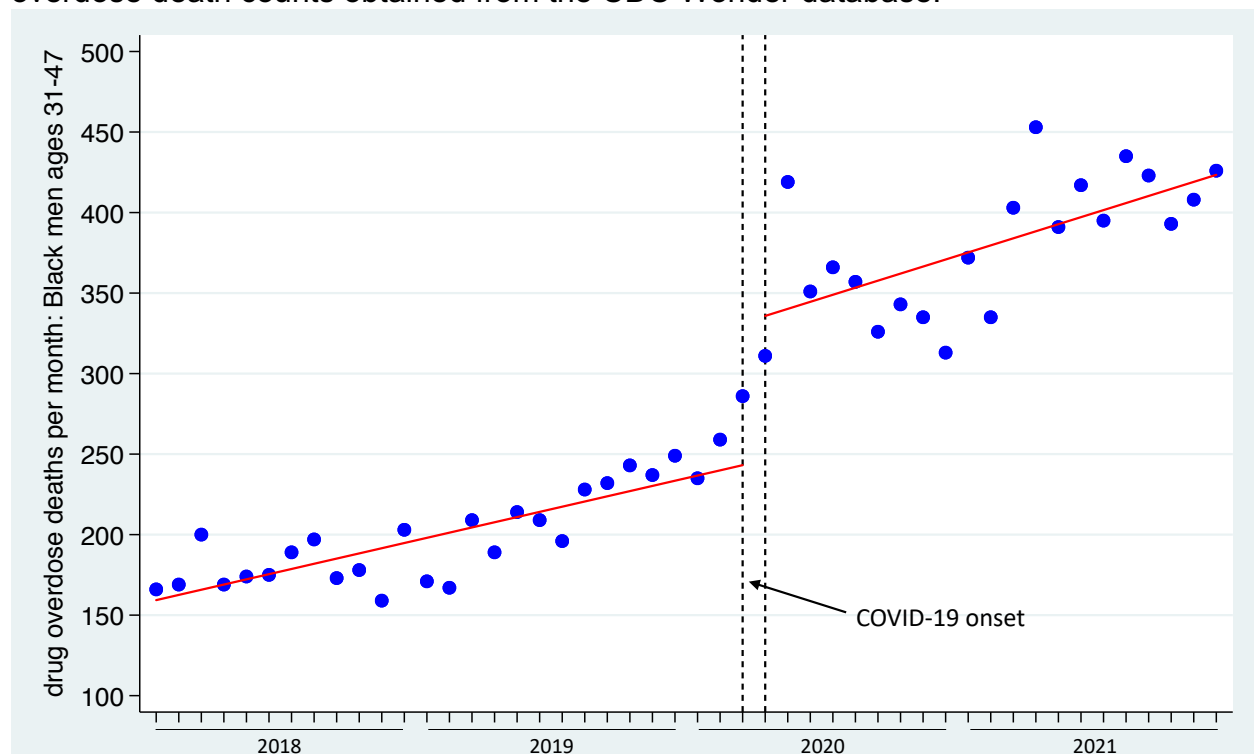

Before March/April 2020, ITSA-estimated overdose deaths were increasing by 1.07 per month (95% CI, 0.55 to 1.59; P<0.001). Deaths increased by 68.1 (95% CI, 36.9 to 99.4; P<0.001) deaths in March/April 2020. The slope was nearly flat at 0.12 deaths per month (95% CI, −1.46 to 1.70; P = 0.876) after April 2020. Extending the post-COVID

intercept and slope through December 2025, the projected number of deaths in 2025 is

2,040 (rounded). Adjusting for the anticipated population change among 19-30 year olds,

the projected number of deaths is 1,880, approximately 60 more deaths than in 2020.

Ages 31-47

Figure S3. Trends in overdose deaths before and after the onset of COVID-19 among Black men ages 31 to 47. Red trend lines are ITSA estimates and blue data points are overdose death counts obtained from the CDC Wonder database.
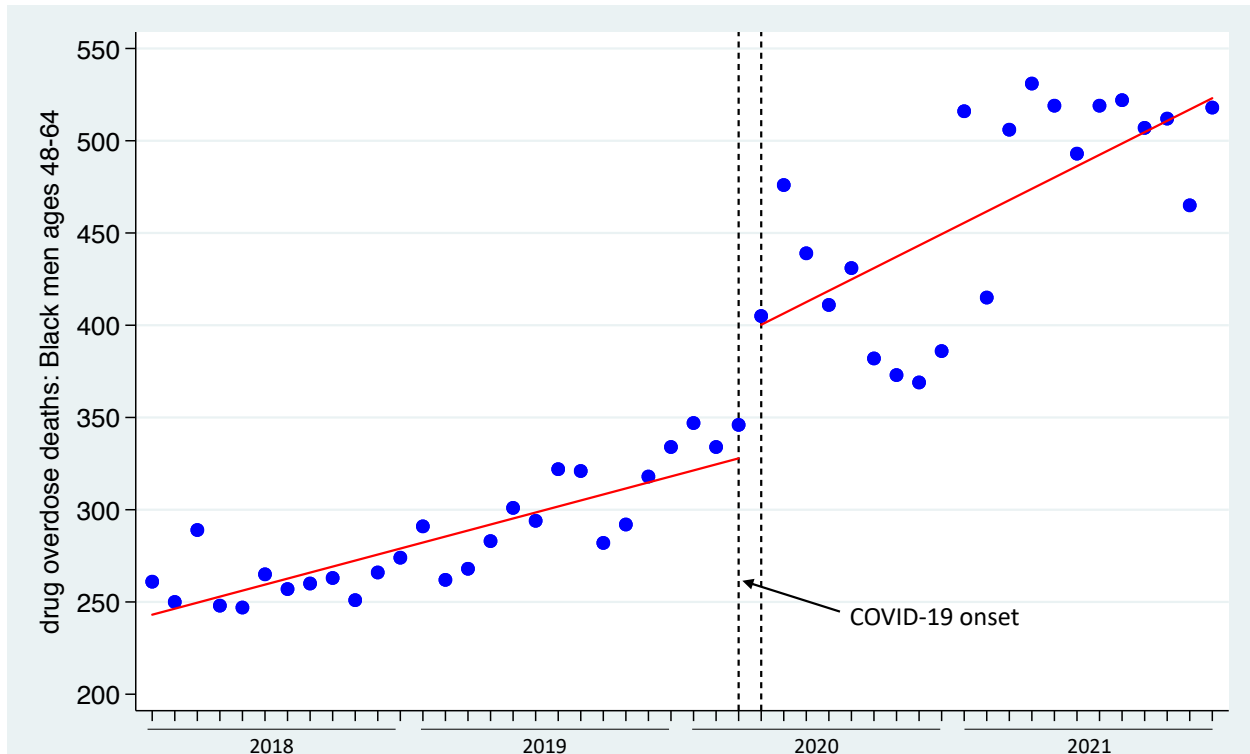

Before March/April 2020, ITSA-estimated overdose deaths were increasing by

3.22 per month (95% CI, 2.26 to 4.12; P<0.001). Deaths increased by 88.3 (95% CI, 39.0

to 138.6; P<0.001) deaths in March/April 2020. The slope was increasing at 4.38 deaths

per month (95% CI, 2.16 to 6.61; P<0.001) after April 2020. Extending the post-COVID

intercept and slope through December 2025, the projected number of deaths in 2025 is

7,260 (rounded). Adjusting for the anticipated population change among 31-47 year olds, the projected number of deaths is 8,070, about 4,110 more deaths than in 2020.

Ages 48-64

Figure S4. Trends in overdose deaths before and after the onset of COVID-19 among Black men ages 48 to 64. Red trend lines are ITSA estimates and blue data points are overdose death counts obtained from the CDC Wonder database.

Before March/April 2020, ITSA-estimated overdose deaths were increasing by 3.26 per month (95% CI, 2.10 to 4.42; P<0.001). Deaths increased by 66.3 (95% CI, -3.30 to 135.8; P = 0.06) deaths in March/April 2020. The slope was increasing at 6.14 deaths per month (95% CI, 2.82 to 9.46; P = 0.001) after April 2020. Extending the post-COVID intercept and slope through December 2025, the projected number of deaths in 2025 is 9,330 (rounded). Adjusting for the anticipated population change among 48-74

year olds, the projected number of deaths is 8,850, about 4,130 more deaths than in 2020.

The difference between the ITSA-projected number of deaths in 2025 and the count of actual deaths in 2020, by age group, are presented in Table 1 and displayed in Figure 3.

IV – Naïve forecast adjusting for intervention programs designed to mitigate the national drug overdose crisis

Federal, state, and local governments are increasingly committed, through policy initiatives and funding, to expanding access to drug prevention, treatment, and harm reduction services. The efforts have yielded an unprecedented range and number of programs across the nation. As a comparison forecast, we project the effect of reducing overdose deaths by 3 percent per year due to these intervention efforts. Over 4 years (2022-2025), this amounts to an 11.5% reduction in each of the age groups relative to the naïve forecast.

The value of 3% per year was chosen as it was comparable to the observed estimated annual percent change in cancer (2.8%) and heart disease (2.5%) deaths in Black men.* Reductions in cancer and heart disease mortality represent the result of substantial efforts in both prevention and treatment, and we posit that a 3% per year reduction of overdose deaths from their projected rate could reflect equally concerted efforts in preventing overdose mortality. Figure 3 shows the impact of the 3% mitigation forecast, together with the naïve forecast and the ITSA-based projections, relative to observed deaths in 2020.

_____

* Best AF, Haozous EA, Berrington de Gonzalez A, Chernyavskiy P, Freedman ND, Hartge P, Thomas D, Rosenberg PS, Shiels MS. Premature mortality projections in the USA through 2030: a modelling study. Lancet Public Health. 2018 Aug;3(8):e374-e384. doi: 10.1016/S2468-2667(18)30114-2.

V - The shape of the drug overdose mortality curve with respect to age was stable over time; comparison of the overdose mortality curves of Black and White men

Figure S5. Raw and smoothed age-overdose mortality curves, 2017-2020.
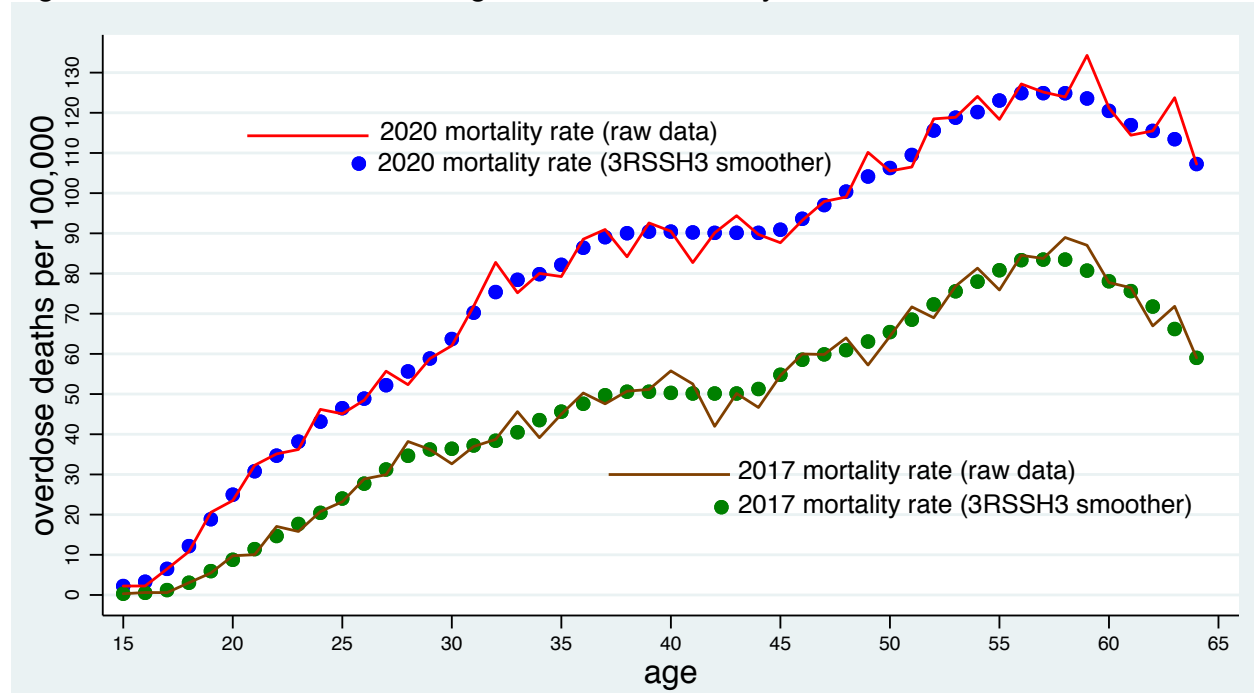
The higher amplitude of the 2020 series sets in around age 18 and accelerates again at around age 30 (Figure S5). Thereafter, the two series appear to run in parallel.

In addition to visual inspection, we examined the statistical association of the yearly mortality rates (Table S2).

Table S2. Pearson correlation matrix for raw and smoothed mortality rates, 2017-2021, Black male individuals, ages 15-64.*

	raw data				smoothed data			
	2018	**2019**	**2020**	**2021**	**2018**	**2019**	**2020**	**2021**
2017	0.96	0.97	0.98	0.97	0.99	0.99	0.99	0.98
2018		0.97	0.97	0.96		0.99	0.99	0.98
2019			0.97	0.97			0.99	0.98
2020				0.98				0.99

*For the 2021 provisional data, the age range was 17-64 as the CDC
  suppressed the values for ages 15 and 16 because n's <10 persons.

Comparison of the drug overdose mortality curves of Black and White men.

As a point of interest, we provide a graph comparing the drug overdose mortality curves of Non-Hispanic Black and White men. The mortality curves are very different (Figure S6), suggesting a different array and balance of risk and protective factors over the life cycle. Among White men, the death rate peaks around age 39 and then declines. Among Black men, the death rate continues to increase through the 40's and 50's and peaks around age 59. Note, too, the death rate is higher among younger White men than younger Black men, but much greater among older Black men than older White men.

Figure S6. 2020 age-specific overdose deaths per 100,000 among non-Hispanic Black (red curve) and non-Hispanic White (blue curve) men in five-year age groups.
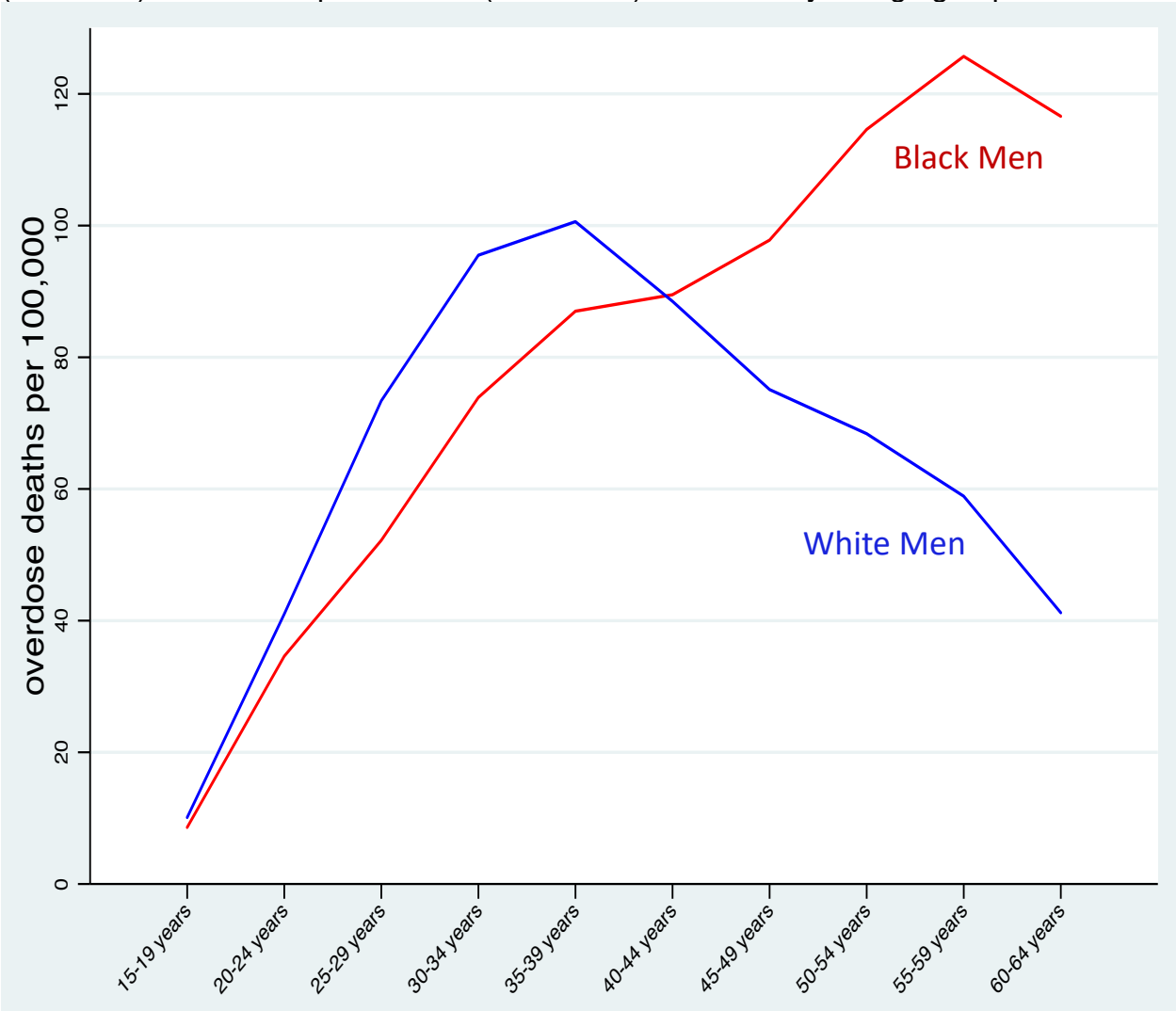
VI - Cohort effects were not observed

Visual inspection of the data series (Figure S7) does not reveal an upward or downward cohort trend (no red arrows slanting right by about 3 data points), that would make one or more of the generations consistently higher or lower than the others. The black arrow at age 30 shows the point at which the 2020 mortality rate separates most noticeably from the 2017 rate, which accounts for most of the period (difference in amplitude) effect, after which the two series run in parallel.

Figure S7. Comparison of 2017 and 2020 inflection points in the age-overdose mortality curves.
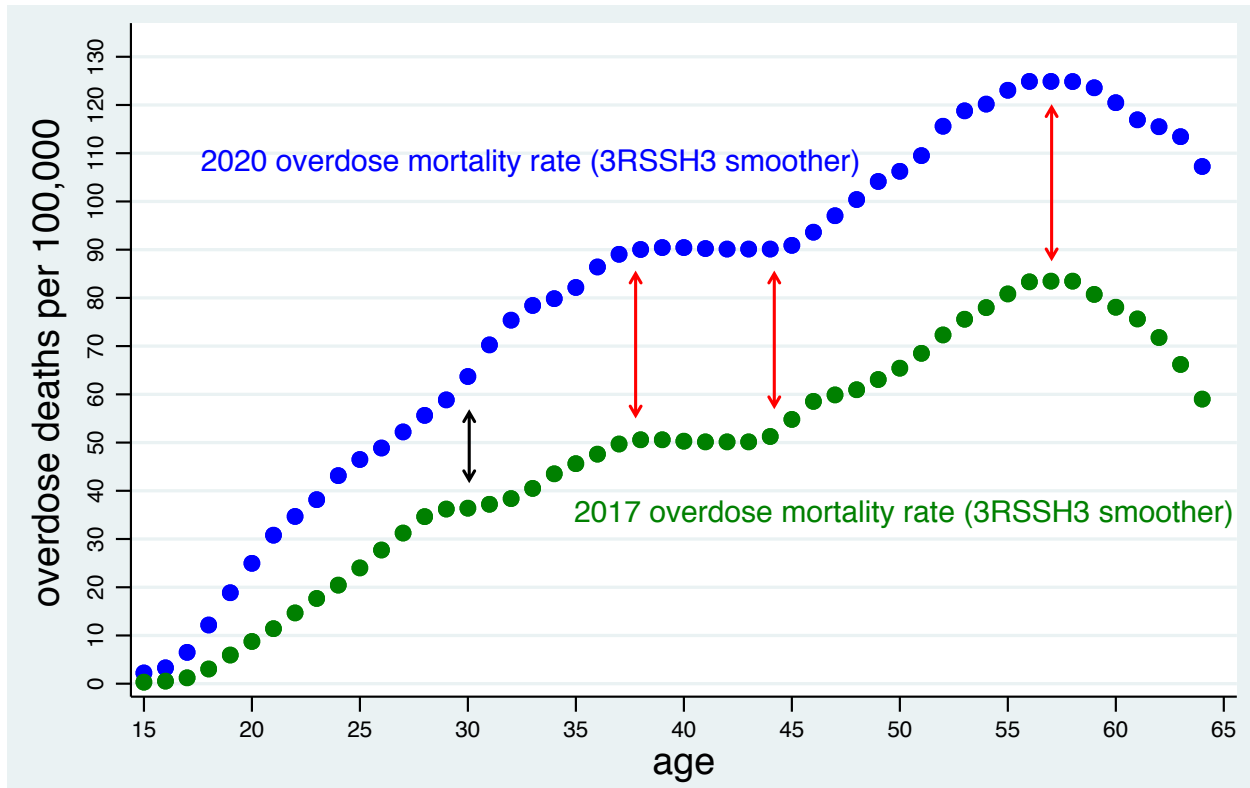
VII – Projected number of drug overdose deaths by age in 2025

To determine the expected number of age-specific drug overdose deaths in 2025, we applied the 2020 overdose mortality rates to the projected 2025 population (data smoothed using Tukey's 3RSSH3 procedure). To calculate the increase (decrease) in overdose deaths, we subtracted 2020 observed from 2025 projected deaths (Table S3).

Table S3. Projected increases/decreases in drug overdose deaths by age from 2020 to 2025 deaths among Black male individuals, ages 15-64.

Age	2020 Drug Overdose Mortality Rate	2020 Drug Overdose Deaths	2025 Projected Population	2025 Projected Overdose Deaths	Projected Deaths in 2025 minus Actual Deaths in 2020
15	2.2	7	314,428	7	0
16	3.3	7	317,889	10	3
17	6.5	20	317,696	21	1
18	12.2	34	316,425	39	5
19	18.9	67	313,585	59	-8
20	25.0	79	310,373	77	-2
21	30.8	106	312,211	96	-10
22	34.7	116	312,211	108	-8
23	38.2	119	311,570	119	0
24	43.1	152	318,396	137	-15
25	46.5	156	322,564	150	-6
26	48.9	175	323,417	158	-17
27	52.2	207	323,370	169	-38
28	55.6	197	323,483	180	-17
29	58.9	221	327,804	193	-28
30	63.7	227	339,306	216	-11
31	70.3	244	359,899	253	9
32	75.4	262	362,832	274	12
33	78.4	227	365,591	287	60
34	79.8	235	365,224	292	57
35	82.2	230	354,329	291	61
36	86.4	243	332,714	288	45
37	89.0	251	310,848	277	26
38	90.0	230	296,092	267	37
39	90.4	250	287,091	260	10
40	90.4	254	280,235	253	-1
41	90.2	214	271,122	245	31
42	90.1	224	266,642	240	16
43	90.1	230	265,049	239	9
44	90.1	210	263,451	237	27
45	90.9	211	259,139	236	25
46	93.6	215	249,412	234	19
47	97.0	232	240,384	233	1
48	100.4	243	233,815	235	-8
49	104.1	280	229,493	239	-41
50	106.3	270	226,743	241	-29
51	109.5	251	236,883	259	8
52	115.6	279	223,685	259	-20
53	118.8	277	222,777	265	-12
54	120.2	299	221,006	266	-33
55	123.1	299	219,753	270	-29
56	124.9	316	218,335	273	-43
57	124.9	305	235,713	294	-11
58	124.9	296	215,727	269	-27
59	123.6	319	218,045	269	-50
60	120.5	294	246,601	297	3
61	116.9	261	218,731	256	-5
62	115.5	253	214,142	247	-6
63	113.4	263	207,133	235	-28
64	107.3	215	204,200	219	4
Total		10,572	14,027,564	10,537	-35