Racial/ethnic disparities in parental loss due to drugs and firearms in the United States,1999 - 2020

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Introduction

In 2022, 108,500 Americans died of drug overdose, an increase of 52% since 2019. Concurrently, there were 48,83 firearms-related deaths in 2021, an 8% increase from 2020. Recently, both drug- and firearm-related mortality has increased among children and adolescents, becoming the number one and number three most common cause of death in this group, respectively (1).

In addition to the direct impacts of mortality, children are potentially doubly affected by drug- and firearm-related mortality through the loss of a parent, which has been associated with negative mental health outcomes (2). Further, substantial racial/ethnic disparities in mortality translate to vastly different exposure to parental loss, contributing to the cumulative racial disadvantage (3). Despite the public health significance, national estimates of parental loss due to drugs and firearms remain unknown.

Here, we use demographic projection methods to estimate parental loss due to drugs and firearms by race and ethnicity.

Methods

Using publicly available death certificate data, and corresponding bridged-race estimates, from the National Center for Health Statistics (NCHS), we calculated age-, sex-, and race/ethnicity-

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specific mortality rates for drugs, firearms, and all other causes from 1990 through 2020. Birth counts and age-specific fertility rates by race/ethnicity were obtained from the NCHS.

To estimate cause-specific parental loss, we used a kinship matrix projection model (eMethods), which uses demographic methods to project mortality and fertility rates into populations based on familial relationships (4). We produce estimates for the number and percent of children, those less than 18 years of age, losing at least one parent over the period 1999-2020, by race/ethnicity and cause of death.

Results

Between 1999 and 2020, 673 thousands (95% CI: 665 to 681) children experienced parental loss due to drugs and 390 thousands (95% CI: 384 to 396) due to firearms (Figure 1). Over this time period, the number of children who experienced parental loss increased 300% due to drugs and 30% due to firearms (Table 1).

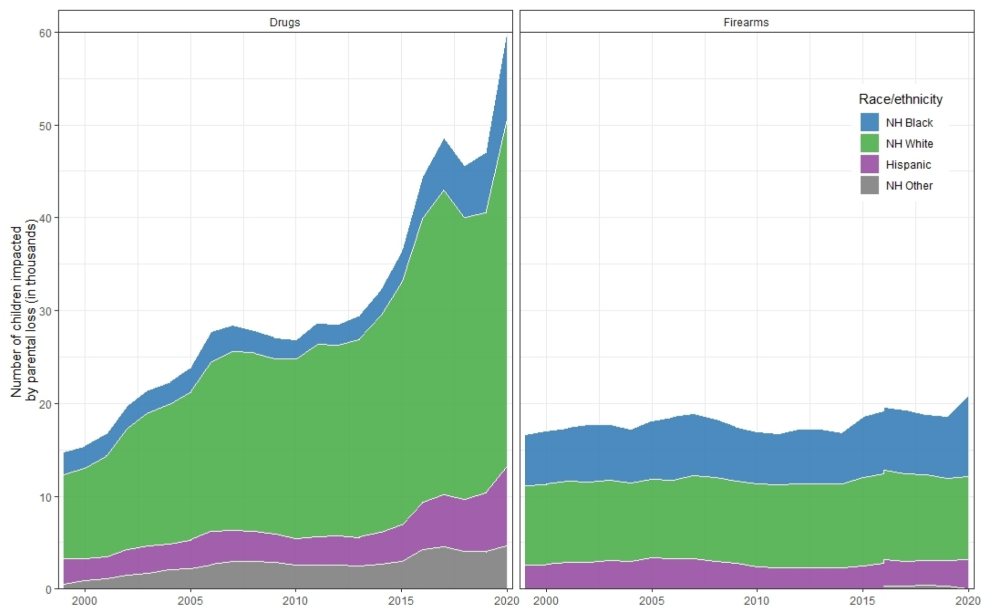

Figure 1: Number of children losing at least one parent due to drugs or firearms, 1999-2020

Overall, non-Hispanic White children were most impacted; however, non-Hispanic Black children experienced a disproportionate burden. For example, in 2020, 3.4% of non-Hispanic Black children experienced parental loss due to drugs and firearms combined compared to 2.5% of non-Hispanic White children and 1.4% of Hispanic children (Table 1). The percentage of children who lost a parent due to drugs has increased for all race/ethnic groups, with a marked acceleration beginning in 2015, resulting in 2.0% of all non-Hispanic White children and 1.8% of all non-Hispanic Black children experiencing parental loss from drugs in 2020. Parental loss due to guns has remained relatively flat across all racial/ethnic groups with the exception of non-Hispanic Black children who experienced an increase in 2020.

Discussion

Over the period 1999-2020, we estimated that over one million children experienced parental loss due to drugs or firearms. Recent years showed an increase in the number of children experiencing parental loss due to drugs, most pronounced for the non-Hispanic Black population. The loss of kin has been shown to have educational, economic, psychological, and medical implications for children (2, 3, 5, 6), and has implications for those children who may require support from the foster care system. Death by both drugs and firearms are socioeconomically patterned, reflecting the US' deep history of gun culture and structural exclusion of groups from economic opportunity. Parental loss from these causes may be one way in which racial/ethnic disparities are transmitted across generations and interventions designed to address drugs, firearms, and their corresponding inequities must consider the indirect impact these deaths have on families as well.

This study is subject to several limitations. Our estimate does not reflect an empirical estimate but a demographic projection based on vital statistics, which makes the assumption that the age distribution of parents is assumed to be independent of their cause of death. Race and ethnicity recording on death certificates are prone to misclassification. Because multiracial fertility rates do not exist, we used models stratified by race/ethnicity, which does not reflect the demographic reality of many Americans.

	Parental loss due to drugs								Parental loss due to firearms							
	1999			2020			1999 through 2020		1999			2020			1999 through 2020	
	Estimated parental loss (in thousands)	Births (in thousands)	%	Estimated parental loss (in thousands)	Births (in thousands)	%	Cumulative (95% CI) (in thousands)	Percent increase	Estimated parental loss (in thousands)	Births (in thousands)	%	Estimated parental loss (in thousands)	Births (in thousands)	%	Cumulative (95% CI) (in thousands)	Percent increase
NHW	9.1 (8.9 - 9.2)	2346	0.4	37.3 (36.9 - 37.6)	1843	2	456 (449.9 - 462)	4.1	8.6 (8.4 - 8.8)	2346	0.4	9 (8.8 - 9.2)	1843	0.5	196 (192.1 - 200)	1.0
NHB	2.5 (2.3 - 2.6)	589	0.4	9.5 (9.3 - 9.7)	530	1.8	75.3 (72.6 - 78)	3.9	5.5 (5.3 - 5.6)	589	0.9	8.6 (8.4 - 8.8)	530	1.6	137.3 (133.5 - 141.2)	1.6
Hispanic	2.7 (2.6 - 2.8)	764	0.4	8.5 (8.3 - 8.7)	867	1.0	82.7 (79.5 - 85.9)	3.1	2.6 (2.4 - 2.7)	764	0.3	3.2 (3.1 - 3.3)	867	0.4	60.9 (58.2 - 63.7)	1.2
Total	14.8 (14.5 - 15)	3959	0.4	60 (59.5 - 60.4)	3614	1.7	673.1 (665.2 - 681)	4.1	16.3 (16 - 16.6)	3959	0.4	20.8 (20.5 - 21)	3614	0.6	389.9 (384 - 396)	1.3

Table 1: Number and percent of children losing a parent, 1999 -2020.

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Supplemental materials

Data

In order to estimate parental loss by cause of death, we required death counts by cause, fertility rates, and population counts, stratified by age, sex, and race/ethnicity.
We used publicly available multiple causes of death data from January 1, 1990, through December 31, 2020, from the National Center for Health Statistics (1). We differentiated firearms-, drugs-related, and all other causes of death. We tabulated cause-specific deaths for all ethnic groups by one-year age classes (i.e., 0, 1, 2, …, 85+). The ethnic groups considered were non-Hispanic Black, non-Hispanic White, Hispanic, and Total, the latter referring to all Americans of any ethnicity. The US Census were used to obtain the corresponding population estimates (denominators for death rates by ethnic group) (2). Birth counts and age-specific fertility rates were based on the birth certificates, also obtained from the National Center for Health Statistics (3,4).

Matrix Kinship Model

We used the kinship matrix model developed by Caswell and colleagues (5). This methodology builds on the fact that any type of kin of a randomly chosen individual can be seen as a population. Hence, this specific population can be modeled using the traditional deterministic projection method, sharing similarities with the cohort-component projection model (6). The kin type we focused on was the parent (mother and father). The model combined several extensions to use time-varying and sex-differentiated vital rates while accounting for death from multiple causes (7,8,9). The parents' dynamics can be expressed as follows

$$\begin{pmatrix} \mathbf{d}_L^f \\ \mathbf{d}_L^m \\ \mathbf{d}_D^f \\ \mathbf{d}_D^m \end{pmatrix}(x+1, t+1) = \begin{pmatrix} \mathbf{U}_t^f & \mathbf{0} & \multicolumn{2}{c}{\mathbf{0}} \\ \mathbf{0} & \mathbf{U}_t^m & & \\ \mathbf{M}_t^f & \mathbf{0} & \multicolumn{2}{c}{\mathbf{0}} \\ \mathbf{0} & \mathbf{M}_t^m & & \end{pmatrix} \begin{pmatrix} \mathbf{d}_L^f \\ \mathbf{d}_L^m \\ \mathbf{d}_D^f \\ \mathbf{d}_D^m \end{pmatrix}(x, t)$$

where the matrix $\mathbf{U}_t$ of dimension $(\omega \times \omega)$ contains the survival probabilities on its main subdiagonal; the matrix $\mathbf{M}_t$ of dimension $(\alpha\omega \times \omega)$ contains the probabilities of dying from the causes considered on its main diagonals; $\mathbf{d}_L$ refers to the age distribution of the parent living and $\mathbf{d}_D$ reflects the age distribution of the parent dying by cause, in year t when a child is aged x; upper scripts f and m corresponds to female and male, respectively; subscript t refers to the year; $\omega = 86$ which was the number of ages considered and $\alpha = 3$ as we considered three different causes of death: drugs, firearms, and all other causes combined. The block matrix on the right-hand side allows to project the parents' age distribution (alive or dead) over time, as their child ages. Note that the child's ages considered here are from birth to 18 years old (the age limit to enter foster care). The model is fit on each race/ethnic group separately.

The model requires as input the age distribution of parents of offspring (7). We assumed that in a given year t, both parents were alive at the time of birth and the age distribution of parents at the birth of their child (when $x = 0$) is expressed as $\boldsymbol{\pi}_\mathbf{t} = \frac{\mathbf{f}_t \circ \mathbf{n}_t}{||\mathbf{f}_t \circ \mathbf{n}_t||}$, where $\mathbf{f}_t$ is a vector of dimension $(\omega \times 1)$ containing age-specific fertility rates and $\mathbf{n}_t$ is a vector of dimension $(\omega \cdot 1)$ being the age distribution of the overall population. Hence, at the birth of a child in year t,

$$\begin{pmatrix} \mathbf{d}_L^f \\ \mathbf{d}_L^m \\ \mathbf{d}_D^f \\ \mathbf{d}_D^m \end{pmatrix}(0,t) = \begin{pmatrix} \boldsymbol{\pi}_\mathbf{t}{}^f \\ \boldsymbol{\pi}_\mathbf{t}{}^m \\ \mathbf{0} \\ \mathbf{0} \end{pmatrix}$$

The model differentiates between female and male fertility, where male fertility has been modeled. Age-specific fertility rates for males consist of shifted age-specific fertility rates for females, where the shift equals the difference in the mean age at childbearing between the two genders. Hence, we assumed the two gender's fertility have a similar intensity but differ in tempo (10).

In order to obtain reasonable estimates of the age distribution of parents in 2000, we started the parents' dynamics in 1990 but cause-specific mortality by ethnic group was not available for the period 1990-1998. During this period, we simplified the block-matrix to only contain survival probabilities, meaning that we only projected the age distribution of parents alive before 1999 ($\mathbf{M}_t = \mathbf{0}$ for $t < 1999$). We additionally recorded the age distribution of parents dying by cause from 1999 onward. As it is commonly done in these models, before 1990, we assumed that the earliest available rates have been operating for a long time (stable population assumption).

Two metrics — obtained using outputs from the parents' dynamics — were of particular interest. First, the probability of bereavement of a randomly selected child in the population was approximated by

$$\text{Prob.(at least one parent death)}(x,t) = 1 - (1 - d_t/2)^2$$

where d_t represents the mean number of dead parent at age x of their child in year t (9). Second, the number of children aged less than 18 years old losing a parent in year t (CLP_t). We computed it as follows

$$CLP_t = \sum_{x=0}^{17} \left(l_{x,t} \cdot B_t\right) \cdot \text{Prob.(at least one parent death)}(x,t)$$

where $l_{x,t}$ corresponds to the fraction of the hypothetical cohort surviving to age x in the period life table for both sex combined in year t (using the same data as for $\mathbf{U_t}$ but not differentiating by sex); and B_t is the number of births recorded in the U.S. in year t. These two metrics were computed separately for each ethnic group.

Incorporating Uncertainty

In order to reflect uncertainty in the kin dynamics, we generalized the Chiang method (11) for multiple causes of death. Let q_x^j, q_x, and D_x be the cause-specific probability of dying for cause $j \in$ {drug, firearm, other} at age x, all-causes probability of dying at age x from the observed life tables, and observed number of deaths at age x, respectively. For each age-class $[x, x+1]$, we assumed that cause-specific deaths were realizations from a Multinomial distribution where the number of trials was equal to the people at risk computed as $\frac{{}_nD_x}{{}_nq_x}$ and the success probabilities for each trial were the probabilities of dying from drugs, firearms, and all other causes. We thus simulated an i-th series of death counts as follows:

$$\mathbf{D_{x,i}} \sim \text{Multinomial}\left(\frac{D_x}{q_x}, q_x^{drug}, q_x^{firearm}, q_x^{other}\right),$$

where $\mathbf{D_{x,i}}$ is the i-th simulated vector of death counts from the three causes considered. Similarly, for the fertility component of the model, we simulated an i-th series of birth counts as follows:

$$Births_{x,i} \sim \text{Poisson}(f_x \cdot N_x),$$

where $Births_{x,i}$ is the i simulated birth count at age x, f_x is the observed fertility rate at age x, and N_x is the observed population aged x.
We repeated this procedure 4,000 times obtaining 4,000 associated life tables, $\mathbf{U_t}$, $\mathbf{M_t}$, and $\boldsymbol{\pi}_\mathbf{t}$ for both sexes which were then used as inputs in the Matrix Kinship Model. We thus obtained 4000 realizations of the different outputs of interest. The medians and 2.5 and 97.5 quantiles of these distributions provided point estimates and 95% confidence intervals for our estimates.

Validation

The age distribution of parent of children is playing a key role in our method. It is the population that is projected with the Matrix Kinship Model. This distribution is however not available by sex and race/ethnic group. As stated above, it was obtained from a weighted distribution of fertility and population age structures for each race/ethnicity combination. In order to validate this assumption, we compared the modeled distributions with empirical estimates obtained using the Current Population Survey and its Fertility and Marriage Supplement collected in June every year. We used the years 2017-2019, and focused on age distribution of parents of children, not differentiating by race/ethnicity, and irrespective of parity.

The survey estimates are plotted in the Figure below and compared against estimates from the model. We concluded that the modeled age distributions of parents used in the model were realistic as compared to survey data.

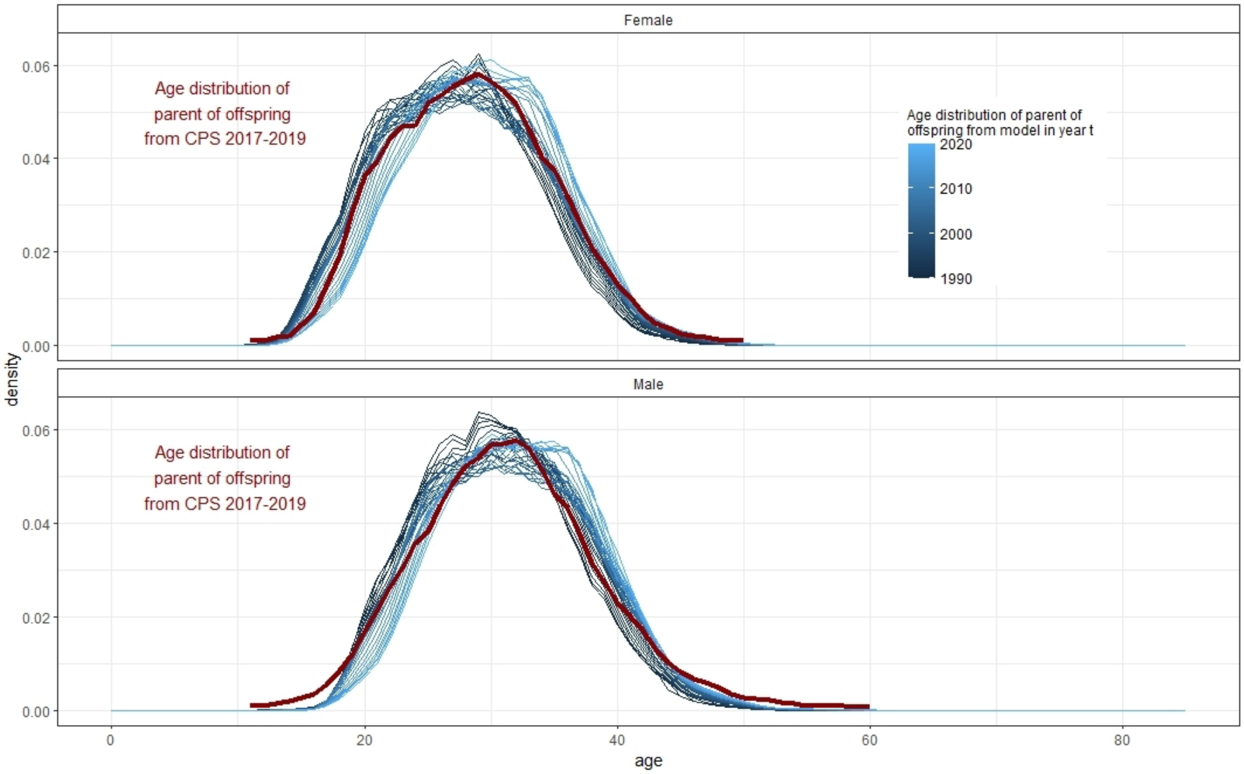

Figure: Comparing the age distribution of parents in Current Population Survey (CPS) to estimates from matrix-based projection model.

References supplemental materials

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