

Supplementary Online Content

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eMethods.

This supplementary material has been provided by the authors to give readers additional information about their work.

eMethods.

A. Data descriptions

a. Participating U.S. states

In this study, we considered mortality data from a total of 14 U.S. states, representing a total population of 106,627,534 Americans. The work presented emerged from an ongoing series of collaborations that we established in Spring 2020, when we reached out to all state departments across the 50 U.S. states. To date, we have received a positive response from 43 DOHs and have successfully executed data sharing agreements with 14 of them, which are included in this study. These 14 states account for 32% of the U.S. population and 33% of its adolescent population, with representation from the ten HHS regions (**Supplementary List 1**). Moreover, data use agreements have been approved and are now pending legal validation in 18 additional states, while our applications are currently underway or in review in the remaining 11 states.

Supplementary List 1. List of U.S. states with available data, by HHS region.

- **Region 1:** Connecticut, Vermont
- **Region 2:** New Jersey
- **Region 3:** Virginia
- **Region 4:** Georgia
- **Region 5:** Indiana, Ohio
- **Region 6:** Arkansas, Oklahoma
- **Region 7:** Nebraska
- **Region 8:** Colorado, Montana
- **Region 9:** California
- **Region 10:** Alaska

b. Death data characterization, by U.S. state

For each of the 14 considered states, details about population demographics as well as about death data sources are provided in **Supplementary List 2**.

Supplementary List 2. Characterization of data sources for each of the 14 considered states. For each state, the following elements are provided: state population (overall, adolescents), data source, date of last data update, number of individual death records (when applicable). With the exception of Georgia, where occurrence deaths were not immediately available for analysis, suicides reflected in this study are occurrence deaths rather than residential deaths. Although the magnitude of occurrence and residential deaths can differ, the geographical mobility of the adolescent population remains limited; thus, for the population of interest, our results are unlikely to be sensitive to this choice.

- **Alaska (AK)**
 - *State population* – Overall: 731,545; Adolescents: 94,176 (12.9%)
 - *Data source*: State DOH, Vital Statistics, (DUA, IRB)
 - *Date of last data update*: 10/27/2021
 - *Number of individual death records*: Over 2015-2020: 27,534
- **Arkansas (AR)**
 - *State population* – Overall: 3,018,000; Adolescents: 397,717 (13.2%)
 - *Data source*: State DOH, Vital Statistics, (DUA, IRB)
 - *Date of last data update*: 10/28/2021
 - *Number of individual death records*: Not applicable (aggregate dataset)
- **California (CA)**
 - *State population* – Overall: 39,510,000; Adolescents: 5,062,831 (12.8%)
 - *Data source*: Publicly available online query tool system at <https://cal-vida.cdph.ca.gov/VSQWeb/>
 - *Date of last data update*: 10/10/2021
 - *Number of individual death records*: Not applicable
- **Colorado (CO)**
 - *State population* – Overall: 5,759,000; Adolescents: 728,987 (12.7%)
 - *Data source*: State DOH, Vital Statistics, (DUA, IRB)
 - *Date of last data update*: 10/29/2021
 - *Number of individual death records*: Not applicable (aggregate dataset)
- **Connecticut (CT)**
 - *State population* – Overall: 3,565,000; Adolescents: 543,134 (15.2%)
 - *Data source*: State DOH, Vital Statistics, (DUA, IRB)
 - *Date of last data update*: 10/25/2021
 - *Number of individual death records*: Not applicable
- **Georgia (GA)**
 - *State population* – Overall: 10,620,000; Adolescents: 1,459,536 (13.7%)
 - *Data source*: Publicly available online query tool system at <https://oasis.state.ga.us/oasis/webquery/qryMortality.aspx>
 - *Date of last data update*: 10/28/2021
 - *Number of individual death records*: Not applicable
- **Indiana (IN)**
 - *State population* – Overall: 6,732,000; Adolescents: 904,788 (13.4%)
 - *Data source*: State DOH, Vital Statistics, (DUA, IRB)
 - *Date of last data update*: 11/08/2021
 - *Number of individual death records*: 419,085 (over 2015-2020)
- **Montana (MT)**
 - *State population* – Overall: 1,069,000; Adolescents: 129,384 (12.1%)
 - *Data source*: State DOH, Vital Statistics, (DUA, IRB)
 - *Date of last data update*: 10/27/2021
 - *Number of individual death records*: 64,335 (over 2015-2020)

- **Nebraska (NE)**
 - *State population* – Overall: 1,934,000; Adolescents: 266,584 (13.8%)
 - *Data source*: State DOH, Vital Statistics, (DUA, IRB)
 - *Date of last data update*: 11/02/2021
 - *Number of individual death records*: Not applicable (aggregate dataset)
- **New Jersey (NJ)**
 - *State population* – Overall: 8,882,000; Adolescents: 1,104,539 (12.4%)
 - *Data source*: Publicly available online query tool system at <https://www-doh.state.nj.us/doh-shad/query/builder/provdth/Mort/Count.html>
 - *Date of last data update*: 10/27/2021
 - *Number of individual death records*: Not applicable
- **Ohio (OH)**
 - *State population* – Overall: 11,690,000; Adolescents: 1,487,578 (12.7%)
 - *Data source*: Publicly available online query tool system at <https://publicappstst.odh.ohio.gov/EDW/DataBrowser/Browse/Mortality>
 - *Date of last data update*: 10/26/2021
 - *Number of individual death records*: Not applicable
- **Oklahoma (OK)**
 - *State population* – Overall: 3,957,000; Adolescents: 535,055 (13.5%)
 - *Data source*: State DOH, Vital Statistics, (DUA, IRB)
 - *Date of last data update*: 04/19/2021
 - *Number of individual death records*: 259,486 (over 2015-2020)
- **Virginia (VA)**
 - *State population* – Overall: 8,536,000; Adolescents: 1,067,063 (12.5%)
 - *Data source*: State DOH, Vital Statistics, (DUA, IRB)
 - *Date of last data update*: 11/05/2021
 - *Number of individual death records*: 400,378 (over 2015-2020)
- **Vermont (VT)**
 - *State population* – Overall: 623,989; Adolescents: 74,274 (11.9%)
 - *Data source*: State DOH, Vital Statistics, (DUA, IRB)
 - *Date of last data update*: 10/18/2021
 - *Number of individual death records*: 34,095 (over 2015-2020)

c. Determination of the underlying cause of death

This study focuses on the underlying cause of death corresponding to each individual vital record. The following ICD-10 codes were considered to characterize intentional self-harm (suicide) as the underlying cause of death: X60–X84 and Y87.0. A detailed definition of each ICD code is provided in **Supplementary List 3**.

Supplementary List 3. Description of individual ICD-10 codes characterizing intentional self-harm (suicide).

- **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, 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.
- **X65:** Intentional self-poisoning by and exposure to alcohol.
- **X66:** Intentional self-poisoning by and exposure to organic solvents and halogenated hydrocarbons and their vapors.
- **X67:** Intentional self-poisoning by and exposure to carbon monoxide and other gases and vapors.
- **X68:** Intentional self-poisoning by and exposure to pesticides.
- **X69:** Intentional self-poisoning by and exposure to other and unspecified chemicals and noxious substances.
- **X70:** Intentional self-harm by hanging, strangulation, and suffocation.
- **X71:** Intentional self-harm by drowning and submersion.
- **X72:** Intentional self-harm by handgun discharge.
- **X73:** Intentional self-harm by rifle, shotgun, and larger firearm discharge.
- **X74:** Intentional self-harm by other and unspecified firearm discharge.
- **X75:** Intentional self-harm by explosive material.
- **X76:** Intentional self-harm by smoke, fire, and flames.
- **X77:** Intentional self-harm by steam, hot vapors, and hot objects.
- **X78:** Intentional self-harm by sharp object.
- **X79:** Intentional self-harm by blunt object.
- **X80:** Intentional self-harm by jumping from a high place.
- **X81:** Intentional self-harm by jumping or lying before moving object.
- **X82:** Intentional self-harm by crashing of motor vehicle.
- **X83:** Intentional self-harm by other specified means.
- **X84:** Intentional self-harm by unspecified means.
- **Y87:** Late effects of intentional self-harm.

B. Definition of confidence intervals used for suicide-related mortality estimates

For each outcome, we compared the pandemic period (2020) to the pre-pandemic period (2015–2019).

For (N, adolescent suicides) and (N, overall suicides)

We used the following 95% confidence interval for the average count of adolescent and overall suicides during the pre-pandemic period (2015–2019).

$$95\% CI = \bar{x} \pm t \frac{s}{\sqrt{n}}$$

\bar{x} : average count of adolescent suicides in baseline years (2015-2019)

s: standard deviation of count of adolescent suicides in baseline years (2015-2019)

n: number of baseline years considered (n=5 in this study)

t: t-statistic for an alpha-level of 0.05 and 4 degrees of freedom (t=2.776)

For the proportion of suicides among adolescents

We used the following 95% confidence interval for the average proportion of suicides among adolescents during the pre-pandemic period (2015–2019).

$$95\% CI = \bar{x} \pm t \frac{s}{\sqrt{n}}$$

\bar{x} : average proportion of suicides among adolescents in baseline years (2015-2019)

s: standard deviation of proportion of suicides among adolescents in baseline years (2015-2019)

n: number of baseline years considered (n=5 in this study)

t: t-statistic for an alpha-level of 0.05 and 4 degrees of freedom (t=2.776)

C. Alternative outcomes

a. Comparison of proportion of adolescent suicides: 2019 versus 2020

As an alternate pre-pandemic period (instead of the 2015–2019 pre-pandemic period presented in our main text), we also compared the proportion of suicides among adolescents in 2020 to the year before (2019), following the approach described in the CDC NVSS Vital Statistics Rapid Release of November 2021 (Report #16: Provisional Numbers and Rates of Suicide by Month and Demographic¹ Characteristics: United States, 2020). This comparison is less subject to trends in shifting burden that may be present in the 5-year period presented in the main text. The directionality remains intact when using 2019 rather than 2015–2019 as a comparator for all states with statistically significant outcomes in the main text (Supplementary List 6).

Supplementary List 6. Comparison of the proportion of suicides among adolescents in 2019 versus 2020 (expressed as a percentage), by state.

- **Alaska (AK)** – 2019: 15.2; 2020: 8.3; % Change: -45.0%
- **Arkansas (AR)** – 2019: 6.0; 2020: 7.0; % Change: 17.0%

¹Note: This CDC NVSS report did not present statistics for our age group of interest (i.e., adolescents aged 10–19), though statistics were presented for 10–14 year-olds and 15–24 year-olds.

- **California (CA)** – 2019: 4.1; 2020: 5.4; % Change: 31.0%
- **Colorado (CO)** – 2019: 7.9; 2020: 7.8; % Change: -1.0%
- **Connecticut (CT)** – 2019: 4.9; 2020: 4.1; % Change: -15.2%
- **Georgia (GA)** – 2019: 5.6; 2020: 7.1; % Change: 26.6%
- **Indiana (IN)** – 2019: 5.0; 2020: 8.2; % Change: 64.8%
- **Montana (MT)** – 2019: 8.6; 2020: 5.4; % Change: -37.0%
- **Nebraska (NE)** – 2019: 6.1; 2020: 7.1; % Change: 16.9%
- **New Jersey (NJ)** – 2019: 4.3; 2020: 5.8; % Change: 34.3%
- **Ohio (OH)** – 2019: 6.5; 2020: 5.5; % Change: -16.0%
- **Oklahoma (OK)** – 2019: 7.7; 2020: 8.0; % Change: 3.8%
- **Virginia (VA)** – 2019: 5.8; 2020: 7.4; % Change: 26.2%
- **Vermont (VT)** – 2019: 5.6; 2020: 6.1; % Change: 9.0%
- **All 14 states** – 2019: 5.7; 2020: 6.5; % Change: 14.0%

b. Rate of suicide among adolescents (per 100k residents)

As an additional alternate outcome, we also determined the rate of suicide among adolescents (aged 10–19) per 100k residents in the 14 states comprised in our cohort. The suicide rate captures both changes in the actual number of suicides among adolescents (numerator) and changes in the adolescent population size (denominator), thereby adjusting for any existing demographic trends. The directionality remains similar when using suicide rate among adolescents as an outcome for suicidality rather than the outcomes presented in the main text (Supplementary List 7).

Supplementary List 7. Comparison of the rate of suicide among adolescents in 2019 versus 2020 (per 100k residents), by state.

- **Alaska (AK)** – 2019: 34.3; 2020: 18.3; % Change: -46.7%
- **Arkansas (AR)** – 2019: 8.3; 2020: 10.3; % Change: 24.5%
- **California (CA)** – 2019: 3.6; 2020: 4.4; % Change: 20.6%
- **Colorado (CO)** – 2019: 13.5; 2020: 14.2; % Change: 5.3%
- **Connecticut (CT)** – 2019: 4.4; 2020: 3.1; % Change: -28.8%
- **Georgia (GA)** – 2019: 6.1; 2020: 7.3; % Change: 19.4%
- **Indiana (IN)** – 2019: 5.3; 2020: 8.7; % Change: 63.4%
- **Montana (MT)** – 2019: 17.0; 2020: 11.5; % Change: -32.2%
- **Nebraska (NE)** – 2019: 7.1; 2020: 7.5; % Change: 5.1%
- **New Jersey (NJ)** – 2019: 2.7; 2020: 3.4; % Change: 24.3%
- **Ohio (OH)** – 2019: 7.9; 2020: 6.1; % Change: -22.9%
- **Oklahoma (OK)** – 2019: 11.8; 2020: 12.6; % Change: 6.1%
- **Virginia (VA)** – 2019: 6.1; 2020: 7.3; % Change: 20.2%
- **Vermont (VT)** – 2019: 6.7; 2020: 8.1; % Change: 21.4%
- **All 14 states** – 2019: 6.0; 2020: 6.5; % Change: 8.7%