CBEM®

CHILDHOOD BEREAVEMENT ESTIMATION MODEL

TECHNICAL APPENDIX

The Childhood Bereavement Estimation Model (CBEM) represents the most comprehensive effort towards quantifying the prevalence of childhood bereavement in the U.S. Addressing limitations of past estimations, the model extends prior research by establishing a theory-based tool incorporating inputs that are customizable geographically, temporally, and relationally. The model generates retrospective (current) and prospective (projected) estimations due to the death of a parent or sibling. Rather than gathering new data, the model combines reputable, existing, population-level data sources to approximate the magnitude of childhood bereavement.

This Technical Appendix describes model enhancements for both annual report and key topic report releases starting in 2020.

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2022 Overview

2022

- There were no changes to the CBEM's quantitative framework in 2022
- Mortality, natality, and population input data updated
    - Five-year cumulative data period updated to 2016-2020 from 2015-2019

2022 Standard National and State Reports

- Incorporating 2020 data means impacts from the first year of the COVID-19 pandemic are captured
    - Significant increase in the number and percentage of children who will be bereaved by age 18 and by age 25

Why did Judi's House/JAG Institute conduct CBEM analyses by race and ethnicity?

2021 KEY TOPIC

RACE & ETHNICITY

- Judi's House/JAG Institute conducted CBEM analyses by race and ethnicity to:
    - Explore and quantify potential differences in childhood bereavement within and across the country and states according to the race or ethnicity of a child and their parents
    - Provide additional detail to complement our 2021 state and national-level bereavement analyses
    - More fully incorporate the detail available in publicly available vital statistics.

How were the reported categories selected?

- CBEM results reflect the race and ethnicity categories available for the years 2015-2019 within the Center for Disease Control and Prevention's WONDER (Wide-ranging ONline Data for Epidemiologic Research, US DHHS, 2020) 1999-2019 Underlying Cause of Death by Bridged Race Categories database.
    - The CDC WONDER database has the following reporting options for race and ethnicity, respectively:
        - **Race**
            American Indian or Alaska Native
            Asian or Pacific Islander
            Black or African American
            White
        - **Ethnicity**
            Hispanic or Latino
            Not Hispanic or Latino
            Not Stated

- Aggregated mortality and population data were extracted for these race and ethnicity categories separately to serve as inputs to the CBEM. The ethnicity category, Not Stated, was not included in analyses because mortality data for this category are not reported with an associated population.

What changes were made to CBEM methods or input variables for the analyses?

- CBEM bereavement results by race and ethnicity assume each child has two adult caregivers (i.e., parents) and that both caregivers are of the same race or ethnicity as the child. Seventy-three percent of all first live births in CDC WONDER's database for the years 2016-2019 were to parents who had the same race. These data were used to calculate the difference in fathers' and mothers' ages used in the analysis (see details below under the description of Father's age at first birth).
- CBEM methodology was not changed to produce bereavement results by race and ethnicity, but input variables were adjusted, where possible, to match the race and ethnicity categories and to accommodate data suppression issues. Specifically:
- Age-based populations and deaths
    - To address data suppression issues with youth mortality data, Judi's House/JAG Institute requested population and mortality data from CDC WONDER for two age groupings for each race and ethnicity category: ages 1-10 and ages 11-17.
    - Population and mortality data for these age groupings were then evenly allocated to each of the single-year age group in the category (e.g., data for ages 1-10 were utilized as input values for single-year age groups of age 1, age 2, age 3 through age 10).
    - Given high rates of mortality for the first year of life, Judi's House/JAG Institute utilized a single-year age group for each race and ethnicity category for this group (i.e., age < 1 year).

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- Mother's age at first birth
    - State and national values for the average age of mothers at first birth by race and ethnicity for 2015-2019 were retrieved from CDC WONDER and used as CBEM inputs.
- Father's age at first birth
    - Judi's House/JAG Institute used the same calculation process described below for the 2021 CBEM reports to calculate the difference in father's and mother's age at first birth using national-level data where the fathers and mothers were of the same race or the same ethnicity category. This process produced national estimates of the difference in father's and mother's age at first birth for the following race categories: *American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, and White*.
    - For consistency with the race categories available in CDC WONDER's mortality database, a weighted average difference from the *Asian and Native Hawaiian* or *Other Pacific Islander* categories was calculated for use with the mortality data for the *Asian or Pacific Islander* category. This process was then repeated for the *Hispanic or Latino* and *Not Hispanic or Latino* categories.
    - Judi's House/JAG Institute utilized national-level differences in mother's and father's age at first birth by race and ethnicity for national and state level analyses given data suppression issues.
    - The national differences in father's and mother's age at first birth by race and ethnicity were added to the values for the average age of mothers at first birth to calculate CBEM input values for the average age of father's at first birth.

Why are state CBEM results for certain categories listed as "Not Reported"?

- To produce reliable, stable estimates, Judi's House/JAG established the following criteria to determine when a race or ethnicity category population in a state would be excluded from the CBEM analysis (based on the 5-years of CDC WONDER data for 2015-2019):
    - An average annual population in the race or ethnicity category for those age 0-60 is less than 30,000
    - For a given race category: A population that represents less than 2.0% of the state's total age 0-60 population
    - For a given ethnicity category: A population that represents less than 2.5% of the state's total age 0-60 population
        - *The criterion for ethnicity has a larger threshold value because there are fewer reporting options for ethnicity compared to race.*
- Race and ethnicity categories that met these criteria were excluded from the state's CBEM analysis and listed as "Not Reported." The race and ethnicity categories in the following states met both exclusion criteria:
    - American Indians or Alaska Natives: *Arizona, Connecticut, Delaware, Washington D.C., Hawaii, Indiana, Iowa, Kentucky, Maine, Mississippi, Nebraska, New Hampshire, Rhode Island, South Carolina, Tennessee, Vermont, West Virginia*
    - Asians or Pacific Islanders: *Maine, Montana, West Virginia, Wyoming*
    - Blacks or African Americans: *Idaho, Montana*
    - Hispanics or Latinos: *Maine, Vermont, West Virginia*

Why are state Leading Causes of Death results for certain categories "Not Reported"?

- CBEM Key Topic: Race and Ethnicity reports include data for the top five leading causes of death for each race and ethnicity category to provide important context to the childhood bereavement results.
- Top five leading causes of death data were not reported under the following conditions:
    - Data were suppressed by CDC WONDER and thus were not available to report
    - CBEM results were not produced given considerations outlined above

Concluding 2021 CBEM Key Topic: Race and Ethnicity considerations

- Judi's House/JAG Institute anticipates that using age groupings to produce population and mortality input data by race and ethnicity categories for children age 1-17 has a small impact on bereavement results compared to using data specific to each single-year age group. The death of a child age 1-17 is relatively rare (hence the suppression issues encountered). Without producing the actual data for each single-year age group for direct comparison it is not possible to conclude whether the use of the age group data increased or decreased sibling bereavement compared to using actual values for each single-year age group.

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- Analyses are constrained to the race and ethnicity categories available in CDC WONDER for mortality and population data for the 5-year period of 2015-2019. There may be additional reporting options available for future analyses as there are additional race categories available in a second CDC WONDER mortality dataset (i.e., 2018-2019: Underlying Cause of Death by Single-Race Categories). Judi's House/JAG Institute will continue exploring all reporting options.

Why was the CBEM enhanced in 2021?

2021

- Judi's House/JAG Institute enhanced the CBEM to:
    - Improve the accuracy of results
    - Make better use of publicly available vital statistics

What was enhanced?

- CBEM input variable: Father's age at first birth
    - As noted in the 2020 section, CBEM calculations assume each child has two adult caregivers (i.e., parents) and requires defining the two caregivers' ages at the time of the child's birth. Although these data link the caregivers' ages to specific genders, the parental bereavement calculations generated by the CBEM are not gender-specific.
    - *Fathers' age at first birth* was previously calculated using a published value for the average difference in age for fathers and mothers (Khandwala, Zhang, Lu, & Eisenberg, 2017). In 2021 Judi's House/JAG Institute replaced this assumption with more recent data on parents' ages from the Center for Disease Control and Prevention's WONDER (Wide-ranging ONline Data for Epidemiologic Research, US DHHS, 2020) system to develop national and state-specific values for the average difference in fathers' and mothers' ages.
    - Judi's House/JAG Institute calculated the average difference in fathers' and mothers' ages at a mothers first live birth with the following information for years 2016-2019 from WONDER's Natality, 2016-2019 expanded dataset (US DHHS, 2020):
        - The number of births with an associated age range for the father
        - The reported average mothers' age for each *Age of Father* category
    - Calculations involved the following steps:
        - Fathers in each category were assigned an average age
            - The midpoint was used for defined range categories (e.g., 22 years for the 20–24 years category)
            - Fathers are assumed to be 15 years old in the *age under 15* category
            - Fathers are assumed to be 55 years old in the *age 55+* category
        - Weighted average ages for mothers and fathers across age categories were calculated using:
            - Total number of births across the *Age of Father* categories
            - Assumed and reported average ages for fathers and mothers, respectively
        - The average mothers' age was subtracted from the average fathers' age to produce the difference in parents ages.
    - Resulting parents' age differences overlap the previously used value of 2.30 years from Khandwala et al. (2017), with a range of 1.98 years (Wisconsin) to 2.78 years (Florida); the national average is 2.35 years.

How do these enhancements impact CBEM results?

- Moving to state-specific estimates of caregiver age has the following net impacts:
    - Estimates of bereavement due to parent death and bereavement due to sibling or parent death ***increase*** in locations where the updated data result in ***older*** first-time parents.
    - Estimates of bereavement due to parent death and bereavement due to sibling or parent death ***decrease*** in locations where the updated data result in ***younger*** first-time parents.

Concluding 2021 CBEM considerations *(as noted in the 2020 section)*

- CBEM results may vary year-to-year reflecting changes in data (e.g., first-time parents getting older, shifts in mortality rates, changing populations).
    - Accordingly, some changes in the 2021 results compared to 2020 would be expected regardless of the model enhancements described above.

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- Annual changes in the national and state results noting "1 in X children will be bereaved..." will, generally, occur less often than changes in the reported percentage of bereaved children.
    - The "X" value changes only when threshold percentage values are crossed because a given "X" value corresponds to a range of results for the percentage of bereaved children.
    - For example, when a report indicates that "1 in 11 children will be bereaved," this can encompass a range from roughly 8.7% to 9.5% of children who will be bereaved. Thus, even if we observe an increase in bereavement from 8.8% to 9.5% across time, the "1 in X" will remain "1 in 11".

2020

Overview

- Judi's House/JAG Institute enhanced the Childhood Bereavement Estimation Model (CBEM) in 2020 to improve its accuracy, expand its analytical scope, and make better use of publicly available vital statistics.
- Judi's House/JAG Institute worked with biostatisticians at the Center for Innovative Design and Analysis at the University of Colorado Anschutz Medical Campus, School of Public Health to plan and implement the CBEM enhancements.
- This document describes CBEM inputs, CBEM enhancements, and the general impact of both.

CBEM Inputs - How did the previous version of the CBEM produce results?

- For a description of CBEM development and historical methodology, see Burns, Griese, King, and Talmi, 2020
- Previously the CBEM calculated childhood bereavement estimates using standard methods and assumptions from the field of survival analysis (e.g., binomial probability distribution and life table methodologies) with available population-specific information.
- Data reflecting the most recent five-year period in the Center for Disease Control and Prevention's (CDC) WONDER databases were used to define the following CBEM input variable values
    - *Population size:* The number of persons in a five-year age group (e.g., 5-9 years old)
    - *Deaths:* Total deaths in the period for each five-year age group
    - *Average annual mortality rate:* Calculated for each five-year age group using the *Population size and Deaths* values
- The five-year data period helped control for inter-annual variability and minimize suppression in requested vital statistics.
- Values for the *Population size, Deaths, and Average annual mortality rate* CBEM input variables were specific to the reporting geography (e.g., national, state).
- The following sources were used to define additional CBEM input variables values
    - CBEM calculations assume each child has two adult caregivers (i.e., parents) and requires defining the two caregivers' ages at the time of the child's birth. Although these data link the caregivers' ages to specific genders, the parental bereavement calculations generated by the CBEM are not gender-specific.
        - *Mothers' age at first birth:* Based on published data for the average age of biological mothers at first childbirth in the U.S. (Martin, Hamilton, Osterman, Driscoll, & Drake, 2018)
        - *Fathers' age at first birth:* Calculated using a published value for the average difference in age for fathers and mothers (Khandwala, Zhang, Lu, & Eisenberg, 2017). This value was combined with the Mothers' age at first birth.
    - *Average number of siblings per child:* Developed from U.S. Census Bureau survey results on the living arrangements of children (U.S. Census Bureau, Economics and Statistics Administration, 2013)

Why was the CBEM enhanced?

- Judi's House/JAG Institute enhanced the CBEM to:
    - Improve accuracy of results,
    - Make better use of publicly available vital statistics to produce more localized (i.e., county-level) results,
    - Establish a robust framework for future model enhancements

What was enhanced?

- Bereavement calculations
    - The CBEM assumptions about modeling mortality data and the specific quantitative approaches were changed to ensure consistency with standard practices in the field of survival analysis while allowing for increased reporting accuracy.
    - The CBEM now produces county level results in addition to national and state level results.

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- CBEM input variables
    - National/State Levels: Population size, Deaths, and Average annual mortality rates at the national and state levels are defined for single-year age groups for the most recent five-year period from CDC WONDER to improve accuracy and limit the need for assumptions in the calculations. This impacts the following CBEM input variables:
        - *Population size:* The number of persons in a single-year age group (e.g., 5-years old and 6-years old, identified separately instead of being part of a 5-9 years old group)
        - *Deaths:* Total deaths in the period within each single-year age group
        - *Average annual mortality rate:* Calculated for each single-year age group using the *Population size and Deaths values*
            - To address privacy concerns, the CDC suppresses data in the CDC WONDER databases if there are nine or fewer reported deaths or nine or fewer residents in a defined locality. When data are suppressed at the state level, the CBEM uses five-year or ten-year age groups to produce bereavement estimates.
    - County Level: Population size, Deaths, and Average annual mortality rates at the county level are obtained in ten-year age groups for the most recent ten-year period from CDC WONDER to address suppression issues at this level of reporting. This impacts the following CBEM input variables:
        - *Population size:* The number of persons in a ten-year age group (e.g., 5-14 years old, and 15-24 years old; the first ten-year age group defined in CDC WONDER is 5-14 years old)
        - *Deaths:* Total deaths in the period within each ten-year age group
        - *Average annual mortality rate:* Calculated for each ten-year age group using the *Population size and Deaths values*
        - When data are suppressed at the county level, the CBEM draws information from other counties in the state to produce bereavement estimates.
            - With the exception of Michigan*, when data suppression reaches a threshold of 30% across all age groups in a county, data from all counties in the state with this level of suppression are aggregated to produce an estimate that is then assumed to be representative of these underlying counties.
    - *Mothers' Age at first birth:* Data are obtained from the CDC WONDER Births Database. Using this source, the average mothers' age at first live birth varies by state and county (or an aggregated county value for each state). The years of data used to support these values at the state and county levels match the Population size, Deaths, and Average annual mortality data years (i.e., most recent five-year period at the state and national level, most recent ten-year period at the county level).
    - *Fathers' age at first birth:* Using the state and county specific Mothers' age at first birth CBEM input variable, Fathers' age at first birth is calculated using the published value for the difference in age for fathers and mothers (Khandwala, Zhang, Lu, & Eisenberg, 2017).
    - *Average number of siblings per child:* The input value for the assumed average number of siblings per child is updated to reflect a more recent and detailed national survey (U.S. Census Bureau, 2016).

How do these enhancements impact CBEM results?

- The enhanced model's use of single-year age group mortality data at the state level and different quantitative approaches produces state and national results reflecting slightly ***less*** childhood bereavement when evaluated with the same data used for the 2019 reports.
- There is no basis for comparison for the county-level results which are new in 2020 and will be produced every five years moving forward.
- Updated sourcing and data for calculating the average number of siblings per child increased the value from 0.848 to 1.442. This change has a net effect that ***increases*** estimates of childhood bereavement due to sibling death and bereavement due to sibling or parent death.
- Moving to state and county-specific estimates of parent age has the following net impacts:
    - Estimates of bereavement due to parent death and bereavement due to sibling or parent death ***increase*** in locations where the new data result in ***older*** first-time parents.
    - Estimates of bereavement due to parent death and bereavement due to sibling or parent death ***decrease*** in locations where the new data result in ***younger*** first-time parents.

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- *Current* bereavement results are reported with *projected* bereavement results.
    - The CBEM has always produced ***current*** and ***projected*** bereavement estimates, though past reporting in national and state summaries has focused exclusively on the *projected bereavement* results.
    - *Projected* bereavement results reflect the number and percent of youth who will experience the death of a parent or sibling by the time they reach a given age.
    - *Current* bereavement results reflect the number and percent of youth who, at a given time, have experienced the death of a parent or sibling.

Concluding 2020 CBEM considerations

- CBEM results may vary year-to-year reflecting changes in data (e.g., first-time parents getting older, shifts in mortality rates).
    - Accordingly, some changes in the 2020 results compared to 2019 would be expected regardless of the model enhancements described above.
- Annual changes in the national and state results noting "1 in X children will be bereaved…" will, generally, occur less often than changes in the reported percentage of bereaved children.
    - The "X" value changes only when threshold percentage values are crossed because a given "X" value corresponds to a range of results for the percentage of bereaved children.
    - For example, when a report indicates that "1 in 11 children will be bereaved," this can encompass a range from roughly 8.7% to 9.5% of children who will be bereaved. Thus, even if we observe an increase in bereavement from 8.8% to 9.5% across time, the "1 in X" will remain "1 in 11".

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*For questions please contact cbem@judishouse.org.

judi's house JAG Institute
For Grieving Children and Families

Judi's House/JAG Institute is a research-based nonprofit in Denver devoted solely to supporting grieving children and their families.

New York Life Foundation

Judi's House/JAG Institute partnered with the New York Life Foundation to create the Childhood Bereavement Estimation Model.