

MORTALITYMINDER

Open source web application enabling healthcare researchers, providers, payers, and policy makers to gain actionable insights into how, where, and why mortality rates are rising in the United States (US)

- Explores mortality trends for midlife adults ages 25-64 across the United States from 2000 to 2017.
- Identifies social and economic factors associated with increased mortality trends at the county-level for US and individual states.
- Visualizations demonstrate determinants and their impact on mortality trends.

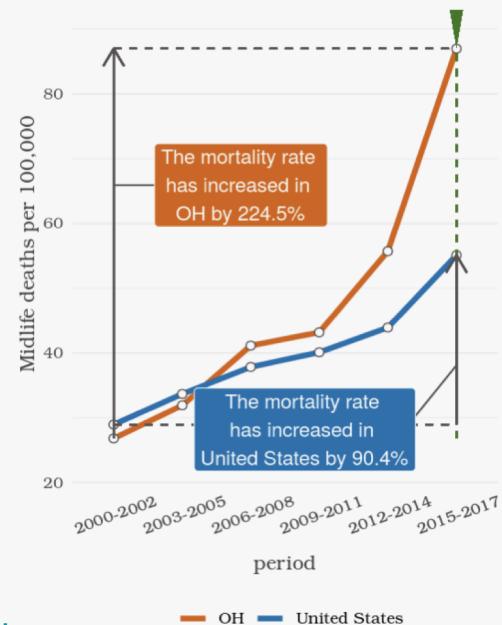
Web app:

MortalityMinder.idea.rpi.edu

Demo Video:

http://bit.ly/mortalityminder_video_final

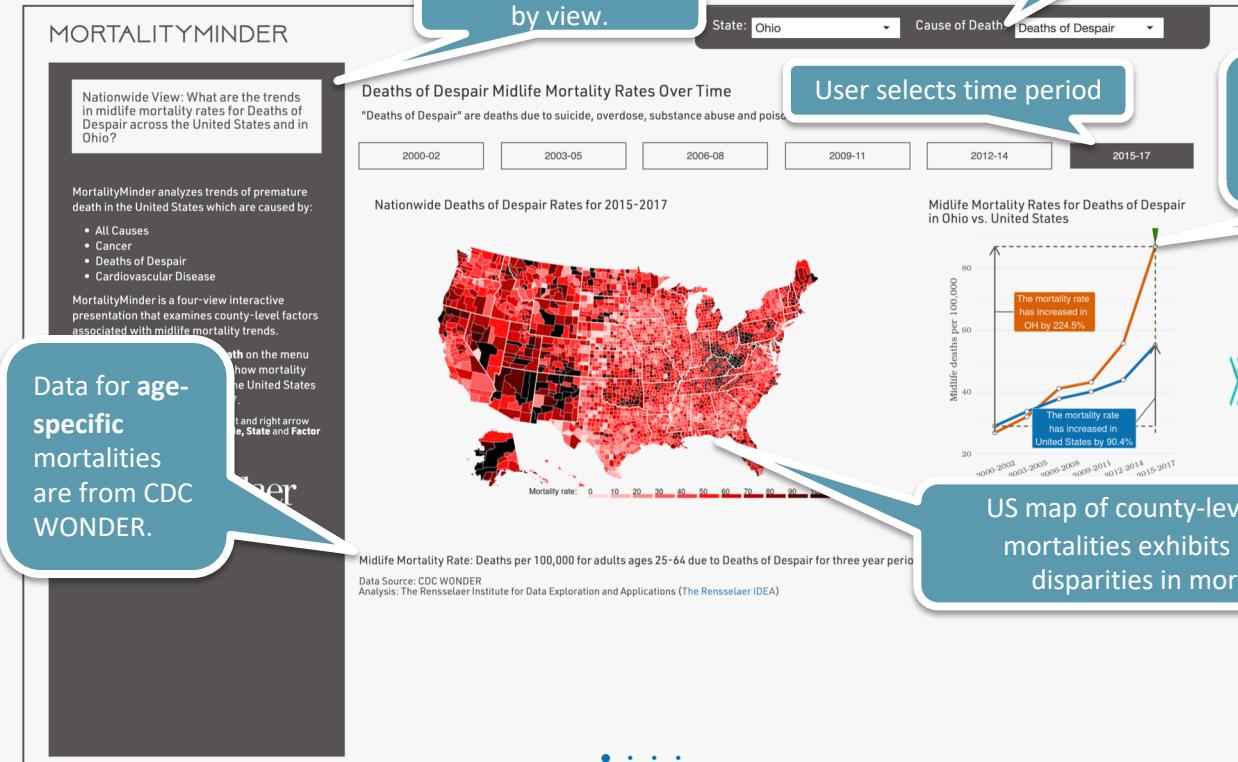
Midlife Mortality Rates for Deaths of Despair in Ohio vs. United States



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National View: Reveals national and state mortality rate trends through time



User selects Cause of Death and State or United States.

Rate Graph compares change in state and national midlife mortality rates from 2000-2017.

Users can get more details in the State and Factor view by clicking << or >> or using left or right arrows.



Data Sources and Preparation

Mortality Rate Data (2000-2017) from
[Wonder.CDC.org](https://wonder.cdc.gov)

- Selected crude midlife mortality rate data of adults ages 25-64 per county because it demonstrates actual premature mortality rates experienced by Americans.
- Calculated mortality rates in three-year chunks from CDC Wonder Detail to reveal trends and avoid data suppression by CDC. Suppressed data was imputed.
- Used national, state and county rates for major causes of death: Cancer, Cardiovascular Disease, Deaths of Despair (suicide and self harm), and All Cause.

County-level Social and Economic Factors from
[CountyHealthRankings.org](https://www.countyhealthrankings.org)

- Downloaded factors from over 20 primary sources gathered by CountyHealthRankings.org, maintained by the Robert Woods Johnson Foundation.
- Started with 150+ factors addressing health behaviors, clinical care, education, employment, social supports, community safety, and physical environments.
- Reduced to ~70 factor by curating and limiting to those correlating with at least one cause of death at the national level.
- Descriptions linked to primary sources.

MortalityMinder is open source and easily expands to other age-adjusted, age-specific, and group-specific mortality rates, death causes, and/or features.



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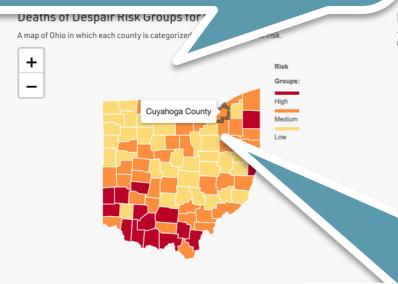
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State View: Summarizes a specific states mortality trends and disparities

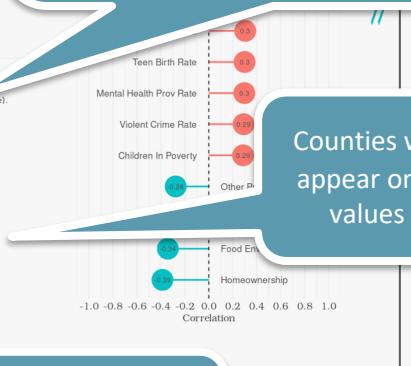
User selects time period shown in the **Mortality Rate Map**.



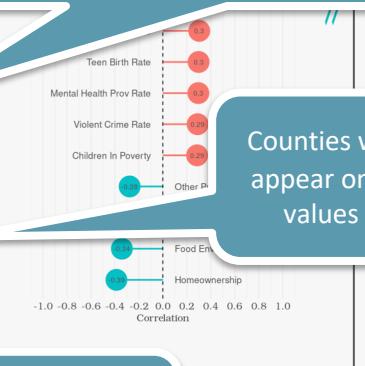
Counties that share similar midlife mortality rates are categorized into **Risk Groups**. Map showing counties colored by risk groups reveals regional disparities.



Trend Graph summarizes regional disparities through time by plotting mean mortality rates for each risk group. User can compare risk groups to see if better or worse than the national average (Blue). Selected county is the dotted line.



Counties with suppressed data do not appear on the **Trend Graph**. Imputed values are used to create maps.

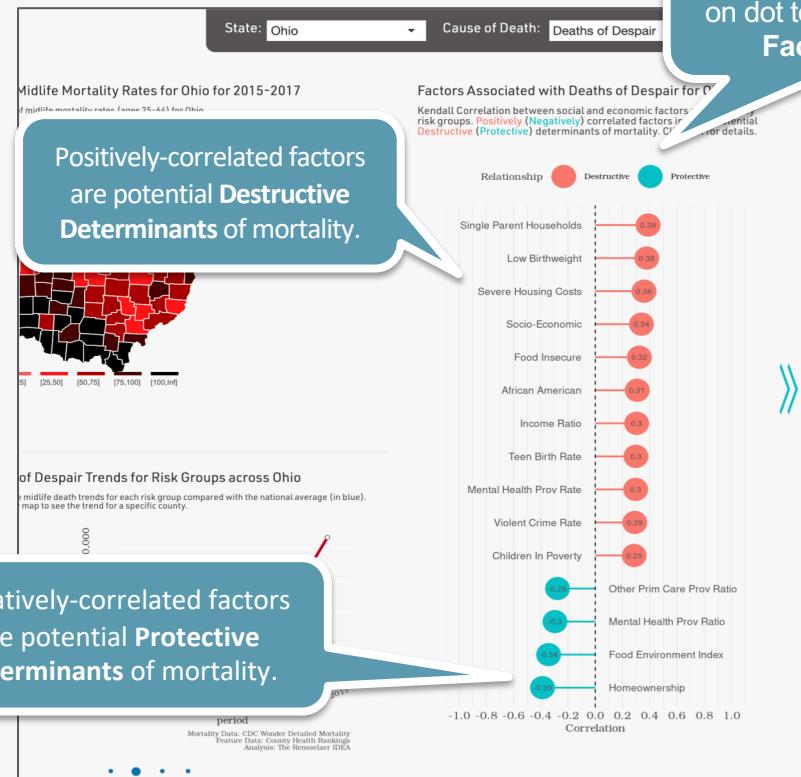


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State View: Reveals county-level social and economic factors associated with midlife mortality rates

- Performs rigorous association study by ordering county Risk Groups by 2015-2017 mortality rate, and computes Kendall Tau Correlation between Factors and Risk Groups.
- Reports up to 15 most significantly ($p\text{-value} < .05$) associated factors.
- Analysis method of combining Risk Group clustering by K-means with Kendall Correlation was selected for robustness, rigor, and effectiveness.
- Alternative analysis methods easily added to open source architecture.
- Limitation: Associated factors are correlated to midlife mortality rates. Further investigation is needed to see if they are actual determinants of mortality.



Hover on dot to see factor definition. Click on dot to see details in Factor View.

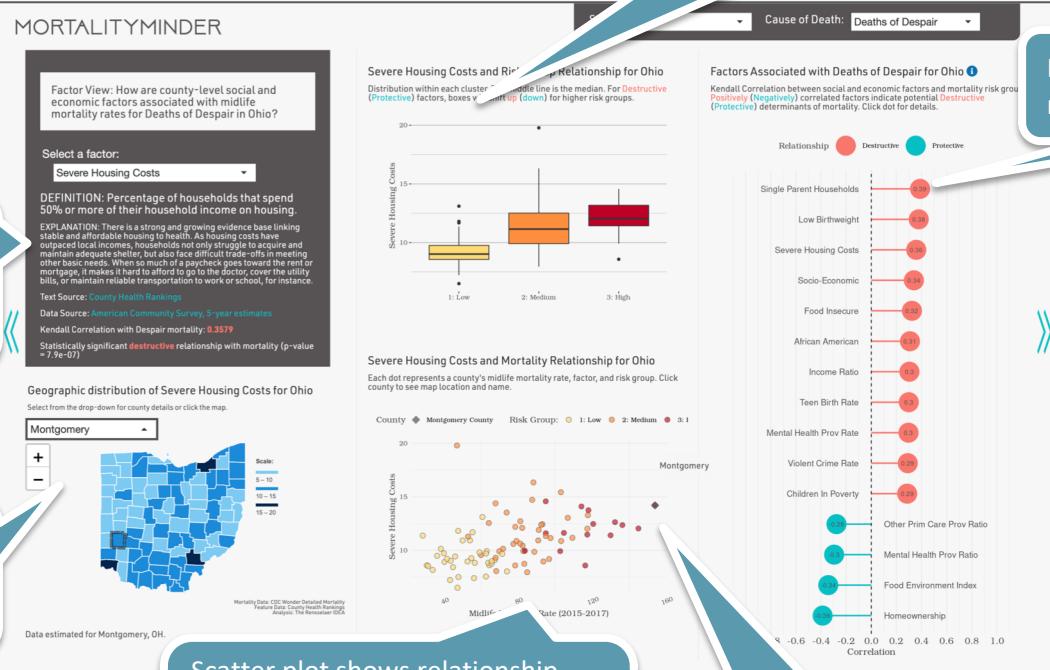


Factor View: Examines how potential determinants are associated with midlife mortality

Select Factor.

Report on Factor with definitions, links to sources, correlation with significance, and maps.

Select a county using dropdown or by clicking on any map for county rates.



Box plots show distribution within each Risk Group of the selected Factor.

Factor Analysis shown for reference.

Selected county is highlighted on plot.

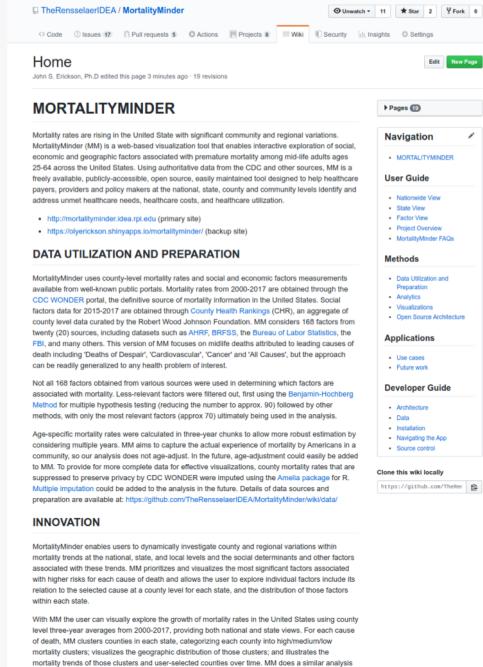


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Implementation as Public Open Source Project

- Best-practice code and full documentation available on Github
 - Implemented in open source R language and environment for statistical computing and graphics using standard packages.
 - Evolves rapidly based on feedback from users.
- Highly Interactive Design
 - Combines R's Shiny platform with popular Javascript frameworks to provide a modern, highly interactive user experience.
 - Phase 2 design based on Formal Usability Study (25+ users) and recommendations of advisory board of healthcare professionals and designers.
- Easily Customized, Reusable, and Maintainable Framework
 - Agile development can include new data streams, analyses, visualizations, and health care problems.
 - Readily ingests reliable high-quality surveillance data from wonder.cdc.org and over 20 sources via CountyHealthRankings.org



The screenshot shows the GitHub repository page for 'TheRensselaerIDEA/MortalityMinder'. The page includes a header with repository details, a code editor, and various navigation links. The main content area displays sections for 'MORTALITYMINDER' and 'DATA UTILIZATION AND PREPARATION', each with detailed descriptions and links to external resources. On the right side, there are sections for 'Navigation', 'Methods', 'Applications', 'Developer Guide', and a 'Clone this wiki locally' button.

MORTALITYMINDER

Mortality rates are rising in the United States with significant community and regional variations. MortalityMinder (MM) is a web-based visualization tool designed to help identify predictors of social, economic and geographic factors associated with premature mortality among middle adults ages 25-64 across the United States. Using authoritative data from the CDC and other sources, MM is a freely available, publicly-accessible, open source, easily maintained tool designed to help healthcare payers, providers and policy makers at the national, state, county and community levels identify and address unmet healthcare needs, healthcare costs, and healthcare utilization.

<http://mortalityminder.idea.rpi.edu> (primary site)
<https://jerryekson.shinyapps.io/mortalityminder/> (backup site)

DATA UTILIZATION AND PREPARATION

MortalityMinder uses county-level mortality rates and social and economic factors measurements available from well-known public portals. Mortality rates from 2000-2017 are obtained through the CDC WONDER portal, the definitive source of mortality information in the United States. Social factors data for 2015-2017 are obtained through County Health Rankings (CHR), an aggregated county-level dataset developed by the Robert Wood Johnson Foundation. Data is collected from twenty (20) sources, including datasets such as AHRF, BRFS, the Bureau of Labor Statistics, the FBI, and many others. This version of MM focuses on middle deaths attributed to leading causes of death including 'Deaths of Despair', 'Cardiovascular', 'Cancer' and 'All Cause', but the approach can be readily generalized to any health problem of interest.

All 168 factors obtained from various sources were used in determining which factors are associated with mortality. Less-relevant factors were filtered out, first using the Benjamin-Hochberg Method for multiple hypothesis testing (reducing the number to approve, 90) followed by other methods to further reduce most relevant factors (approx. 70) resulting in the final set.

Age-specific mortality rate were calculated in three-year chunks to allow more robust estimation by considering multiple years. MM aims to capture the actual experience of mortality by Americans in a community, so our analysis does not age-adjust. In the future, age-adjustment could easily be added to MM. To provide for more complete data for effective visualizations, county mortality rates that are suppressed to preserve privacy by CDC WONDER were imputed using the Amelia package for R. Details on how these values were added to the analysis in the future, along with data sources and preparation are available at: <https://github.com/TheRensselaerIDEA/MortalityMinder/blob/master>

INNOVATION

MortalityMinder enables users to dynamically investigate county and regional variations within mortality trends at the national, state, and local levels and the social determinants and other factors associated with these trends. MM prioritizes and visualizes the most significant factors associated with higher risks for each cause of death and allows the user to explore individual factors in close relation to the selected cause at a county level for each state, and the distribution of those factors within each state.

With MM the user can visually explore the growth of mortality rates in the United States using county level three-year averages from 2000-2017, providing both national and state level. For each cause of death, MM clusters counties in each state and then each county into regions. It shows mortality trends via maps, the geographic distribution of those clusters, and illustrates the mortality trends of those clusters and user-selected counties over time. MM does a similar analysis



Insights

- MortalityMinder documents the disturbing rise in midlife Deaths of Despair due to suicide, overdose, and self-harm and as well as other national/regional increases in midlife mortality rates due to Cancer, and Cardiovascular Disease, and All Causes.
- Highlights potential social determinants through statistical analysis of factors associated with disparities in regional trends in mortality rates.
 - Provides county-level confirmation of trends and hypothesized causes.
 - Insights can be used to create region-specific interventions and best practices.
- Confirms the midlife mortality rate increases reported in Wolf and Schoomaker, JAMA 2019, but provides much greater insights into community-level variations and their associated factors to help determine remedies.
- Enables rigorous analysis of potential determinants of health by local, state, and national healthcare organizations to support development of programs, policies, and procedures to find and address unmet health care needs to improve longevity.



Tool Benefits

- Repeatability and Scalability:
 - Analytical and visualization results are fully repeatable and reproducible, by cloning the GitHub code repository or by directly downloading results via the app.
 - Users can get analyses at the National, State, and County levels.
 - The app will scale based on the hosting resources available. It was developed, tested and hosted for the competition on multi-core servers, but performs well on personal machines.
 - Similar apps could be developed for other health trends and associated social determinants by adding data sources.
- Future Deployment:
 - MortalityMinder is currently hosted on a virtual server at Rensselaer and at Shinyapps.io.
 - MortalityMinder continues as an open source project dedicated to improving life expectancy in the United States.
 - The app continuously evolves in an agile framework to incorporate user feedback and introductions of new data streams, analyses, visualization, and health care problems.
 - The innovative visualizations and analytics in MortalityMinder can be customized and/or incorporated into other applications by using the provided code.
 - App is designed for use on laptops and monitors. Mobile devices are left as future work.

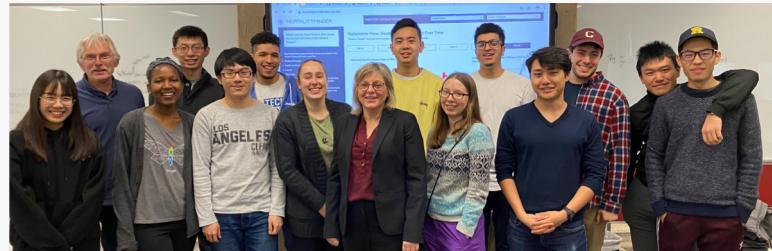


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Further Information

- MortalityMinder public deployments:
 - <https://mortalityminder.idea.rpi.edu/>
 - <https://olyerickson.shinyapps.io/MortalityMinder/>
- Overview Video
 - http://bit.ly/mortalityminder_video_final
- MortalityMinder Open Source GitHub:
 - <https://github.com/TheRensselaerIDEA/MortalityMinder>
- Full documentation provided on GitHub Wiki
 - <https://github.com/TheRensselaerIDEA/MortalityMinder/wiki>
- MortalityMinder was created by undergraduate and graduate students in the Health Analytics Challenge Lab at Rensselaer Polytechnic Institute with support from the United Health Foundation and the Rensselaer Institute for Data Exploration and Applications. MortalityMinder was directed by Kristin P. Bennett and John S. Erickson. Many thanks to the MortalityMinder Advisory Board: Ms. Anne Yau, United Health Foundation; Dr. Dan Fabius, Continuum Health; Ms. Melissa Kamal, New York State Department of Health; and Dr. Tom White, Capital District Physicians' Health Plan.



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Refer questions to erickj4@rpi.edu. Submit user requests to [GitHub](#).

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