# **Documentation for R Shiny Dashboard**

Below provides an overview of the R Shiny dashboard associated with the manuscript 'Urban Heat Island Impacts on Heat-Related Cardiovascular Morbidity: A Time Series Analysis of Older Adults in US Metropolitan Areas'. The dashboard serves as an interactive supplemental material for the manuscript and allows for interaction with the manuscript's primary results. The primary purpose of the dashboard is to display a variety of interactive tables and figures and allow for the results to be downloaded. Information on the datasets and analyses used to generate the results displayed on the dashboard can be found in the associated manuscript.

The dashboard can be viewed here: <https://rstudio-connect.dmap-stage.aws.epa.gov/content/c0b492eb-2c37-4018-a0d3-a4563b9add51/>

The code and data for the dashboard can be viewed here: <https://github.com/USEPA/Heat-CVD-UHI-Dashboard>

**Overview of Dashboard Functionality**

The dashboard has 4 different tabs, each of which allow for interaction with different results and information from the manuscript. The dashboard default loads to the ‘Overall & Subpopulation Results’ tab. From there, the user can change tabs to explore and interact with and explore different results. A description of each tab is below.

*‘About’ Tab*

The ‘About’ tab provides the user with information on the overall purpose of the dashboard, what each tab contains, and who to contact for any questions. It also displays the abstract for the associated manuscript to provide the user with an overview of the project, the datasets used, and the analyses conducted.

Graphical user interface, application, Word

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*Figure 1. Screenshot of the ‘About’ Tab*

*‘Overall & Subpopulation Results’ Tab*

The ‘Overall & Subpopulation Results’ tab displays interactive figures and tables for the heat-related risk and burden across all 120 metropolitan areas included in the analysis. The user can view the cumulative exposure-response/lag-response curves and forest plots, bar plots, and tables of the heat-related risk and attributable burden for different subpopulations (age, sex, race, diabetes status, chronic kidney disease status) and urban heat island intensity (UHII) levels (all, low, high). In addition to exploring the risk and burden results, the user can also read the key takeaways for the results displayed as well as download the results for all subpopulations and UHII levels.

*Graphical user interface, application, Word

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*Figure 2. Screenshot of the ‘Overall & Subpopulation Results’ Tab*

*‘MSA-Specific Results’ Tab*

The ‘MSA-Specific Results’ tab displays interactive figures and tables for the heat-related risk and burden in each of the 120 metropolitan areas included in the analysis. The user can compare and explore the risk and burden across different metropolitan areas, overall and by UHII level, through the interactive forest/bar plot and interactive map. The forest/bar plot can be colored and sorted by different area-level metrics to enable further exploration. The user can also explore the results for a specific metropolitan area by using the dropdown menu and/or by clicking on a city in the forest/bar plot or interactive map. For the selected metropolitan area, the cumulative exposure-response curve, and a table with the metropolitan area-specific risk and attributable burden results, are displayed. The user can also read the key takeaways for the results displayed as well as download the results for all metropolitan areas and UHII levels.

*Graphical user interface, application, Word

Description automatically generated*

*Figure 3. Screenshot of the ‘MSA-Specific Results’ Tab*

*‘Exposure & Outcome Maps’ Tab*

The ‘Exposure & Outcome Maps’ tab allows the user to explore the ZIP code-level datasets that were used to generate the results displayed on the other tabs. In the interactive map, the user can see the 9,917 ZIP codes in the 120 metropolitan areas that were included in the analysis and explore the ZIP code-level temperature metrics, number of cardiovascular hospitalizations, and UHII metrics.

**Graphical user interface, application, Word

Description automatically generated**

*Figure 4. Screenshot of the ‘Exposure & Outcome Maps’ Tab*

Below provides information on the R packages and data inputs used in the R shiny dashboard, as well as the data that can be downloaded from the dashboard.

**R Packages**

The following R packages are used in the R shiny dashboard:

|  |  |  |
| --- | --- | --- |
| *Package name* | *Package Title* | *Documentation* |
| shiny | Web Application Framework for R | <https://cran.r-project.org/web/packages/shiny/index.html> |
| shinydashboard | Create Dashboards with 'Shiny' | <https://cran.r-project.org/web/packages/shinydashboard/index.html> |
| leaflet | Create Interactive Web Maps with the JavaScript 'Leaflet' Library | <https://cran.r-project.org/web/packages/leaflet/index.html> |
| htmlwidgets | HTML Widgets for R | <https://cran.r-project.org/web/packages/htmlwidgets/index.html> |
| bslib | Custom 'Bootstrap' 'Sass' Themes for 'shiny' and 'rmarkdown' | <https://cran.r-project.org/web/packages/bslib/index.html> |
| tidycensus | Load US Census Boundary and Attribute Data as 'tidyverse' and 'sf'-Ready Data Frames | <https://cran.r-project.org/web/packages/tidycensus/index.html> |
| sf | Simple Features for R | <https://cran.r-project.org/web/packages/sf/index.html> |
| plotly | Create Interactive Web Graphics via 'plotly.js' | <https://cran.r-project.org/web/packages/plotly/index.html> |
| forcats | Tools for Working with Categorical Variables (Factors) | <https://cran.r-project.org/web/packages/forcats/index.html> |
| shinyWidgets | Custom Inputs Widgets for Shiny | <https://cran.r-project.org/web/packages/shinyWidgets/index.html> |
| listviewer | 'htmlwidget' for Interactive Views of R Lists | <https://cran.r-project.org/web/packages/listviewer/index.html> |
| jsonlite | A Simple and Robust JSON Parser and Generator for R | <https://cran.r-project.org/web/packages/jsonlite/index.html> |
| dlnm | Distributed Lag Non-Linear Models | <https://cran.r-project.org/web/packages/dlnm/index.html> |
| DT | A Wrapper of the JavaScript Library 'DataTables' | <https://cran.r-project.org/web/packages/DT/index.html> |
| dplyr | A Grammar of Data Manipulation | <https://cran.r-project.org/web/packages/dplyr/index.html> |
| shinycssloaders | Add Loading Animations to a 'shiny' Output While It's Recalculating | <https://cran.r-project.org/web/packages/shinycssloaders/index.html> |

**Data Input**

Below provides information on the datasets the R shiny dashboard relies on. These datasets are used to display the interactive figures and tables.

|  |  |
| --- | --- |
| *Filename* | *Description* |
| cbsa\_pred\_tmean.Rdata | Includes the cumulative model coefficients, variance-covariance matrices, and temperature distributions for each of the 120 core based statistical areas (CBSAs), overall and by urban heat island intensity (UHII) level. The data in this file is used to generate the cumulative exposure-response curves displayed in the ‘MSA-Specific Results’ tab. |
| cbsa\_rr\_an\_results.RDS | Contains the CBSA-level heat-related risk and burden results, overall and by UHII level. The data in this file is used to create the forest and bar plots and table displayed in the ‘MSA-Specific Results’ tab. |
| cbsa\_shapes\_with\_data.RDS | Contains the shapes of the 120 CBSAs with their heat-related risk and burden results, overall and by UHII level. The data in this file is used to create the interactive map in the ‘MSA-Specific Results’ tab. |
| subgroup\_all\_results.RDS | Contains all subpopulation-level heat-related risk and burden results, overall and by UHII level. The data in this file is used to create the forest and bar plots and table displayed in the ‘Overall & Subpopulation Results’ tab. |
| full\_list\_pooled\_ests.RDS | Includes the cumulative model coefficients, variance-covariance matrices, and temperature distributions for each subpopulation, overall and by UHII level. The data in this file is used to generate the cumulative exposure-response curves displayed in the ‘Overall & Subpopulation Results’ tab. |
| full\_list\_pooled\_ests\_99.RDS | Includes the lag-response model coefficients, variance-covariance matrices, and temperature distributions for each subpopulation, overall and by UHII level. The data in this file is used to generate the lag-response curves at the 99th temperature percentile displayed in the ‘Overall & Subpopulation Results’ tab. |
| simp\_05\_zip\_shapes\_with\_data.RDS | Contains the shapes of the 9,917 ZIP codes with their temperature, UHII, and cardiovascular hospitalization data. The data in this file is used to generate the interactive map displayed in the ‘Exposure & Outcome Maps’ tab. |

**Downloadable Data**

Below details the datasets that can be downloaded from the R Shiny dashboard, along with data dictionaries for each file.

|  |  |
| --- | --- |
| *Filename* | *Description* |
| MSA-Level-Results.csv | Downloaded from the ‘MSA-Specific Results’ tab. Contains the CBSA-level heat-related risk and burden results, overall and by UHII level. |
| Overall-Subpop-Results.csv | Downloaded from the ‘Overall & Subpopulation Results’ tab. Contains all subpopulation-level heat-related risk and burden results, overall and by UHII level. |

*Data dictionary for ‘MSA-Level-Results.csv’:*

|  |  |
| --- | --- |
| *Variable* | *Description* |
| Metropolitan Area (MSA) | Name of the metropolitan statistical area (MSA), pulled from the US Census Bureau: <https://www.census.gov/geographies/reference-files/time-series/demo/metro-micro/delineation-files.html> |
| UHII Level | Urban heat island intensity (UHII) level. Options: Overall (all ZIP codes); Low UHII (ZIP codes in the first quartile of UHII); High UHII (ZIP codes in the fourth quartile of UHII) |
| # ZIP Codes | Number of ZIP codes in the MSA at the specified UHII level |
| # Hospitalizations | Total number of cardiovascular disease (CVD)-related hospitalizations in the ZIP codes in the MSA at the specified UHII level between 2000-2017 |
| 99th Temp. %ile (°C) | 99th percentile of daily average temperature across the ZIP codes included in the MSA at the specified UHII level, 2000-2017 |
| MHT (°C) (95% CI) | Minimum hospitalization temperature (MHT) of the MSA and 95% confidence interval (CI). Calculated using the minimum hospitalization percentile (MHP), which is the same for all CBSAs at a specified UHII level: Overall MHP: 92 (95% CI: 90, 95); Low UHII MHP: 93 (95% CI: 88, 100); High UHII MHP: 92 (95% CI: 90, 95) |
| RR (99th vs. MHP) (95% CI) | Relative risk (RR) of CVD hospitalization at the 99th temperature percentile relative to the MHP, with 95% CI. Calculated using the MSA-specific cumulative exposure-response curve. |
| AN (Temp. ≥ MHP) (95% CI) | Heat-attributable number (AN) and 95% CI. Number of cardiovascular hospitalizations attributable to temperatures above the MHP, 2000-2017. |
| Annual AR (Per 100,000 Beneficiaries) (95% CI) | Average annual heat-attributable rate (AR) of cardiovascular hospitalizations per 100,000 Medicare beneficiaries and 95% CI. Heat = temperatures above the MHP. |

*Data dictionary for ‘Overall-Subpop-Results.csv’:*

|  |  |
| --- | --- |
| *Variable* | *Description* |
| Group | Variable identifying the subpopulation group for the results. Options: All, Age, Sex, Race, Diabetes, Chronic Kidney Disease (CKD). |
| Subpopulation | Variable identifying the specific subpopulation for the results. Options: All – All; Age – 65-74, 75-84, 85-114; Sex – Male, Female; Race – Black, White; Diabetes – Yes, No; CKD – Yes, No. |
| UHII Level | Urban heat island intensity (UHII) level for the results. Options: Overall (all ZIP codes); Low UHII (ZIP codes in the first quartile of UHII); High UHII (ZIP codes in the fourth quartile of UHII) |
| # MSAs | Number of MSAs included the subpopulation at the specified UHII level |
| # ZIP Codes | Number of ZIP codes included the subpopulation at the specified UHII level |
| # Hospitalizations | Total number of cardiovascular disease (CVD)-related hospitalizations in the ZIP codes included the subpopulation at the specified UHII level between 2000-2017 |
| 99th Temp. %ile (°C) | 99th percentile of daily average temperature across the ZIP codes included in the subpopulation at the specified UHII level, 2000-2017. Value first calculated for each MSA and then averaged across all MSAs. |
| MHP (95% CI) | Minimum hospitalization percentile (MHP) and 95% CI. |
| MHT (°C) (95% CI) | Minimum hospitalization temperature (MHT) and 95% CI. Calculated using the MHP. |
| RR (99th vs. MHP) (95% CI) | Relative risk (RR) of CVD hospitalization at the 99th temperature percentile relative to the MHP, with 95% CI. Calculated using the MSA-specific cumulative exposure-response curves for the specified subpopulation and UHII level. |
| AN (Temp. ≥ MHP) (95% CI) | Heat-attributable number (AN) and 95% CI. Number of cardiovascular hospitalizations attributable to temperatures above the MHP, 2000-2017. |
| Annual AR (Per 100,000 Beneficiaries) (95% CI) | Average annual heat-attributable rate (AR) of cardiovascular hospitalizations per 100,000 Medicare beneficiaries and 95% CI. Heat = temperatures above the MHP. |