Updating the Heat Vulnerability Index (HVI) for Dane County

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2014 Wisconsin HVI Framework

- Used for analysis of all Wisconsin counties.
- BRACE CDC Framework
- 4 variable categories
- Data from 2006-2012

Table 1. Variables included in the Wisconsin heat vulnerability index

Variable	Measure	Year	Data Source	Geography
Population Density				
Population density	Population per square mile	2011	U.S. Census	Block group
Health Factors				
Diabetes	Diabetes prevalence	2006-2010	Behavioral Risk Factor Surveillance System (BRFSS)	County
Asthma	Adult asthma prevalence	2006-2010	BRFSS	County
Hypertension	Hypertension rate	2006-2010	BRFSS	County
Obesity	Percentage obese based on BMI	2009-2011	BRFSS	County
Uninsured	Percentage uninsured	2006-2010	BRFSS	County
Mental health	Percentage of population receiving public mental health services	2011	Division of Mental Health and Substance Abuse Services (DMHSAS)	County
Substance abuse	Percentage of population receiving public substance abuse services	2006-2010	DMHSAS	County
Heat stress	Percentage of population that visited an emergency department for heat stress	2002-2012	Wisconsin Hospital Patient Data System	Zip Code Tabulation Area (ZCTA)
Demographic and Socioeconomic Factors				
Poverty	Percentage of households in poverty	2007-2011	U.S. Census, American Community Survey (ACS)	Block group
Age 0-4	Percentage of population aged 0-4	2007-2011	U.S. Census (ACS)	Block group
Age 85+	Percentage of population aged 85+	2007-2011	U.S. Census (ACS)	Block group
Age 65+ living alone	Percentage of population 65+ living alone	2007-2011	U.S. Census (ACS)	Block group
Living alone	Percentage of population living alone	2007-2011	U.S. Census (ACS)	Block group
Non-white	Percentage of non-white population	2007-2011	U.S. Census (ACS)	Block group
Less than high school education	Percentage of population with less than high school education	2007-2011	U.S. Census (ACS)	Block group
Natural and Built Environment				
Air surface temperature	July 6, 2012, air temperature	2012	Parameter-elevation Regressions on Independent Slopes Model (PRISM)	Raster, 4 k resolution
Air quality, $PM_{2.5}$	July 2012, average of $PM_{2.5}$ concentration (ug/m^3)	2012	Environmental Protection Agency (EPA) Air Quality Index (AQI)	Lat/long (extrapolated)
Air quality, ozone	July 2012, maximum recorded ozone level (ppb)	2012	EPA AQI	Lat/long (extrapolated)
Households without vehicle	Percentage of households without a vehicle	2007-2011	U.S. Census (ACS)	Block group
Developed land cover	Medium and high intensity classification	2006	National Land Cover Database (NLCD)	Raster, 30 m resolution
Nursing home	Nursing home bed count	2013	Division of Long Term Care	Lat/long

Milwaukee's 2023 HVI Framework

- Done by Ryan Honeck at the Milwaukee DHS (collaborator on this project)
- Included similar variables

	Geographic Level	Data Source
Health Variables		
Adult Diabetes pooled prevalence (2014-2019)	Census tract	CDC: Places/BRFSS
Adult Asthma pooled prevalence (2014-2019)	Census tract	CDC: Places/BRFSS
Hypertension pooled prevalence (2013-2019)	Census tract	CDC: Places/BRFSS
Obesity pooled prevalence (2014-2019)	Census tract	CDC: Places/BRFSS
Mental health "less than well >= 14 days" pooled percentage (2014-2019)	Census tract	CDC: Places/BRFSS
Heat-related illness ER visits and hospitalizations (2012-2021)	ZCTA	WHA Information Center
Demographic/Social Factors		
% below poverty line	Census Block Group	Census ACS
% age 0-4	Census Block Group	Census ACS
% aged 65+	Census Block Group	Census ACS
% race other than white	Census Block Group	Census ACS
% adult without high school diplomas	Census Block Group	Census ACS
% living in a nursing home	Lat/Long	Wisconsin DHS
% of households that are overcrowded	Census Tract	CDC: Places/BRFSS
% speak english "less than well"	Census Block Group	Census ACS
Population density	Census Block Group	US Census
Environmental Factors:		
Apparent Max Temperature*, $PM_{2.5}$ level, ozone level at time of extreme heat	Temp: 30km resolution PM 2.5 level & Ozone level: nearest facility	Parameter-elevation Regressions on Independent Slopes Model PRISM
% of surface that is in the medium-high impervious category	30m raster resolution	NLCD
% of households with no vehicle	Census Tract	

Contact Ryan Honeck with questions

Dane County 2024 HVI Framework

Health Variables	Meseaure	Year(s)	Data source	Geography	Lit Review
Heat Illness	Impatient visit for a heat related illness	2016-2022	Wisconsin DHS	Zip Code	N/A
Diabetes	% of adults diagnosed with diabetes	2019-2021	Healthy Dane	Census Tract	Schwartz
Cognative Difficulties	% of population with a cognitive difficulty	2018-2022	Healthy Dane	Census Tract	Stafoggia et. Al.
Obesity	% of adults who are obsese (BMI)	2019-2021	Healthy Dane	Census Tract	CDC

Environmental Variables	Measure	Year(s)	Data source	Geography	Lit Review
Impervious Surface Cover	% of surface area that is impervious. (30 Meter raster)	2021	National Land Cover Database (NLCD)	Zonal Statistics tool, Census Tract	Ma, X. & Peng, S.; Arnold, C. L. & Gibbons, C. J.
Apparent Max Temperature	Ground temperature on August 24rd, 2023	2023	PRISM Climate Data	Nearest Facility	Barnett, Adrian & Ström, C.

Demographic Variables	Measure	Year(s)	Data source	Geography	Lit Review
Below the Poverty Line	% of households in poverty	2022	Census	Census Tract	Curreiro et. Al.
Age 0-4 Years	% of population age 0-4	2022	Census	Census Tract	Curreiro et. Al.
Age 65+ Years	% of population age 65+	2022	Census	Census Tract	Cannuscio et Al.
Identifies as non-White	% of Population that is non-White	2022	Census	Census Tract	O'Neil et Al.
Less than High School Education	% of population without a high school diploma	2022	Census	Census Tract	Kovatas & Hajat
Overcrowded House	% of households that are overcrowded	2022	Census	Census Tract	KK Zander et Al.
Speaks English Less than Well	% of population that speaks english less than well	2022	Census	Census Tract	Aubrecht & Ozceylan

Data Collection and Analysis

Hospital Data Collection

- We contacted Jennifer Broad at the Wisconsin DHS
- She pulled all inpatient and emergency department hospitalizations from 2016-2022 for Dane County residents who had a heat ICD-10 diagnosis or e-code field from fields we identified.

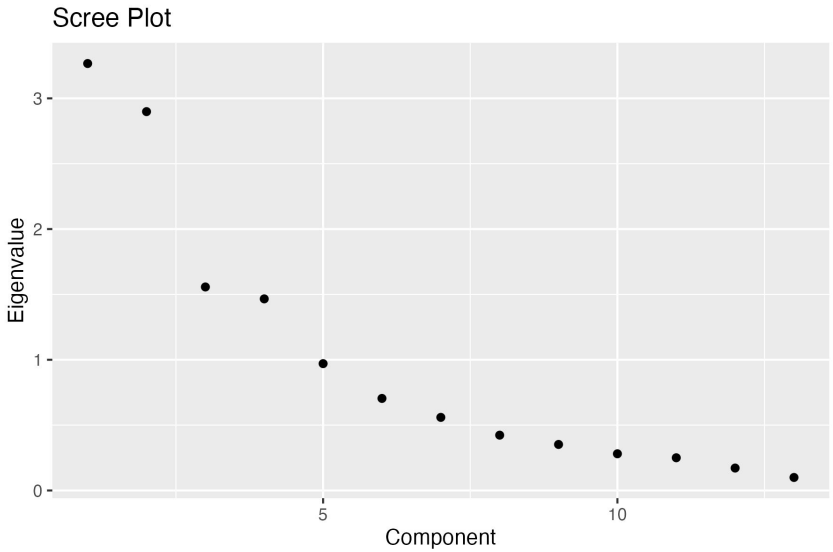
ICD-10 Codes Identified:

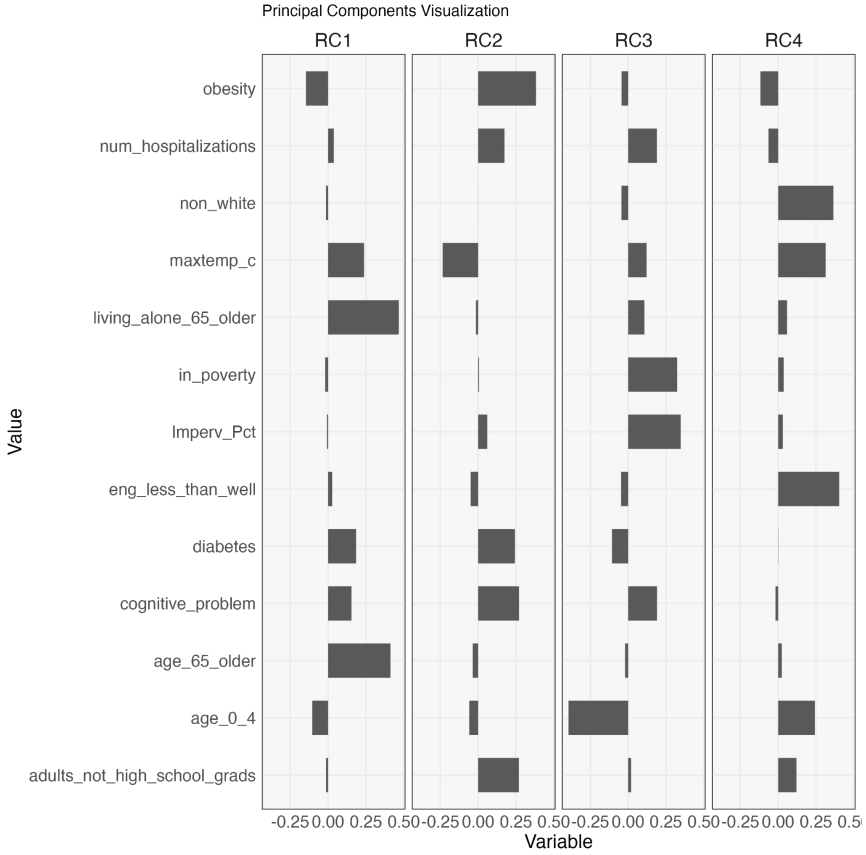
T67.0	T67.01	T67.02	T67.09	T67.1	T67.2	T67.3	T67.4	T67.5	T67.6	X30	X32
Heatstroke and sunstroke	General Heatstroke and sunstroke	Exertional heat stroke	Heatstroke other	Heat Syncope	Heat cramp	Heat exhaustion	Heat exhaustion due to salt depletion	Unspecified heat exhaustion	Heat fatigue	Exposure to natural heat	Exposure to sunlight

A potential source for bias here would be that the data set was unable to separate out patients who were not treated at a Dane County Hospital.

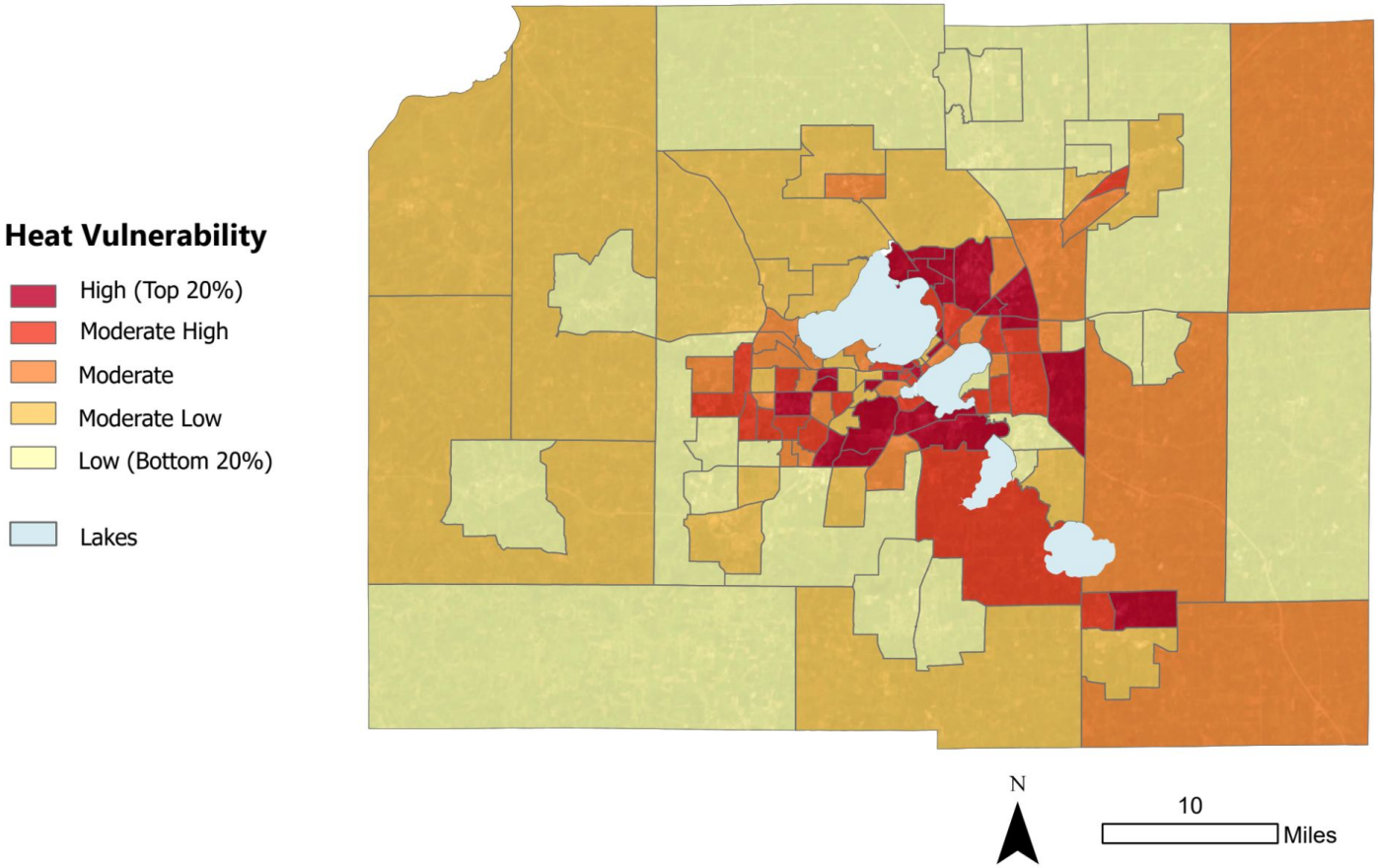
HVI Analysis (Methods)

- Performed Principal Component Analysis on 13 Variables
- Included varimax rotation
- 4 components selected





HVI Analysis (Visual)

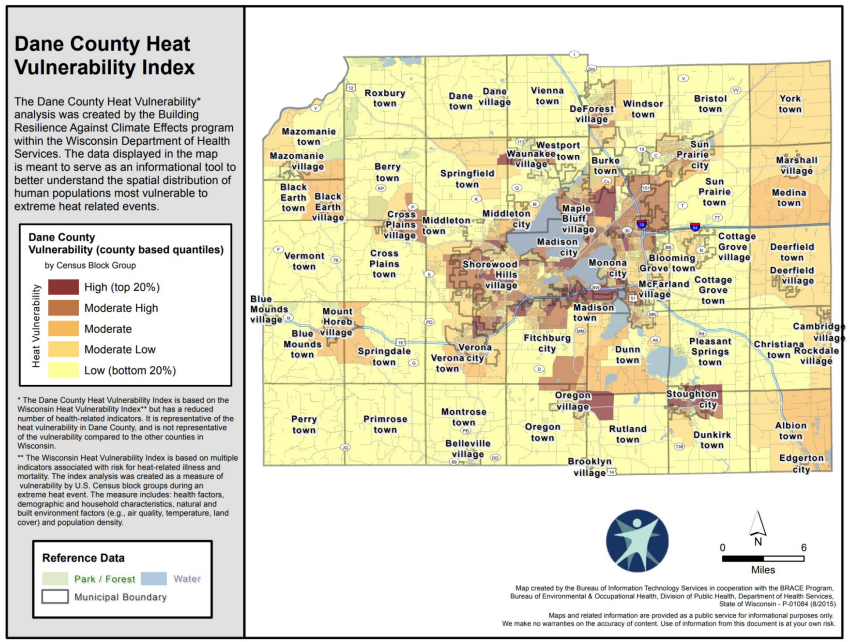


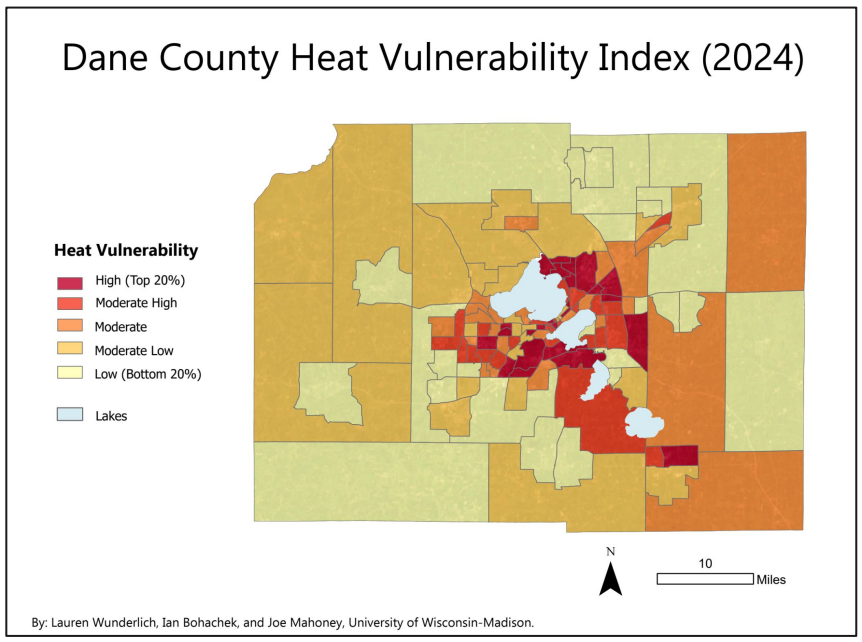
By: Lauren Wunderlich, Ian Bohachek, and Joe Mahoney, University of Wisconsin-Madison.

Contact Joe, Ian, or Lauren with questions on GIS data.

HVI Comparison: 2014 v 2024

- Similar findings to 2014.
- General trend towards higher vulnerability in urban areas.
- Noticeable decrease in vulnerability in the Village of Cross Plains.
- Noticeable increase in vulnerability in and near the City of Monona.





Concluding our Findings

Data Availability Limitations

Unfortunately, we were not able to find all of the data we wanted to include from our research on heat vulnerability. Factors we would have included given their availability would have been:

- Persons with asthma
- % of Households without air conditioning
- Persons who are bedridden
- Effect of Dane County Lakes

We also did our analysis with mainly Census Tract data which was the most available publicly. This though, is a larger enumeration unit than the Census Block, which was used for Wisconsin in 2014 and Milwaukee in 2023.

Potential for Expansion

- Access to data on desired variables to improve analysis.
- Block groups offer more granularity.
- Break down vulnerability by Health, Demographic, and Environmental factors.
- Use this framework to update the rest of Wisconsin's counties.
- While we compared vulnerability among the tracts relative to each other, this may not be the only way to analyze this data (i.e. a ranking or non-relative vulnerability analysis)

Questions?

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Supporting Document:

Dane County HVI 2024 Bibliography - Google Docs


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