

## WET BULB GLOBE TEMPERATURE DEFINED

Wet Bulb Globe Temperature (WBGT) is a composite parameter that estimates the combined effects of temperature, humidity, wind and solar radiation, and has been found to be a more effective means of assessing exertional heat illness (EHI) in humans. The US Military noted a drastic reduction in heat illnesses during basic training in the 1950s when they began using WBGT to assess vulnerability to heat.

	WBGT	Heat Index
Uses Temperature	✓	✓
Uses Relative Humidity	✓	✓
Uses Wind	✓	✗
Uses Cloud Cover	✓	✗
Measured in the sun	✓	✗
Measured in the shade	✗	✓
Uses Sun Angle	✓	✗

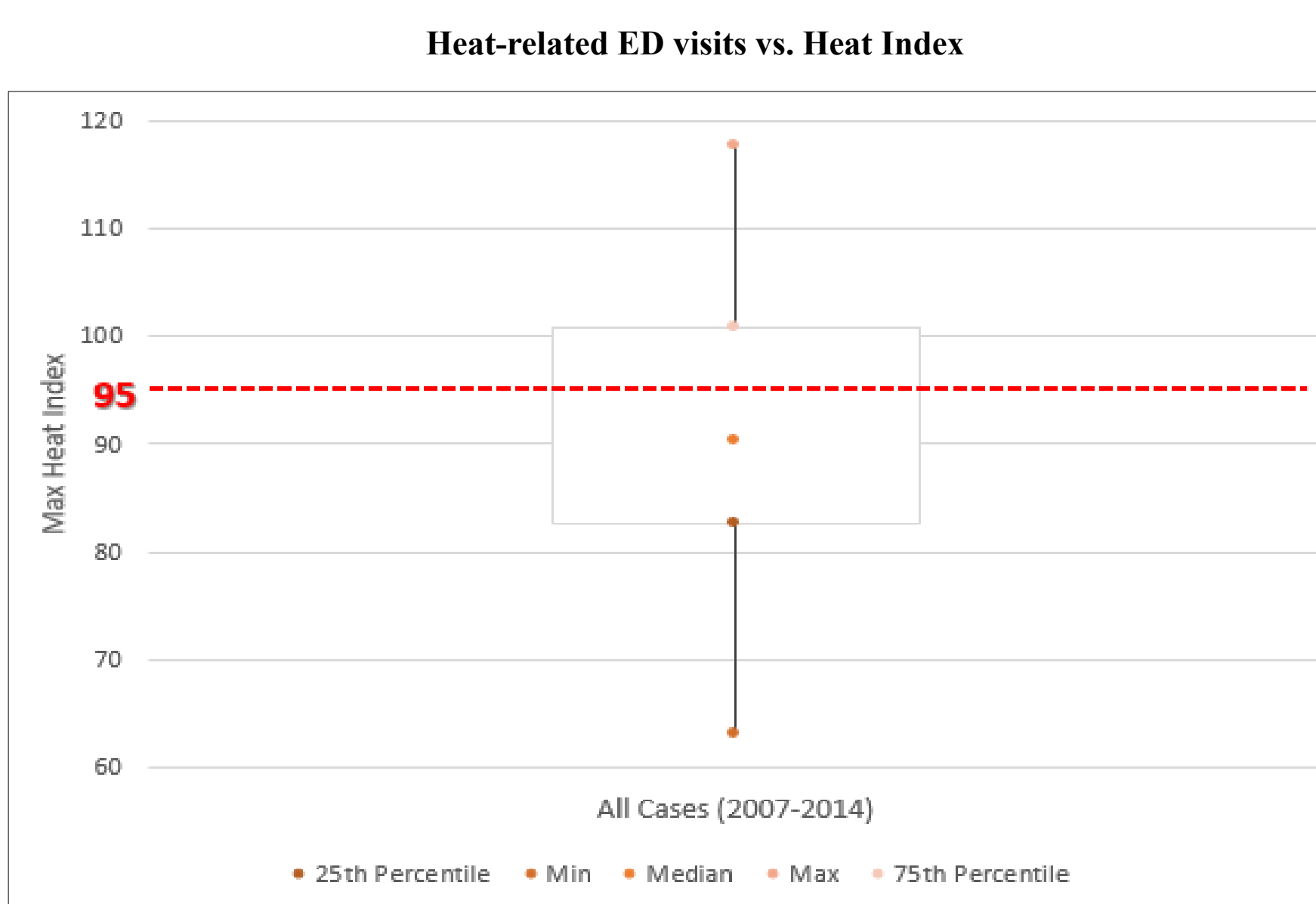
WBGT can be calculated using the following formula:

$$WBGT = 0.7T_w + 0.2T_g + 0.1T_a$$

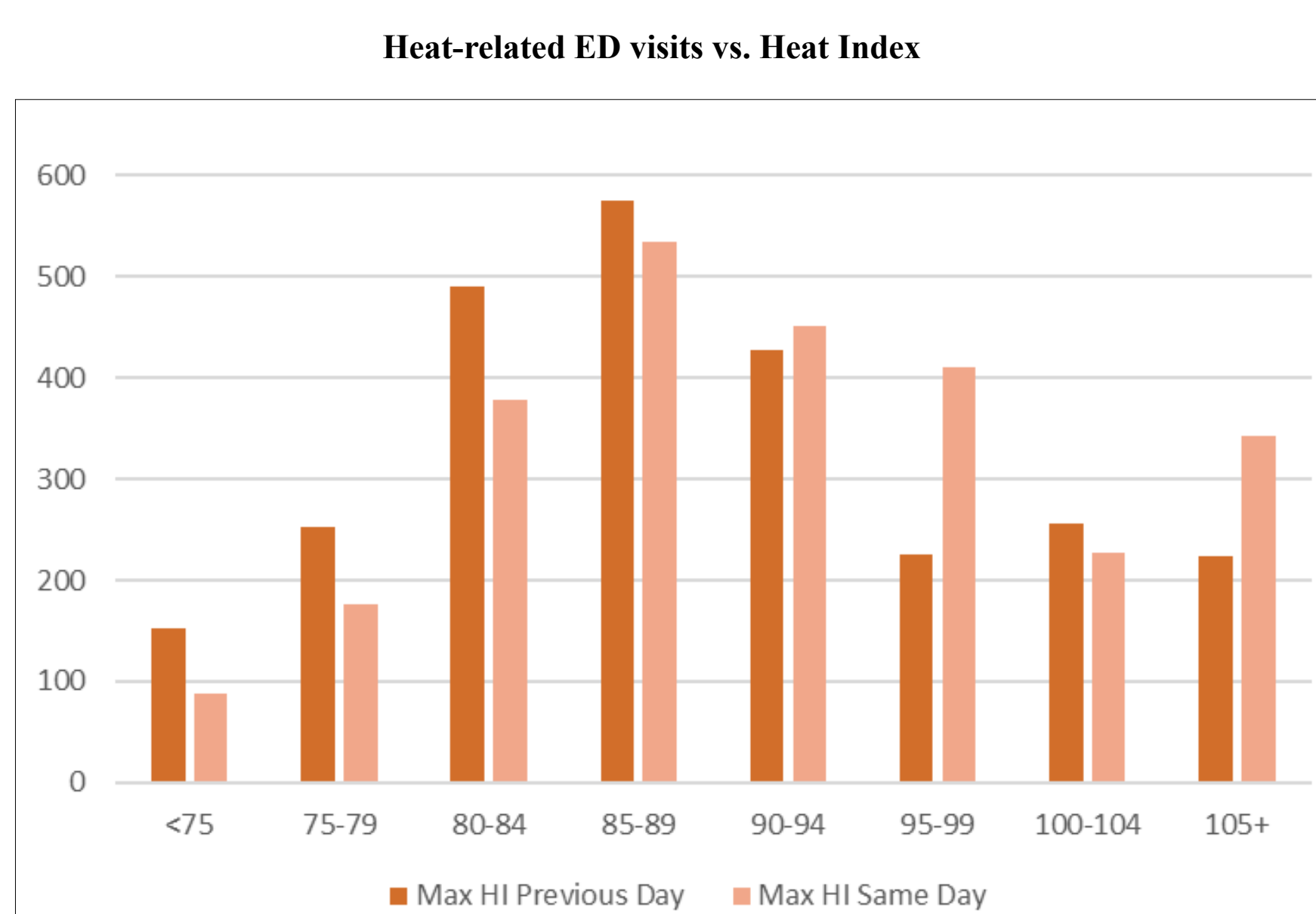
- $T_w$  is the natural wet bulb temperature, which indicates humidity
- $T_g$  is the globe temperature, which indicates radiant heat
- $T_a$  is the ambient air (dry) temperature

## JUSTIFICATION OF WBGT IN LIEU OF HEAT INDEX FOR ACTIVE INDIVIDUALS

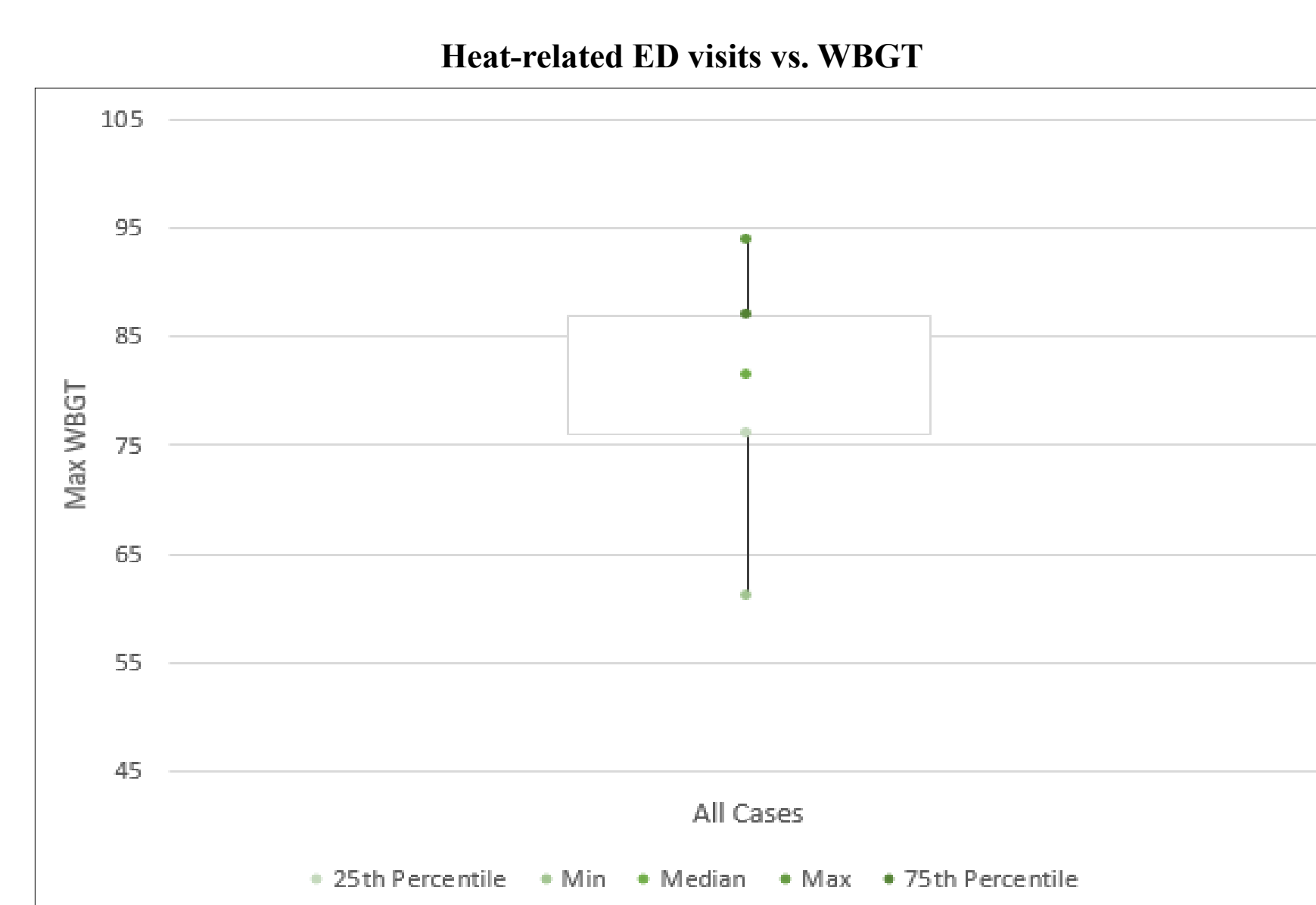
Multiple studies between the National Weather Service (NWS) Twin Cities (WFO MPX) and regional partners (including Hennepin County Medical Center (HCMC), the Minnesota Department of Health, and the University of Minnesota) were conducted over the past several years. These studies, which assessed the relationship between heat morbidity and WBGT, showed that WBGT is more deeply correlated with heat-related emergency department (ED) visits. The results of one such study illustrated the bulk of the heat-related ED visits in the Twin Cities Metro area between 2007 and 2014 occurred when heat index values were below the Twin Cities Metro heat advisory criteria of 95 degrees F (and therefore decision assistance and threat messaging likely fell short of expectations and needs). The following graphics illustrate this issue.



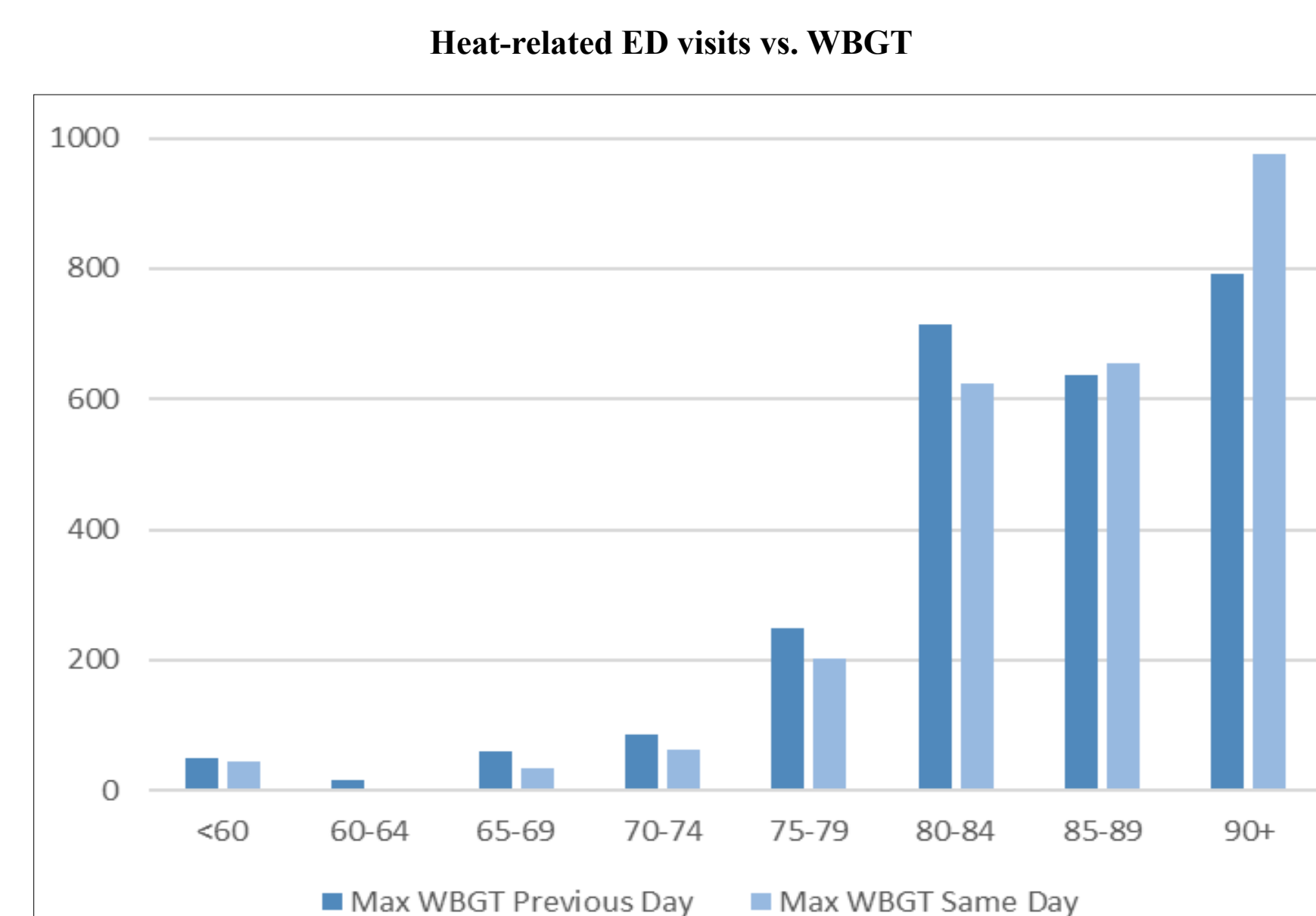
The median of ED visits occurred well below the 95°F criteria issuance threshold for a Heat Advisory in the Twin Cities Metro, indicating that less than 50% of the cases would have been captured using that threshold.



The clustering of ED visits and peak actually occurred well below the 95°F criteria issuance threshold for the Twin Cities Metro.



The lower range in the plot above is indicative of a clearer correlation of ED visits with WBGT values.



There is a clearer relationship of ED visits with WBGT values of 80°F or higher.

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## USE OF WET BULB GLOBE TEMPERATURE ACROSS THE NATION

There is a need for forecasts of WBGT on a nationwide scale. The U.S. Occupational Safety & Health Administration (OSHA) considers the use of a WBGT meter to be the most accurate way to measure heat exposure in real-time applications. Various athletic associations endorse the WBGT as the parameter that best captures heat risk for athletes. The Korey Stringer Institute and the National Athletic Trainers' Association have established guidelines to prevent heat illness in sports. Furthermore, many university sports programs, professional sports teams, and all marathon events use the WBGT. Here are some examples of how WBGT is proving to be successful across the Nation:

### Georgia



Following a series of exertional heat stroke deaths among Georgia HS football athletes, a set of WBGT-based activity modification guidelines was implemented in 2012. Since then, there hasn't been a HS exertional heat stroke death in GA.

### Vermont



Since the inception of WBGT by high schools in 2015, there have been no injuries. Since the heat death of a VT State Trooper during a training exercise, the state of VT is making the monitoring of WBGT a standard. Also utilized in the Burlington marathon.

### Washington



WBGT used at the 2018 Special Olympics USA Games in Seattle.

### Minnesota



Research results inspired recommendations for heat policy changes to use WBGT for MN State High School League athletic activities. Several universities have created modification guidelines based on WBGT.

## PARTNER APPLICATION: HENNEPIN COUNTY EMERGENCY MANAGEMENT MESONET



	Very Low	Low	Moderate	High	Extreme
Active persons heat index (aPHI)	1	2	3	4	5
Wet Bulb Globe temp (WBGT)	77-79°F	80-82°F	83-85°F	86-88°F	>88°F
Suggested precautions	Normal activities Begin to monitor at risk persons	Use discretion for intense or prolonged exercise	Limit duration of outdoor activities to two hours or less	Limit duration of outdoor activities to one hour or less	Cancel outdoor workouts and exercise
Recommended breaks in shade (per hour of activity)	As needed	15 minutes	30 minutes	45 minutes	Do not resume until the index lowers

Website includes NWS forecast data, observations, and activity modification recommendations for the Twin Cities Metro area:  
<https://www.hennepin.us/mesonet/heat-stress>

## NWS WBGT FORECAST RESOURCES: NATIONAL DIGITAL FORECAST DATABASE (NDFD)

The National Digital Forecast Database (NDFD) is the primary means by which the NWS provides digital information to customers and partners. The NWS is providing gridded forecasts of WBGT to the NDFD on an experimental basis for the contiguous United States (CONUS), Pacific Region Weather Forecast Offices, and Puerto Rico in response to user needs for planning purposes and critical decisions related to heat safety. For more information, visit [https://www.weather.gov/media/notification/pns19-24exp\\_wet\\_bulb%20\\_temp.pdf](https://www.weather.gov/media/notification/pns19-24exp_wet_bulb%20_temp.pdf)

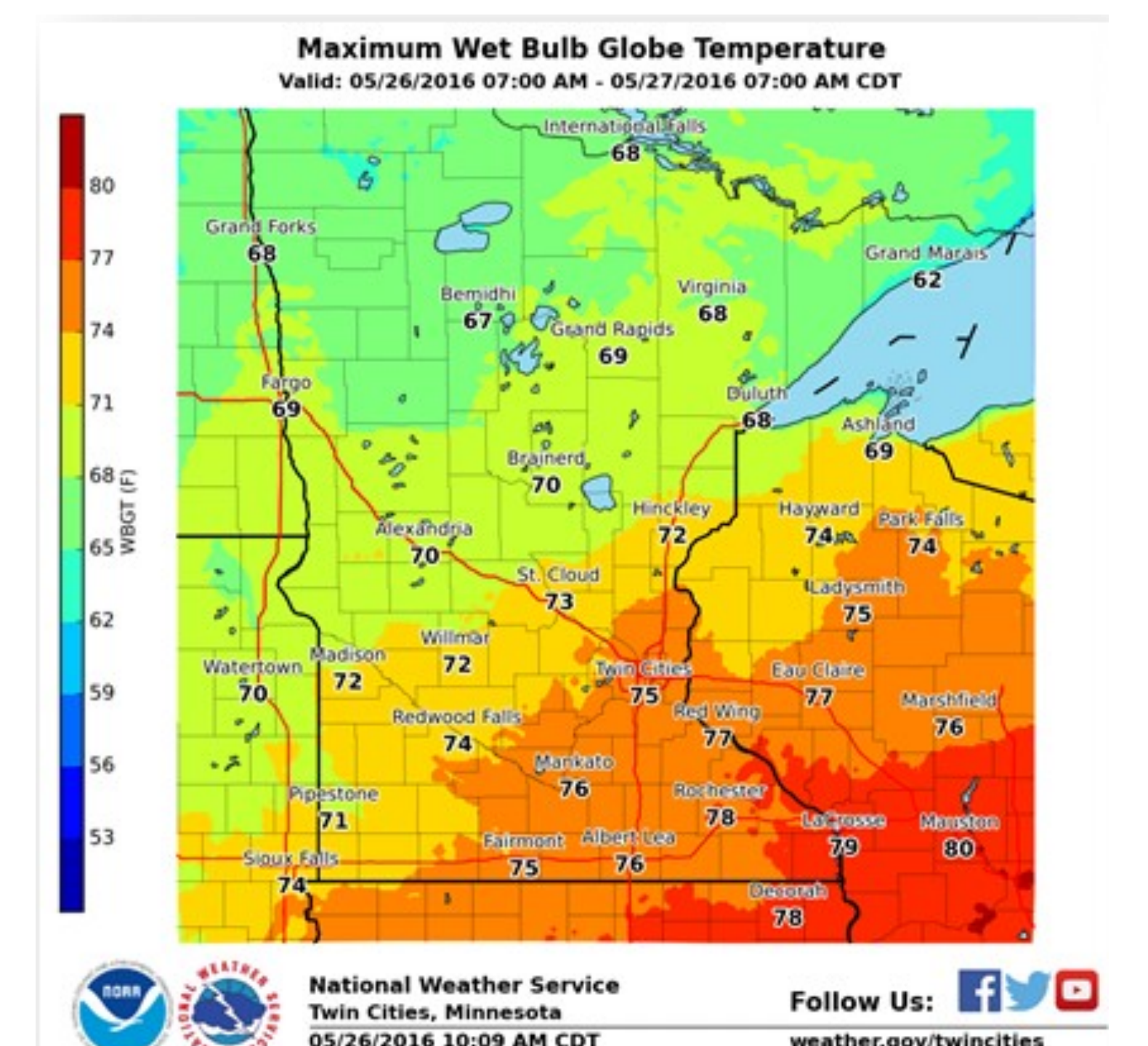
In addition to the current availability of NDFD GRIB2 files, the following public display is tentatively scheduled for a spring/summer 2020 release:

PROTOTYPE - Subject to change

## WEATHER FORECAST OFFICE WBGT DISPLAYS:

WBGT is also tentatively scheduled to be an option for the "Point n Click" forecast on NWS webpages in 2020. In the meantime, some weather forecast offices will have experimental displays available, including WBGT calculators, forecast maps, and safety resources. The images below are one such example:

Examples above from [weather.gov/mpx/wbgt](https://weather.gov/mpx/wbgt)



Example of a forecast map produced from the NWS graphical forecast editor (GFE), which is the foundation of the NDFD database.

