How Do Temperature, Relative Humidity and Heat Index Compare to Trends in Heat-Related Chief Complaints Captured by ESSENCE?

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Background

- Heat-related illnesses can occur when high ambient temperatures overcome the body's natural ability to dissipate heat [1].
- Adults >65 years, children < 5 years, and persons with chronic medical conditions are particularly susceptible and at high risk [2].

Background

- In the United States 8,015 individuals died from excessive heat exposure from 1979 to 2003.
  - In 2001 alone, 300 deaths were caused by excess heat exposure.
- Heat-related deaths and illness are preventable!

Background

- This question is important for Missouri because:
  - A quarter of the workforce are in outdoor/manual occupations [3].
  - Two Missouri cities are on the top 10 US cities with most weather variety [4].
- Availability of high quality data:
  - Statewide syndromic data for past three years.
  - Heat mortality data from routine surveillance.

Background

- Heat index is a measure of apparent temperature based on temperature and relative humidity, and is an important indicator for the National Weather Service (NWS) when issuing heat alerts [5].

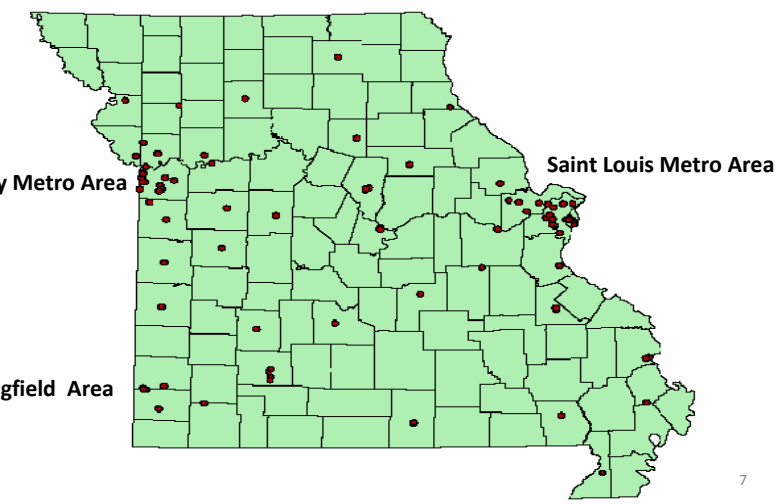
Background

- Heat-related chief complaints reported upon admission from emergency department (ED) visits are collected and analyzed temporally using ESSENCE.

- **ESSENCE** stands for **E**lectronic **S**urveillance **S**ystem for the **E**arly **N**otification of **C**ommunity-based **E**pidemics.

Background

Missouri ESSENCE hospitals



Objective

- To evaluate whether daily temperature, relative humidity, or heat index best relates to trends in ED heat-related chief complaints in Missouri.

Methods

- ESSENCE was queried for ED chief complaints that contained keywords “heat” or “therm” to identify reports of heat stroke, heat exhaustion, heat cramps or hyperthermia.

Methods

- Weather data was assembled with the help of the Saint Louis NWS office for five collection sites in Missouri to obtain a statewide average.

Methods

- Data were compiled every day from May 1 – Sept 30 for 2006, 2007 and 2008. Each summer was evaluated separately.

Methods

- Statistical analysis was performed utilizing Statistical Analysis Software (SAS version 9.2).
- Pearson correlation coefficient (*r)* and coefficient of determination (R^2) were calculated to evaluate the strength of the relationship between ED rates and weather data.

Methods

- Simple linear regression models were also built to determine which weather factor explained most of the fluctuation in rates of heat-related ED visits.

Results

- For every year analyzed, the Pearson correlation coefficient *(r)* for heat index was higher than results for maximum temperature or relative humidity.

- The coefficient of determination (R^2) for heat index was also the largest.

Results

- In the simple linear regression model, heat index was a significant predictor for heat-related ED rates. This was statistically significant at p-value <0.0001 (Table 1).

Results

Table 1. Coefficient of determination results for relationship between three weather variables and heat-related ED visit rates from Missouri ESSENCE, 2006-2008.

	Summer 2006		Summer 2007		Summer 2008	
	R^2	p-value	R^2	p-value	R^2	p-value
ED rates = RH	0.0023	0.6418	0.0319	0.0501	0.0034	0.5378
ED rates = Temperature	0.4468	<0.0001	0.5389	<0.0001	0.4233	<0.0001
ED rates = HI	0.6087	<0.0001	0.6249	<0.0001	0.5792	<0.0001

Results

- Our table suggests that heat index more significantly correlates with, and exhibits a higher degree of a linear relationship with, ED rates than temperature or relative humidity.

Results

- Further analysis using heat-related death rates was conducted.
- No relation is found between elevated heat index (HI) and heat mortality in summer 2006, 2007 and 2008.
- This result may be due to the small sample size (N<25) of heat mortality data.

Results

Table 2. Coefficient of determination results for relationship between three weather variables and heat-related death rates in Missouri from 2006-2008.

	Summer 2006		Summer 2007		Summer 2008	
	R^2	p-value	R^2	p-value	R^2	p-value
Heat death rates = RH	0.0003	0.9502	0.1490	0.0625	0.1557	0.4389
Heat death rates = Temp.	0.0996	0.2337	0.2609	0.0108	0.3863	0.1877
Heat death rates = HI	0.1707	0.1117	0.1767	0.0408	0.3793	0.1930

Conclusions

- Heat index explains the variation in heat-related ED visit rates better than maximum temperature or relative humidity alone.

- Equation for Heat Index:

$$HI = c_1 + c_2T + c_3R + c_4TR + c_5T^2 + c_6R^2 + c_7T^2R + c_8TR^2 + c_9T^2R^2$$

Conclusions

- Use of heat index as an indicator of heat-related ED visits rather than temperature or relative humidity alone is reinforced.
- This is the first time we have systematically linked findings from ESSENCE to quantifiable environmental data.

Conclusions

- With extreme climate change on the rise, ESSENCE will be even more important as a surveillance tool in the coming years.
- Such results can help NWS partners and public health leaders to make informed decisions regarding extreme heat alerts.

Conclusions

Heat Index	Health Effects
80 to 89 degrees	Fatigue is possible with prolonged exposure and/or physical activity.
90 to 104 degrees	Sunstroke, heat cramps, and heat exhaustion are possible with prolonged exposure and/or physical activity.
105 to 129 degrees	Sunstroke, heat cramps, and heat exhaustion are likely. Heat stroke is possible with prolonged exposure and/or physical activity.
130+ degrees	Heat stroke/sunstroke likely with continued exposure.

Conclusions

Examples of Heat advisory warning message in Missouri

- The NWS has issued an **Excessive Heat Warning** for the counties of Clay, Jackson and Platte effective from 10 am Tuesday, June 23 thru 10 pm Wednesday, June 24, 2009. A Heat Advisory remains in effect from now until 10 am tomorrow. The Excess Heat Warning is also in effect for Johnson and Wyandotte counties in Kansas.

Conclusions

- Kansas City Metro response to heat alerts:
  - The Kansas City Health Department coordinates with NWS to send warnings to the metro area and conducts surveillance using ESSENCE, First Watch, and death data.
  - The response (watering tents, cooling shelters, etc.) is coordinated among the Red Cross and four local health jurisdictions in the Kansas City metro area.

Limitations

- The causal association between the increase in heat index and the increase in heat-related ED visits does not necessarily translate to individual sites.
  - In spite of Missouri's extreme variety in its weather, summer temperatures are relatively uniform across the state [6].

Limitations

- Potential confounding or effect modification by air pollution could affect increases in heat-related ED visits.

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