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Distribution of Extreme Heat Days across Louisiana

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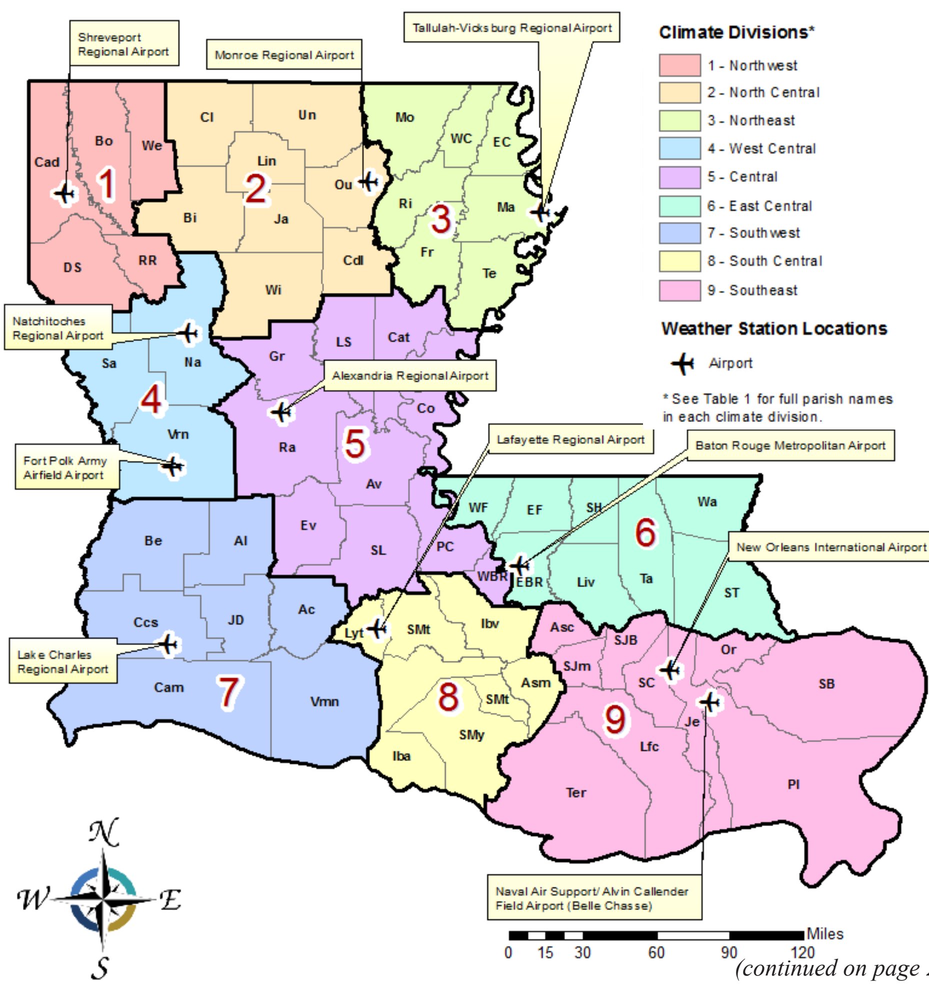
In August 2018, Louisiana summer weather made national news when Forbes published a blog post by climate scientist Brian Brettschneider titled "Who Has the Most Oppressive Weather?" The author determined that Louisiana "is the epicenter of summertime oppressive weather." This was based on the evaluation of temperature data from 380 weather stations across the country between noon and 6 p.m. from 1998-2017. Oppressiveness was defined as either a temperature or heat index ≥ 95°F or a dew point ≥ 75°F coupled with a wind speed ≤ 10 mph. Based on these parameters, Louisiana spent 40-70% of the summers from 1998-2017 between the hours of noon and 6 p.m. in oppressive heat. Conditions that promote oppressive summer heat are very light winds and a consistently high dew point in the Lower Mississippi River Valley. Even if the temperature does not reach 95°F, the heat index or dew point criteria are usually met.

This issue of the Louisiana Morbidity Report discusses extreme heat and heat-stress illness (HSI). Two articles in this edition report on HSI for the state and by climate division from 2010-2016. One article examines HSI in the entire population while the other focuses on workers. Both articles examine the relationship between temperature and heat index and HSI emergency department visits. This article discusses extreme heat in Louisiana's climate divisions. Information is provided about temperature normals, actual temperature and heat index data for 2010-2016 as well as extreme temperature and heat index thresholds utilized in both of the above-mentioned studies.

Methods

Louisiana has nine climate divisions. The parishes within each climate division have nearly homogenous characteristics regarding temperature, precipitation and humidity. We chose one weather station in each climate division to represent the entire cli-

Figure 1. Louisiana Climate Divisions, Parishes, and Respresentative Weather Station Locations



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mate division. Figure 1 is a map of the state divided into climate divisions with the parishes (names abbreviated) and each weather station location labeled. Table 1 provides the full name of the parishes in each climate division. In the West Central and Southeast climate divisions, there were gaps in the primary weather station data (Fort Polk Army Airfield and New Orleans International Airport, respectively); therefore, data from a secondary weather station was used to fill in the gaps.

A climatological normal is the 30-year average value of a meteorological element. The normal describes the climate and serves as a base to compare current conditions. The normal monthly maximum temperature (T_{max}) data for 1981-2010 for each weather station was obtained from the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information. In climate divisions where data from two weather stations was used the normal data were averaged. Temperature, heat index and precipitation data were obtained from the Southern Regional Climate Center's climate data portal and from Iowa State University's Iowa Environmental Mesonet ASOS-AWOS-METAR Data Download Page (https://mesonet.agron.iastate.edu/request/download.phtml). Historical data (1895-2019) were obtained from NOAA's "Climate at a Glance: Statewide Time Series" (https://www.ncdc.noaa.gov/cag/).

Heat index is a measure of how hot it feels temperature-wise when relative humidity is factored in with the actual air temperature. We defined extreme heat as a T_{max} or a maximum heat index (HI_{max}) ≥ 95°F; however, because the northern parts of Louisiana often see triple-digit temperatures in summer, we also examined a threshold of T_{max} or HI_{max} ≥ 100°F. Additionally, a daily low temperature that is too high can promote heat illness. Thresholds for the daily low temperature were investigated at 75°F and 80°F to identify their risk to Louisiana residents.

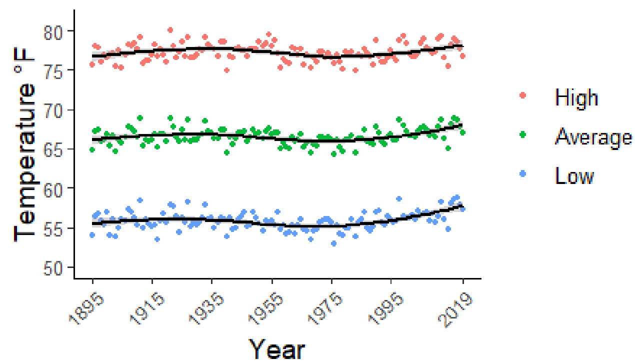
Table 1. Parishes within each Climate Division

Climate Division (#)	Parishes (Parish name abbreviation)
Northwest (1)	Bossier (Bo), Caddo (Cad), DeSoto (DS), Red River (RR), Webster (We)
North Central (2)	Bienville (Bi), Caldwell (Cdl), Claiborne (Cl), Jackson (Ja), Lincoln (Lin), Ouachita (Ou), Union (Un), Winn (Wi)
Northeast (3)	East Carroll (EC), Franklin (Fr), Madison (Ma), Morehouse (Mo), Richland (Ri), Tensas (Te), West Carroll (WC)
West Central (4)	Natchitoches (Na), Sabine (Sa), Vernon (Vrn)
Central (5)	Avoyelles (Av), Catahoula (Cat), Concordia (Co), Evangeline (Ev), Grant (Gr), La Salle (LS), Pointe Coupee (PC), Rapides (Ra), St. Landry (SL), West Baton Rouge (WBR)
East Central (6)	East Baton Rouge (EBR), East Feliciana (EF), Livingston (Liv), St. Helena (SH), St. Tammany (ST), Tangipahoa (Ta), Washington (Wa), West
Southwest (7)	Acadia (Ac), Allen (Al), Beauregard (Be), Calcasieu (Ccs), Cameron (Cam), Jefferson Davis (JD), Vermilion (Vmn)
South Central (8)	Assumption (Asm), Iberia (Iba), Iberville (Ibv), Lafayette (Lyt), St. Martin (SMt), St. Mary (SMy)
Southeast (9)	Ascension (Asc), Jefferson (Je), Lafourche (Lfc), Orleans (Or), Plaquemines (Pl), St. Bernard (SB), St. Charles (SC), St. James (SJm), St. John the Baptist (SJB), Terrebonne (Ter)

Results and Discussion

Figure 2 shows the average summer temperatures from the years 1895-2019 for the whole state. Using a locally estimated scatterplot smoothing regression (LOESS) it can be seen that

Figure 2. Average Summer (May-Sep) Temperatures, Louisiana, 1895-2019



the average temperatures are reasonably stable during this time period with a slight dip around 1975 and an increase since 1995. Currently, the daily low temperatures are increasing faster than the daily high temperatures.

In all climate divisions, the normal T_{max} for May is in the mid-80s and enters the low-90s by June (Table 2). In July and August, the normal T_{max} ranges from the low- to mid-90s, and is slightly higher for the Northwest and North Central climate divisions than it is for the other climate divisions. By September, the summer season is starting to wane, and the normal T_{max} falls to the

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Table 2. Average Maximum Temperature (T_{max}), Maximum Heat Index (HI_{max}) and Normal* T_{max} by Month and Location, 2010-2016

Climate	May	June	July	August	September
Northwest: Shreveport Regional Airport					
Normal T_{max}	84	90	93	94	88
T_{max}	85	93	95	97	92
HI_{max}	86	97	100	101	94
North Central: Monroe Regional Airport					
Normal T_{max}	85	92	94	94	89
T_{max}	85	93	94	95	91
HI_{max}	87	98	101	102	94
Northeast: Tallulah-Vicksburg Regional Airport					
Normal T_{max}	84	90	92	92	87
T_{max}	85	92	93	94	90
HI_{max}	86	98	100	101	93
West Central: Fort Polk Army Airfield/ Natchitoches Regional Airport					
Normal T_{max}	85	91	93	94	88
T_{max}	84	91	92	93	89
HI_{max}	86	96	98	99	92
Central: Alexandria Regional Airport					
Normal T_{max}	85	90	92	93	88
T_{max}	86	92	93	95	90
HI_{max}	87	98	100	101	93
East Central: Baton Rouge Metropolitan Airport					
Normal T_{max}	86	91	92	93	89
T_{max}	86	91	92	93	89
HI_{max}	87	97	100	101	93
Southwest: Lake Charles Regional Airport					
Normal T_{max}	85	89	91	92	88
T_{max}	85	91	92	93	90
HI_{max}	88	98	100	102	94
South Central: Lafayette Regional Airport					
Normal T_{max}	86	91	92	93	89
T_{max}	86	91	91	93	90
HI_{max}	88	98	99	101	94
Southeast: New Orleans International Airport/ Alvin Callender Field Airport (Belle Chasse)					
Normal T_{max}	85	90	91	91	88
T_{max}	85	90	91	91	89
HI_{max}	88	97	100	101	94

All temperatures are in degrees Fahrenheit; * Normal temperature maximums are 30-year averages for the years 1981-2010 as calculated by the the National Oceanic and Atmospheric Adminstration's National Centers for Environmental Information

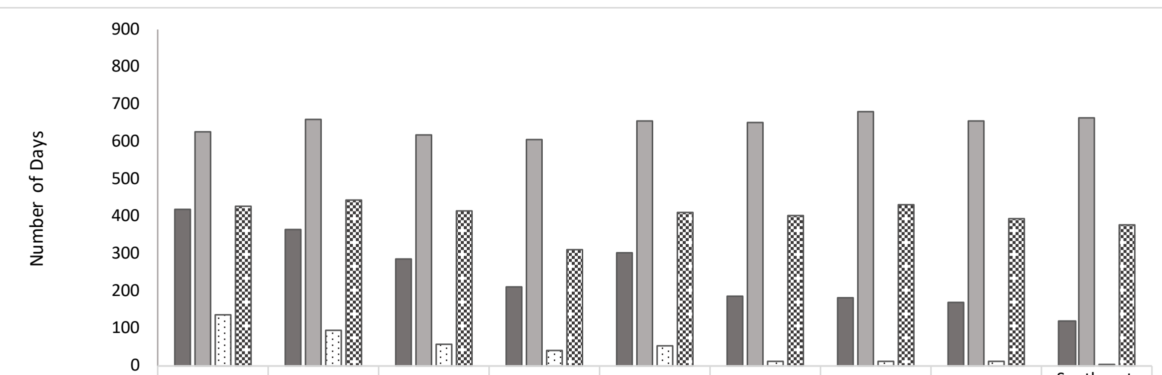
upper-80s.

Across climate divisions, the difference between the average monthly T_{max} for 2010-2016 and the normal T_{max} for each climate division ranged from 0°F-4°F (Table 2). On average, the normal T_{max} has a standard deviation (SD) of 2°F across the months of May-September. Using the average SD as a threshold for substantial deviation from the normal T_{max}, the Northwest climate division had the most substantial increases in average monthly T_{max} compared to normal monthly T_{max}. The T_{max} was 2°F or higher than normal for June through September in the Northwest climate division. The Northeast and Central climate divisions experienced an increased T_{max} in the months of June, August and September. The T_{max} in the North Central and Southwest climate divisions was higher than normal in September. In the East Central, South Central, and Southeast climate divisions, T_{max} did not rise above normal.

For the most part, from 2010-2016, the average HI_{max} is not substantially different among climate divisions (Table 2). The degrees increase between T_{max} and HI_{max} in each climate division is where differences emerge. Generally, the largest increases occurred in the more southern climate divisions, and the smallest increases occurred in the more northern climate division. For example, in August, the average T_{max} was 91°F in the Southeast climate division and 97°F in the Northwest climate division, and the HI_{max} was 101°F in both climate divisions. This means that in the Southeast climate division there was a 10-degree difference between the T_{max} of 91°F and the "feels like" temperature or HI_{max} of 101°F versus a 4-degree difference between the T_{max} of 97°F in the Northwest and the "feels like" temperature or HI_{max} of 101°F in the Northwest climate division.

Figure 3 presents the number of days from 2010-2016 where T_{max} and HI_{max} reached or exceeded the thresholds of at least 95°F or at least 100°F. The southern and East Central climate

Figure 3. Number of Days Daily Maximum Temperature (T_{max}) and Heat Index (HI_{max}) Exceeded Threshold by Location, 2010-2016



	Northwest: Shreveport	North Central: Monroe	Northeast: Tallulah-Vicksburg	W. Central: Fort Polk/ Natchitoches	Central: Alexandria	East Central: Baton Rouge	Southwest: Lake Charles	South Central: Lafayette	Southeast: New Orleans/ Belle Chasse
Tmax ≥ 95	417	365	286	213	302	185	182	170	119
HImax ≥ 95	625	658	620	605	657	650	680	655	666
Tmax ≥ 100	136	93	58	40	55	11	11	12	4
HImax ≥ 100	428	444	413	310	412	401	431	392	377

(Distribution of Extreme Heat Days ... continued from page 3)

Table 3. Average Minimum Temperature (T_{min}), Minimum Heat Index (HI_{min}) and Normal* T_{min} by Month and Location, 2010-2016

Climate Division: Weather Station Location	May	June	July	August	September
Northwest: Shreveport Regional Airport					
Normal T_{min}	63	70	73	72	66
T_{min}	64	73	74	75	68
HI_{min}	64	73	75	76	69
North Central: Monroe Regional Airport					
Normal T_{min}	63	70	72	71	64
T_{min}	63	72	73	73	66
HI_{min}	64	73	74	74	67
Northeast: Tallulah-Vicksburg Regional Airport					
Normal T_{min}	62	68	71	70	63
T_{min}	61	70	72	71	64
HI_{min}	62	71	72	72	65
West Central: Fort Polk Army Airfield/ Natchitoches Regional Airport					
Normal T_{min}	64	72	75	74	67
T_{min}	65	72	74	74	69
HI_{min}	65	72	74	75	69
Central: Alexandria Regional Airport					
Normal T_{min}	64	70	73	72	66
T_{min}	64	72	73	73	67
HI_{min}	64	72	74	74	68
East Central: Baton Rouge Metropolitan Airport					
Normal T_{min}	65	71	74	73	69
T_{min}	65	73	74	74	69
HI_{min}	66	73	75	75	70
Southwest: Lake Charles Regional Airport					
Normal T_{min}	67	73	75	74	69
T_{min}	67	74	76	76	71
HI_{min}	67	75	76	77	71
South Central: Lafayette Regional Airport					
Normal T_{min}	67	73	75	75	70
T_{min}	67	74	75	75	71
HI_{min}	68	75	76	76	71
Southeast: New Orleans International Airport/ Alvin Callender Field Airport (Belle Chasse)					
Normal T_{min}	68	74	75	75	72
T_{min}	68	75	76	77	73
HI_{min}	69	76	77	78	74

All temperatures are in degrees Fahrenheit; * Normal temperature minimums are 30-year averages for the years 1981-2010 as calculated by the the National Oceanic and Atmospheric Adminstration's National Centers for Environmental Information

divisions had fewer than 200 (18.6%) days where $T_{max} \geq$ 95°F, and the Northwest climate division had over 400 (37.3%) days; however, all climate divisions had well over 600 (56%) days where the $HI_{max} \geq$ 95°F, with the greatest number occurring in the Southwest climate division. With the exception of the Northwest climate division, all of the climate divisions had less than 100 (9.3%) days where $T_{max} \geq$ 100°F, the East Central and southern climate divisions had fewer than 20 (1.8%) days; however, most climate divisions experienced over 400 days where $HI_{max} \geq$ 100°F.

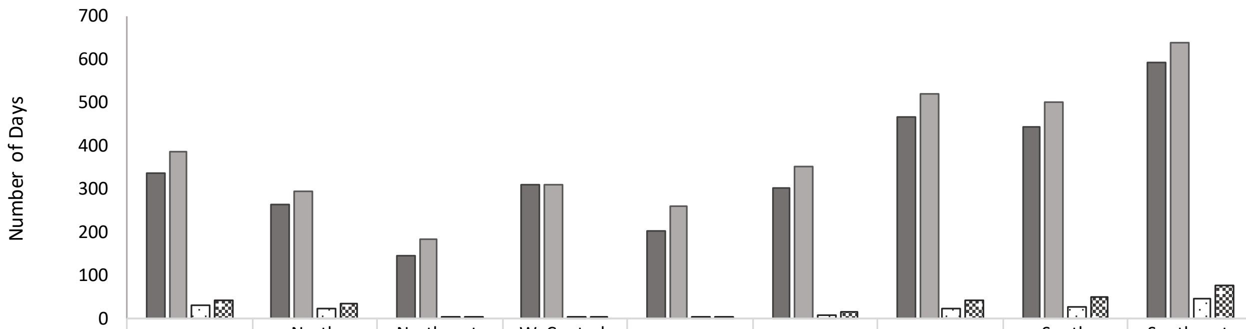
Days with extreme high temperatures are often accompanied by low temperatures that are high as well. In all climate divisions, the normal T_{min} for May is in the low- to mid-60s and enters the low- to mid-70s by June until falling to the mid-60s to low-70s in September (Table 3). In contrast to high temperatures, minimum temperatures are higher in the Southwest, South Central, and Southeast climate divisions. Differences between normal T_{min} and average monthly T_{min} and HI_{min} were less pronounced than normal T_{max} and average monthly T_{max}. The largest deviations from normal T_{min} were in the Southeast climate division where T_{min} and HI_{min} were 2-3°F higher. In general, T_{min} and HI_{min} did not differ significantly.

Figure 4 presents the number of days from 2010-2016 where daily T_{min} and HI_{min} reached or exceeded the thresholds of at least 75°F or at least 80°F. Overall, there were not many days with a T_{min} or HI_{min} over 80°F with the range being between 0 and 79 days. Days with a T_{min} or HI_{min} over 75°F ranged from a low of ~200 days in the Northeast and Central climate divisions while the southern climate divisions had the highest counts at 444-640 days.

The southern (and often the Central) climate divisions, in particular the Southeast climate division, have lower average monthly T_{max} than the northern climate divisions, this trend is reversed for T_{min}. In addition, the southern climate divisions have far fewer days where the $T_{max} \geq$ 95°F or 100°F than climate divisions further north. The primary reason that south Louisiana rarely sees temperatures ≥ 100°F is due to the amount of water around the region. These bodies of water absorb heat through the process of evaporation, which in turn leads to high humidity. High humidity can make it feel like the temperature is in the triple-digits; however, it also produces clouds and thunderstorms, which act to reduce the temperature. If the temperature climbs into the upper 90s, the atmosphere generally responds by creating thunderstorms. In this way, thunderstorms are regulators that, for the most part, prevent the temperature from reaching triple-digits in south Louisiana. Before the cooling effect of the thunderstorm, the heat index can reach the 100s. The northern parts of the state do not have the same insulating bodies of water surrounding them; therefore, they tend to experience a higher average monthly T_{max} and many more

(Distribution of Extreme Heat Days ... continued from page 4)

Figure 4. Number of Days Daily Minimum Temperature (Tmin) and Heat Index (HImin) Exceeded Threshold by Location, 2010-2016



	Northwest: Shreveport	North Central: Monroe	Northeast: Tallulah-Vicksburg	W. Central: Fort Polk/ Natchitoches	Central: Alexandria	East Central: Baton Rouge	Southwest: Lake Charles	South Central: Lafayette	Southeast: New Orleans/ Belle Chasse
Tmin ≥ 75	337	264	148	312	203	305	468	444	593
HImin ≥ 75	389	296	187	312	263	352	522	501	640
Tmin ≥ 80	34	24	4	6	1	11	25	30	47
HImin ≥ 80	45	37	5	6	5	18	44	51	79

days where the T_{max} ≥ 95°F or 100°F than the more southern parts of the state.

Humidity, which is a main determinant of heat index, is a measure of the amount of water vapor in the air. Humidity plays an important role in sweating, the body's primary cooling mechanism. When humidity is high, heat exchange efficiency is impaired which reduces the rate of moisture evaporation from the surface of the skin. As anyone living in south Louisiana knows, when humidity is high, sweat does not evaporate very quickly and you feel hotter than the actual temperature. While prolonged or intense exposure to hot temperatures are obvious risk factors for heat-stress illness, anything that interferes with the body's ability to cool itself, including high humidity, increases the risk for heat-stress illness. While certain areas of the state tend to experience higher actual temperatures and other areas experience higher humidity, the risk of heat-stress illness is high for all of Louisiana.

Occupational Heat-Stress Illness Emergency Department Visits and Hospitalizations in Louisiana and its Climate Divisions, 2010-2016

Anna Reilly, Ph.D., M.P.H.

Working in a hot environment, whether indoors or outdoors, can be dangerous. Core body temperature must be maintained within a very narrow range (97.7-99.5°F). A 2°F increase in body temperature can affect mental functioning; a 5°F increase can result in serious injury or death. Exposure to extreme heat can interfere with sweating, the body's primary cooling mechanism, putting workers at risk of heat-stress illness (HSI). Milder forms of HSI include heat rash, heat cramps and heat exhaustion, which often lead to worker irritability, low morale, absenteeism and shortcuts in procedures. The most serious form of HSI, heat stroke, is a medical emergency that can be fatal. HSI may be an underlying cause of other types of injuries such as heart attacks, falls and equipment accidents. Accidents leading to injuries can occur due to sweaty palms and fogged-up safety glasses; burns can occur from accidental contact with hot surfaces or steam.

Occupations considered high-risk for HSI include firefighters, bakery and kitchen workers, laundry workers, landscapers, agricultural workers, construction workers, oil and gas workers, electrical utility (especially boiler room) workers, mail and package deliverers, and factory workers. These workers are exposed to occupational risk factors for HSI such as heavy physical activity (produces metabolic heat from physical exertion of energy), having to wear personal protective equipment (PPE; may interfere with the body's ability to sweat effectively), and/or hot environmental conditions (e.g., high temperature, humidity, radiant heat sources, and/or limited air movement). Additional personal factors that can increase the risk for HSI include obesity, advanced age (≥ 65 years), poor cardiovascular fitness, underlying health problems, existing burns (may damage or destroy sweat glands), use of certain medications, pregnancy, previous HSI, and lack of acclimatization (heat tolerance).

Thousands of workers in Louisiana are at risk of HSI. Many industries and occupations are vulnerable to HSI, but the industries most affected by HSI due to outdoor heat are construction,

(Occupational Heat-Stress Illness ... continued from page 5)

agriculture, and oil and gas well operations. About 13.2% of Louisiana's workforce is employed in the construction, agriculture or mining (includes oil and gas) industries. Summers in Louisiana get hot and, especially in south Louisiana, humid. The daily maximum heat index (HI_{max}) reached 95°F or higher in all climate divisions for 58-73% of summer days (May-Sep), and reached 100°F or higher for 35-56% of summer days from 2010-2016. Since 2010, the Occupational Health Program has been collecting HSI emergency department (ED) visit data as one of a suite of occupational health indicators submitted to the National Institute for Occupational Safety and Health (NIOSH) every year. This analysis characterizes occupational HSI ED visits and inpatient hospitalizations in Louisiana by age group, sex and comorbidity for 2010-2016. Occupational HSI ED visit rates by climate division are also examined, and the relationship between the number of monthly occupational ED visits and average monthly maximum summer temperatures as well as temperature thresholds of 95°F and 100°F from 2010-2016 is examined.

Methods

State ED records and Louisiana Hospital Inpatient Discharge Database (LaHIDD) records were used to select occupational HSI ED visits and inpatient hospitalizations, respectively, for Louisiana residents admitted from May 1, 2010 – Sep 30, 2016. An HSI case was a record with a primary or secondary diagnosis International Classification of Diseases, 9th/10th Revision, Clinical Modification (ICD-9-CM/ICD-10-CM) code for 'Effects of heat and light'(ICD-9-CM: 992.0 - 992.9; ICD-10-CM: T67.0XXA-T67.9XXA) or an ICD-9-CM/ICD-10-CM external cause of injury code for excessive heat (ICD-9-CM: E900.0, E900.1, E900.9; ICD-10-CM: W92.XXXA, X30.XXXA). Work-relatedness was determined by the presence of workers' compensation as the primary payer or the presence of a work-related external cause of injury ICD code (ICD-9-CM: E000.0, E000.1, E800-E807[.0], E830-E838[.2,.6], E840-E845[.2,.8], E846, E849.1, E849.2, E849.3; ICD-10-CM: Y99.0, Y99.1, Y92.61-Y92.69, Y92.71-Y92.79, Z04.2, Z57.6, Z57.8) for patients at least 16 years of age. ICD-9-CM codes were used for 2010-2015 Q3 data; ICD-10-CM codes for 2015 Q4-2016 data. Cases were flagged for the presence of the following comorbid conditions (as a primary or secondary diagnosis): cardiovascular disease (ICD-9-CM 390-398, 404-429, 440-448, 402), cerebrovascular disease (ICD-9-CM 430.0-438.9), respiratory disease (ICD-9-CM 460.0-519.9), renal disease (ICD-9-CM 580.0-589.9), diabetes (ICD-9-CM 250.0-250.9), and injury (ICD-9-CM 800.0-904.9, 910.0-959.9). ICD-10-CM code equivalents for the ICD-9-CM codes of these comorbid conditions were looked up using a crosswalk table provided by the Louisiana Department of Health's (LDH's) Bureau of Health Informatics.

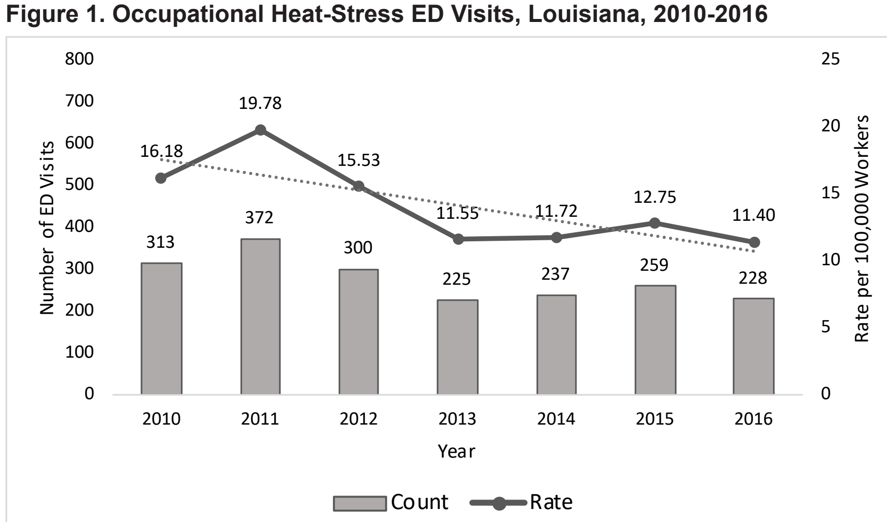
Occupational HSI ED visits and hospitalizations were stratified by year, age group, sex, comorbidity and climate division (based on parish of residence). Prevalence was calculated as the percent of total occupational HSI ED visits or hospitalizations for age group, sex and comorbidity. Comorbidity prevalence among age groups was also calculated. Annual rates per 100,000 workers were calculated for occupational HSI ED visits and hospitalizations, and where appropriate the Mann-Kendall test for trend was done for rates over time. Seven-year average annual rates per 100,000 workers were calculated for occupational HSI ED visits and hospitalizations by age group and climate division. Spearman rank correlation was used to examine the relationship between the monthly number of occupational HSI ED visits, the monthly average maximum temperature (T_{max}), the monthly average HI_{max}, the number of days per month T_{max} and $HI_{max} \geq 95$°F, and the number of days T_{max} and $HI_{max} \geq 100$°F for each year from 2010-2016. Statistical significance was set as $p < 0.05$.

For rate calculation, Louisiana's employed population stratified by age was obtained using NIOSH's Work-related Injury Statistics and Resource Data System's Employed Labor Force application, which utilizes data from the Bureau of Labor Statistics' (BLS) Current Population Survey. The employed population of each parish was obtained from the Local Area Unemployment Statistics, a federal-state cooperative program for which the BLS prepares monthly estimates of total employment and unemployment. Data was aggregated to obtain the employed population of each climate division. All analyses were performed using SAS EG version 7.1 and maps were created using ESRI ArcGIS version 10.6.1.

Results and Discussion

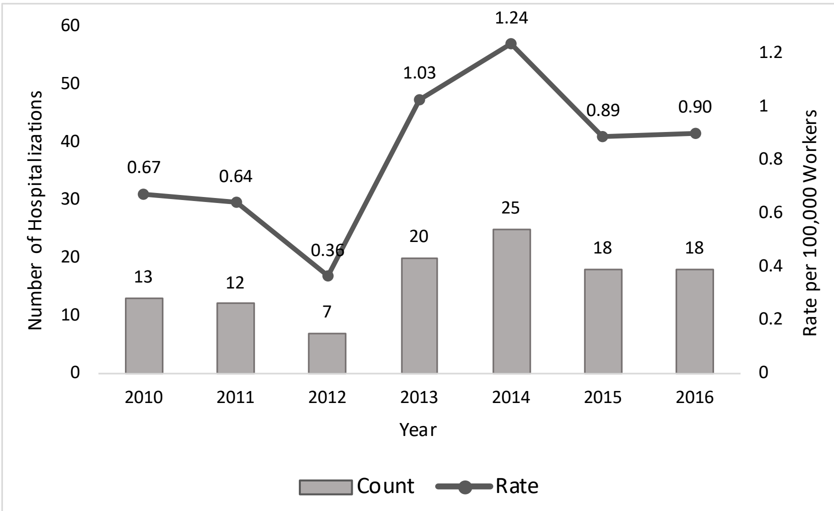
From 2010-2016, the number of occupational HSI ED visits ranged from 225-372 per year, and there was a non-significant downward trend (Kendall's $\tau = -0.6$, p=0.05) in the occupational HSI ED visit rate during this time (Figure 1). The highest rate,

Figure 1. Occupational Heat-Stress ED Visits, Louisiana, 2010-2016



(Occupational Heat-Stress Illness ... continued from page 6)

Figure 2. Occupational Heat-Stress Hospitalizations, Louisiana, 2010-2016



19.78 per 100,000 workers, occurred in 2011; the lowest rate, 11.40, occurred in 2016. The number of occupational HSI hospitalizations ranged from 7-25 per year, and rates ranged from 0.36-1.24 per 100,000 workers (Figure 2). Hospitalizations did not follow a monotonic pattern; therefore, the Mann-Kendall test was not performed. The highest rate occurred in 2014, and the lowest rate occurred in 2012.

Table 1 displays the number and percentage of occupational HSI ED visits and hospitalizations in the state from 2010-2016. There were 1,934 occupational HSI ED visits and 113 occupational HSI hospitalizations, with average annual rates of 13.99 per 100,000 workers and 0.82 per 100,000 workers, respectively. Nearly all occupational HSI ED visits were male and about a third were under 30 years of age. Similar to occupational HSI ED visits, almost all HSI hospitalizations patients were male. About a third of the patients were between the ages of 30-39 years. The ED visit rate for occupational HSI was highest in the youngest age group (< 30 years) and linearly decreased with age; however, occupational HSI hospitalization rates by age group did not follow a linear pattern (Figure 3). The highest rates were for those aged

Figure 3. Occupational Heat-Stress ED Visit and Hospitalization Rates by Age Group, Louisiana, 2010-2016

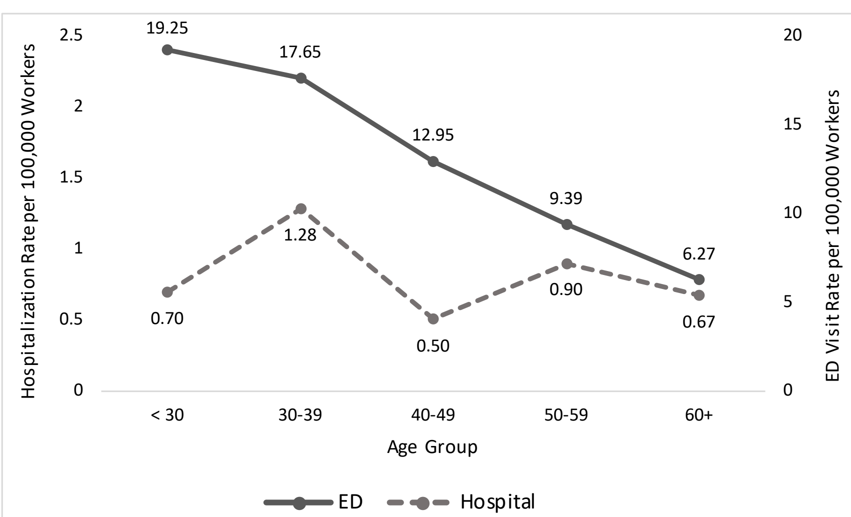


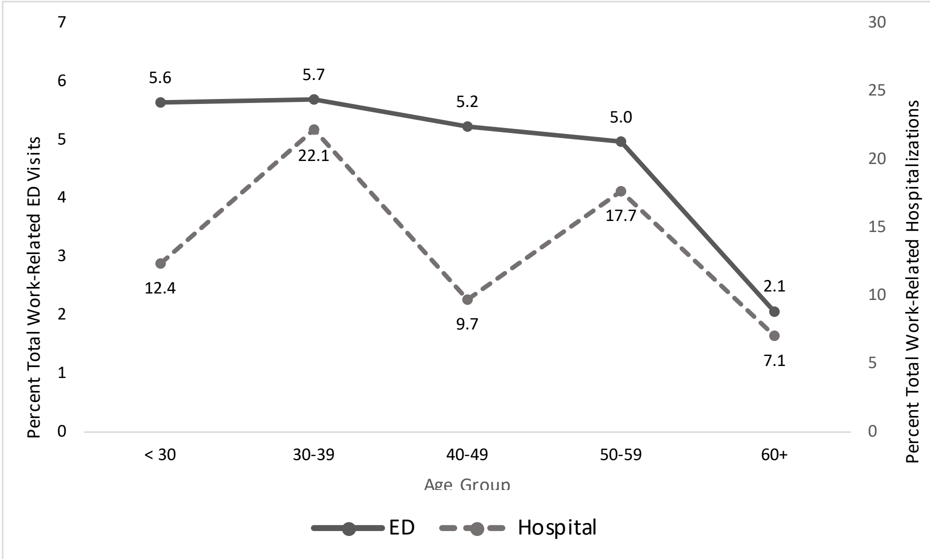
Table 1. Number and Percentage of Occupational Heat-Stress Illness ED Visits and Hospitalizations, Louisiana, 2010-2016

	ED		LAHIDD	
	No.	%*	No.	%*
Total Count	**1,934**	---	**113**	---
Age Group (years)				
< 30	662	34.2	24	21.2
30-39	522	27.0	38	33.6
40-49	386	20.0	15	13.3
50-59	271	14.0	26	23.0
60+	93	4.8	10	8.8
Sex^				
Male	1,768	91.4	108	95.6
Female	164	8.5	4	3.5
Comorbidity				
Cardiovascular	84	4.3	17	15.0
Cerebrovascular	2	0.1	1	0.9
Diabetes	82	4.2	9	8.0
Renal	250	12.9	60	53.1
Respiratory	62	3.2	10	8.8
Injury	42	2.2	2	1.8
None	1,476	76.3	35	31.0

Percentages may not add up to 100 due to rounding and because patients may have had more than one comorbidity . ^Does not include cases where sex (n=2 ED; n=1 LAHIDD) was unknown.

(Occupational Heat-Stress Illness ... continued from page 7)

Figure 4. Comorbidity Prevalence* among Occupational Heat-Stress ED Visits and Hospitalizations by Age Group, Louisiana, 2010-2016

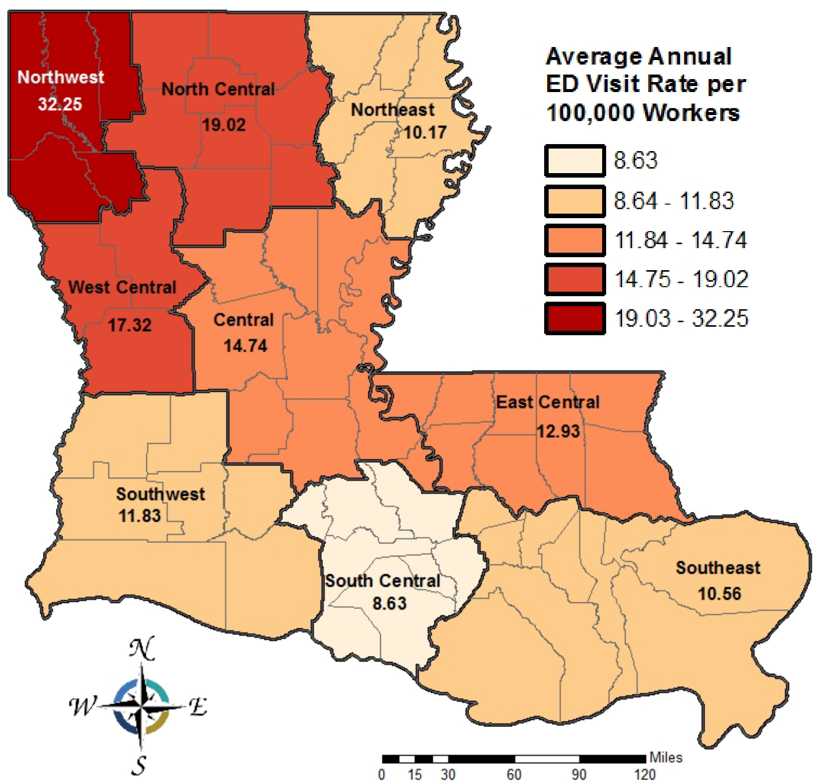


30-39 years followed by those aged 50-59 years. Occupational HSI hospitalization rates for the other age groups were similar.

Most occupational HSI ED visits did not have a comorbid condition (Table 1). Of those with a comorbidity, renal disease was the most common, followed by cardiovascular disease and diabetes. Patients younger than 60 years old accounted for the majority of comorbidities found in this population (Figure 4). Patients aged 60+ years had 2.3-2.7 times fewer comorbidities than younger patients. Comorbidities among occupational HSI hospitalizations were more common than they were among occupational HSI ED visits (Table 1). More than half of the hospitalization cases had renal disease. Cardiovascular disease was also the second most common comorbid condition listed, and diabetes and respiratory disease were nearly tied as the third most common comorbidities. The age groups with the highest occupational HSI hospitalization rates, 30-39 year-olds and 50-59 year-olds, also had the highest percentages of comorbidities (Figure 3). Similar to ED occupational HSI data, the oldest age group had the lowest percentage of comorbidities; the majority of comorbidities found among occupational HSI hospitalizations were distributed among those younger than 60 years of age.

Occupational HSI ED visit rates for 2010-2016 were the highest for the Northwest climate division, which was 1.7 times the rate for the North Central climate division (the next highest rate; Figure 5). The farther north the climate division is, the higher the rate tended to be; with the exception of the Northeast

Figure 5. Occupational Heat-Stress ED Visit Rates by Climate Division, Louisiana, 2010-2016



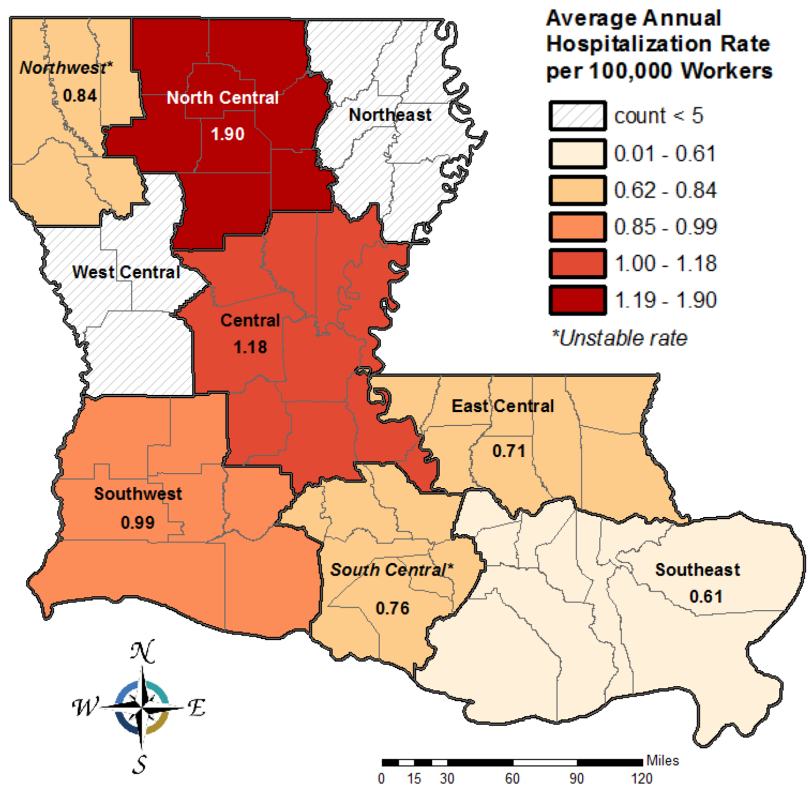
Map produced 9/25/2019 by the Louisiana Department of Health / Office of Public Health / Section of Environmental Epidemiology and Toxicology (SEET). Disclaimer: SEET cannot guarantee the accuracy of the information contained on this map and expressly disclaims liability for errors and omissions in its contents.

(Occupational Heat-Stress Illness ... continued from page 8)

climate division, which had the second lowest rate in the state. Occupational HSI hospitalization rates were highest in the North Central climate division (Figure 6). The rate in the Central climate division, which was the second highest in the state, was 1.6 times lower than the rate in the North Central climate division. Generally, the climate divisions that make up the southeastern part of the state had the lowest rates. Rates were not calculated for the Northeast and West Central climate divisions because case counts were less than five. It should also be noted that the rates for the Northwest and South Central climate divisions are unstable due to low case counts. Case counts less than 12 result in a relative standard error that is greater than or equal to 30%, which yields an unstable rate.

There was a statistically significant correlation between monthly occupational HSI ED visits and average monthly T_{max} (Table 2). The relationship, or correlation, between the two variables is denoted by Spearman's coefficient (r_s), which varies between -1 and +1. An r_s value of zero means there is no correlation; a value on 1 indicates perfect correlation. An r_s value between 0.7-0.9 is indicative of a strong correlation, 0.4-0.6 a moderate correlation, and 0.1-0.3 a weak correlation. [The closer to 1 the value of r_s is the stronger the correlation.] The sign of r_s indicates the direction of the correlation. The correlation was strong for all climate divisions except for the Northeast, West Central, and Southwest climate divisions, where it was moderate. The correlation between monthly occupational HSI ED visits and average monthly HI_{max} was also statistically significant; the strength of correlation was moderate for the Northeast, West Central, and South Central climate divisions and strong for all other climate divisions (Table 2). The correlation between the monthly number of occupational HSI ED visits and the number of days per month $T_{max} \geq 95°F$ was statistically significant for all climate divisions (Table 3). Correlation strength was strong for the Northwest, East Central, and Southeast climate divisions and moderate for the other climate divisions. The correlation between the monthly number of oc-

Figure 6. Occupational Heat-Stress Hospitalization Rates by Climate Divisions, Louisiana, 2010-2016



Map produced 9/25/2019 by the Louisiana Department of Health / Office of Public Health / Section of Environmental Epidemiology and Toxicology (SEET). Disclaimer: SEET cannot guarantee the accuracy of the information contained on this map and expressly disclaims liability for errors and omissions in its contents.

Table 2. Correlation between Monthly Occupational Heat-Stress Illness ED Visits and Average Monthly T_{max} and HI_{max} by Climate Division, 2010-2016

Climate Division: Weather Station Location(s)	Spearman coefficient (r_s)*	
	T_{max}	HI_{max}
Northwest: Shreveport	0.8	0.9
North Central: Monroe	0.7	0.8
Northeast: Tallulah-Vicksburg	0.5	0.5
West Central: Fort Polk Army/ Natchitoches	0.5	0.6
Central: Alexandria	0.7	0.8
East Central: Baton Rouge	0.8	0.8
Southwest: Lake Charles	0.6	0.7
South Central: Lafayette	0.7	0.6
Southeast: New Orleans/ Belle Chasse	0.8	0.7

$p < 0.05$

(Occupational Heat-Stress Illness ... continued from page 9)

cupational HSI ED visits and the number of days per month HI_{max} ≥ 95°F was also statistically significant for all climate divisions (Table 3). For most climate divisions, the correlation strength was strong. In the Northeast, West Central, and South Central climate divisions, it was moderate. Not all climate divisions had a statistically significant correlation between monthly occupational HSI ED visits and number of days per month T_{max} ≥ 100°F (Table 3). Among those that did, correlation strength was strong in the Northwest climate division; moderate in the North Central, West Central, Central, South Central, and Southeast climate divisions; and weak in the East Central climate division. Nearly all climate divisions had a strong statistically significant correlation between the number of occupational HSI ED visits and the number of days per month HI_{max} ≥ 100°F, except for the Northeast, West Central, and South central Climate divisions, which had a correlation of moderate strength (Table 3).

Table 3. Correlation between Occupational Heat-Stress Illness ED Visits and Days per Month T_{max} and HI_{max} Met/Exceeded Threshold by Climate Division, 2010-2016

Climate Division: Weather Station Location(s)	Spearman coefficient (r_s)*			
	Days T_{max} >= 95°F	Days HI_{max} >= 95°F	Days T_{max} >= 100°F	Days HI_{max} >= 100°F
Northwest: Shreveport	0.8	0.9	0.7	0.8
North Central: Monroe	0.6	0.7	0.5	0.8
Northeast: Tallulah-Vicksburg	0.4	0.6	**0.2**	0.5
West Central: Fort Polk Army/ Natchitoches	0.4	0.5	0.4	0.4
Central: Alexandria	0.6	0.8	0.5	0.8
East Central: Baton Rouge	0.7	0.8	0.3	0.8
Southwest: Lake Charles	0.4	0.7	**0.3**	0.7
South Central: Lafayette	0.6	0.6	0.4	0.6
Southeast: New Orleans/ Belle Chasse	0.8	0.7	0.4	0.8

**p < 0.05, unless bold*

Because only more severe cases of HSI require hospitalization, ED visit rates were predictably higher than hospitalization rates for occupational HSI. The occupational HSI ED visit rate peaked in 2011, which coincided with a particularly hot summer across the state. After 2011, the rate decreased and flattened. There was no corresponding increase in occupational HSI hospitalization rate in 2011; the rate has increased since then and may be starting to decrease. The prevalence of male occupational HSI over female occupational HSI for both ED visits and hospitalizations was expected because males tend to work outdoors more than females. Because advanced age is a risk factor for HSI, it is interesting to note that both occupational HSI ED visit and hospitalization rates were higher in younger age groups than older ones. Comorbidity may be a factor. While most ED cases did not have a comorbidity, another risk factor for HSI, those that did tended to be younger. Unsurprisingly, comorbidities were more prevalent among hospitalized cases, which represent more severe cases of HSI. We do not know what occupations these patients held or what risk factors they may have had other than the comorbid conditions in this analysis. Additional information on risk factors such as high-risk occupations or lack of acclimatization to heat could help provide explanation for the higher rates in younger age groups.

Occupational HSI ED visit rates were highest in the Northwest, North Central, and West Central climate divisions, areas that see some of the highest summer temperatures in the state; however, there was strong to moderate correlation between the number of monthly occupational ED HSI visits and several different temperature and heat index measures for nearly all climate divisions. For all climate divisions, as monthly T_{max} or HI_{max} increased, so did the monthly number of ED visits. Similarly, as the number of days per month the T_{max} or HI_{max} ≥ 95°F or 100°F increased, so did the monthly number of ED visits in all climate divisions (except for the Northeast and Southwest when T_{max} ≥ 100°F).

HSI is preventable. Understanding how to deal with heat stress can help to prevent or reduce accidents and is important to workers' health and well-being. Below are some ways to prevent heat-stress illness:

- Drink plenty of fluids. Drink often and before you are thirsty. Drink water every 15 minutes, at least one pint of water per hour.
- Employers should implement an acclimatization schedule if new employees are not used to working in the heat.
- Know signs/symptoms of heat illness; monitor yourself; use a buddy system.
- Block out direct sun and other heat sources.
- Avoid beverages containing caffeine or alcohol.
- Wear lightweight, light colored, loose-fitting clothing
- Take appropriate rest breaks to cool down

The Occupational Safety and Health Administration (OSHA)-NIOSH Heat Safety Tool (https://www.cdc.gov/niosh/topics/heatstress/heatapp.html) is a free app that is available for download through the Apple App Store or Google Play. The app features real-time heat index and hourly forecasts specific to your location, precautionary recommendations specific to heat-index associated risk levels, as well as signs, symptoms and first aid information for HSIs. The app is a great tool that workers and employers can use to help them remain safe while working outdoors.

As average temperatures across the United States increase, occupational HSI is becoming more common and gaining more attention, particularly because OSHA does not have a standard regarding heat. This summer 130 groups including several unions and public health specialists formally petitioned OSHA to start rulemaking to require employers to protect workers from heat. In July 2019, H.R. 3668 was introduced to the U.S. House of

(Occupational Heat-Stress Illness ... continued from page 10)

Representatives, directing OSHA to issue an occupational safety and health standard to protect workers from heat-related injuries and illnesses. Currently, OSHA can cite companies for heat stress violations under its General Duty Clause that requires employers to provide a place of employment that is "free from recognized hazards that are causing or likely to cause death or serious physical harm to employees." In the absence of an OSHA standard, NIOSH has developed criteria for an occupational heat exposure standard that specifically covers recommendations regarding engineering and administrative controls and PPE, which can be found here: https://www.cdc.gov/niosh/docs/2016-106/pdfs/2016-106.pdf?id=10.26616/NIOSHPUB2016106

Data Limitations

Because work-relatedness is not captured in ED or LaHIDD data, workers' compensation as the primary payer or the presence of a work-related e-code is used as a proxy. Many work-related injuries are never associated with a workers' compensation claim, and work-related e-code usage may not be consistent; therefore, this method is expected to undercount the actual number of occupational cases. The number of heat cases may also be undercounted. Heat is not always recognized as the cause of heat-induced injuries and can easily be misclassified because many heat-related symptoms overlap with other more common diagnoses. Practice pattern and payment mechanisms may affect diagnostic coding and decisions by health care providers to hospitalize patients. Veterans Affairs and institutionalized population records are not included in these data. Because we did not have information about where the patient worked, climate division was assigned based on parish of residence as a proxy. It is likely that misclassification bias occurred, as not everyone works in the parish in which they reside.

Heat-Stress Illness and Mortality in Louisiana

John Anderson, M.Sc.; Kate Friedman, M.N.S., Anna Reilly, Ph.D., M.P.H.; Arundhati Bakshi, Ph.D.

Abstract/Summary

Several programs within the Louisiana Department of Health (LDH), Section of Environmental Epidemiology & Toxicology (SEET) have been analyzing heat-stress illness. SEET's Occupational Health Program has reported on preliminary health effects of climate (2015) while tracking the effects of heat on Louisiana's workforce. The Environmental Health Tracking Program (LDH Tracking) has mainly considered the heat effects of climate as related to the surveillance of heat-stress illness. SEET has been a catalyst since 2015 for a series of outreach initiatives to improve public awareness, in an effort to keep everyone - from infants to older adults - safe from the effects of heat.

Working closely with the State Climatologist, the two SEET programs have collaborated on this article to describe the health effects of heat among Louisianans during 2010-2016. Most crucial from a public health messaging point of view, males aged 20-44 were found to be at the greatest risk of developing heat-stress illnesses, as determined by the higher frequency of this age group being treated in the Emergency Department (ED) or hospital setting for heat-stress during 2010-2016.

The major highlights of the article are summarized below:

1. Young people aged 20-44 years are most likely to require ED intervention for heat-stress illnesses.
2. Males aged 20-44 years and females aged 65+ years are most likely to require hospitalization.
3. People in the following climate divisions may be at a higher risk of experiencing heat stress illnesses that require medical intervention: Northwest, North Central, Central, and Southwest.
4. The highest rates of mortality due to heat-stress illness were observed in West Central and Southwest climate divisions, although the numbers are relatively small for the period analyzed (2010-2016) and are not likely a trend.
5. Based on a series of regression analyses, rates of ED visits, especially for males, were found to be moderately associated with daytime temperatures >= 95°F (~ 35°C) or a heat index >= 100°F (~ 38°C).

Introduction

As discussed in previous articles, extreme temperatures can overwhelm the body's ability to regulate its temperature. Prolonged exposure to very high temperatures can result in illnesses such as heat rash, heat cramps, heat exhaustion, heatstroke, and can eventually lead to death. Certain medical conditions such as diabetes, cardiovascular disease, respiratory disease, and cerebrovascular disease can be exacerbated by exposure to extreme heat.

Heat stress affects everyone differently. At particular risk are adults who are older, people working outside, athletes, homeless individuals, individuals with underlying chronic disease(s), pregnant women, children and individuals who are taking drugs that affect temperature regulation (e.g., beta-blockers, diuretics, and major tranquilizers). Healthy teens and middle-aged adults are at risk as well if they engage in vigorous physical activity (work or athletics) and do not take proper precautions to prevent heat-stress illness. Increased metabolism is one factor that places pregnant women at risk of being affected by heat illness before other individuals, potentially leading to premature labor or ad-

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verse birth outcomes. People who do not have access to cooling facilities, such as the homeless and individuals with low income, are highly vulnerable to complications due to heat-stress illness because they generally lack the means to recover from heat exhaustion. Cooling centers for the economically disadvantaged can be a lifeline during extremely high temperatures and extreme heat advisories that extend for multiple days in a row.

Heat advisories and heat waves are a serious concern in Louisiana. In August 2019, the heat index exceeded 110°F (about 43°C) for several days across many Louisiana cities. As previously discussed in this issue, however, how the same temperature “feels” can differ significantly between North Louisiana and South Louisiana. For instance, some general trends (2000-2016) indicate that heat in southern Louisiana may feel more oppressive than in northern Louisiana due to higher humidity levels. A combination of the temperature and humidity in the southern parishes often results in a higher heat index, which is a measure of what the temperature “feels like” to the human body (Figure 1).

Meanwhile, perhaps surprisingly, northern Louisiana registers a greater number of days where the maximum temperatures exceeds 95°F, versus southern Louisiana, which is closer to the equator and thereby receives more direct sun angles (Figure 2). According to the State Climatologist, this is in part due to inland distance from the moderating effects of the Gulf of Mexico. In essence, the Gulf acts like a shock absorber to temperature, making summer temperatures a little cooler in South Louisiana than that experienced in Northern Louisiana, and in winter, it causes warmer temperatures to the South. Northern Louisiana also registers a greater number of days when the nighttime temperature does not fall below 80°F (27°C), which hampers the human body’s ability to recover from an exceptionally hot day. Because many individuals may be unlikely to take note of heat stress until they begin to feel physically uncomfortable, this may put northern Louisianans at a greater risk of experiencing heat-stress illnesses.

Methods

Temperature data, collected from weather monitoring stations across Louisiana’s nine Climate Divisions, were obtained as described in the temperature article of this LMR. ED and hospitalization data (2010-2016) were processed to retrieve heat-stress illness cases (ICD-9 codes: 992, E900.0, E900.9; ICD-10 codes: T67, X30, X32) for Louisiana residents. Cases were limited to those occurring between May and September. To measure the effects of climate and air temperature, ED/hospital visits resulting from exposure to excessive heat of artificial origin were excluded. Mortality data were obtained from the Louisiana Department of Vital records and processed for the same ICD-10 codes as ED/hospitalization data to retrieve the number of deaths due to exposure to excessive natural heat. Due to the overall low counts of mortality due to heat exposure, these data were not limited to the months of May-September. Age-adjusted rates were calculated by multiplying the crude rate (age group case counts/pop. × 100,000) by the ratio of the population of that age group to the U.S. population in the year 2000. Data were analyzed and

Figure 1. Percent Days Heat Index >95°F (2000-2016)

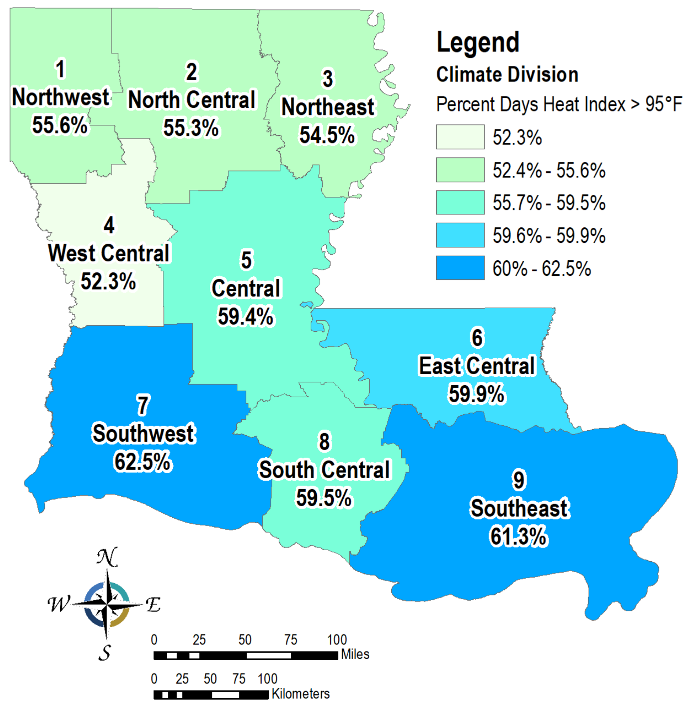
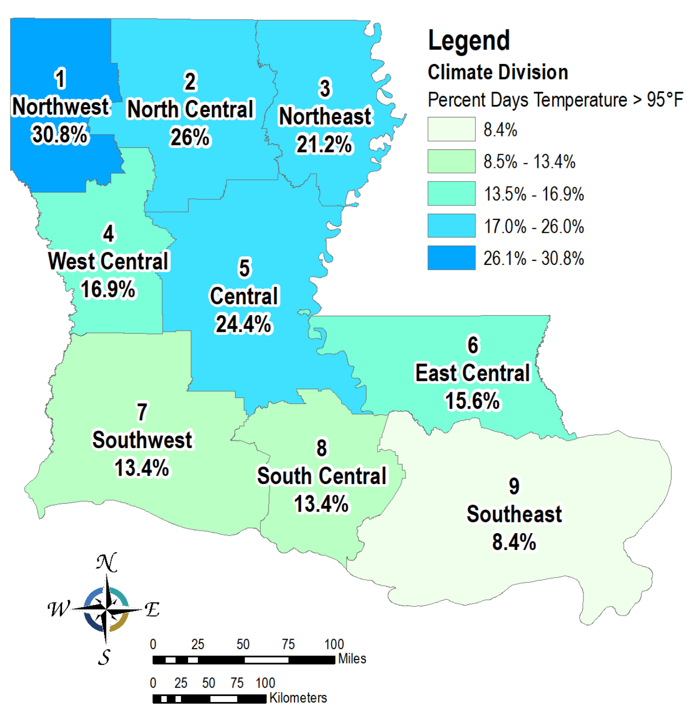


Figure 2. Percent Days Temperature >95°F (2000-2016)



(Heat-Stress Illness and Mortality... continued from page 12)

graphed using the "R" programming language. Any records with a relative standard error (RSE) over 30% were marked with an asterisk (*) to indicate that the rate calculated is unstable and should be interpreted with caution. Typically, small case counts yield unstable rates as a tiny (potentially insignificant) change in counts can result in a large difference in rates, making it difficult to make meaningful comparisons. Data with counts less than five or denominators less than 100,000 population were suppressed and are represented with blanks on figures.

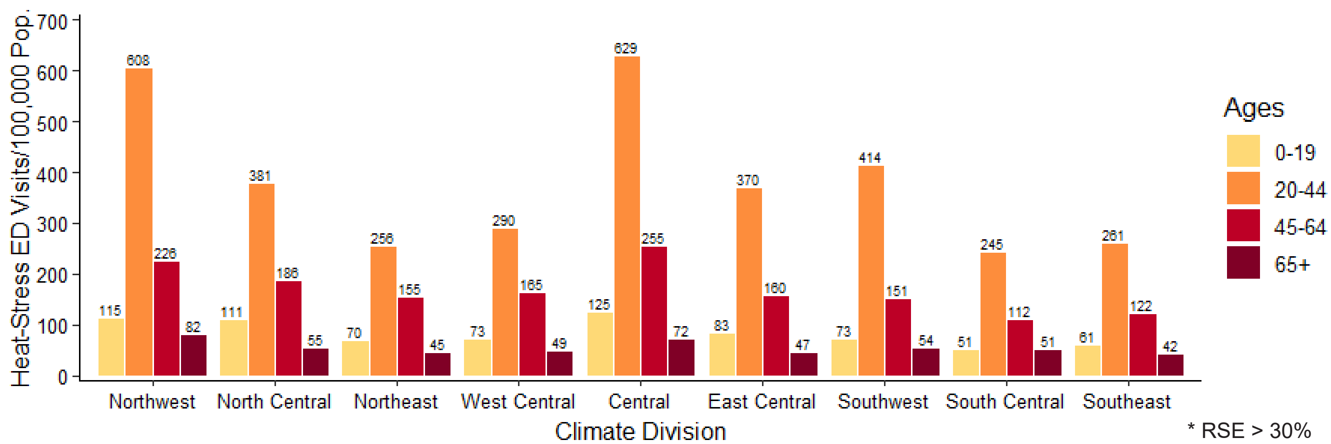
Regression analyses were conducted to understand how well the independent variables (various measures of heat; on the x-axis) could explain and predict the dependent variables (ED or hospital visits; on the y-axis). The strength of the correlation between the independent and dependent variables (for example, how well the heat index explained the ED visit rate) was determined by the value of the correlation coefficient (R^2), which ranges from zero to one. An R^2 value of zero implies that none of the data on the y-axis could be explained by the predictors on the x-axis, whereas $R^2 = 1$ implies that 100% of the data on the y-axis could be explained by the variables on the x-axis. The correlation coefficients from linear regressions were used to discern the climactic factors that would best predict the rates of ED visits/hospitalizations for heat-stress illnesses. The climate factors with the best predictive capability would have the greatest implications for effective messaging.

Results

Emergency Department Visits

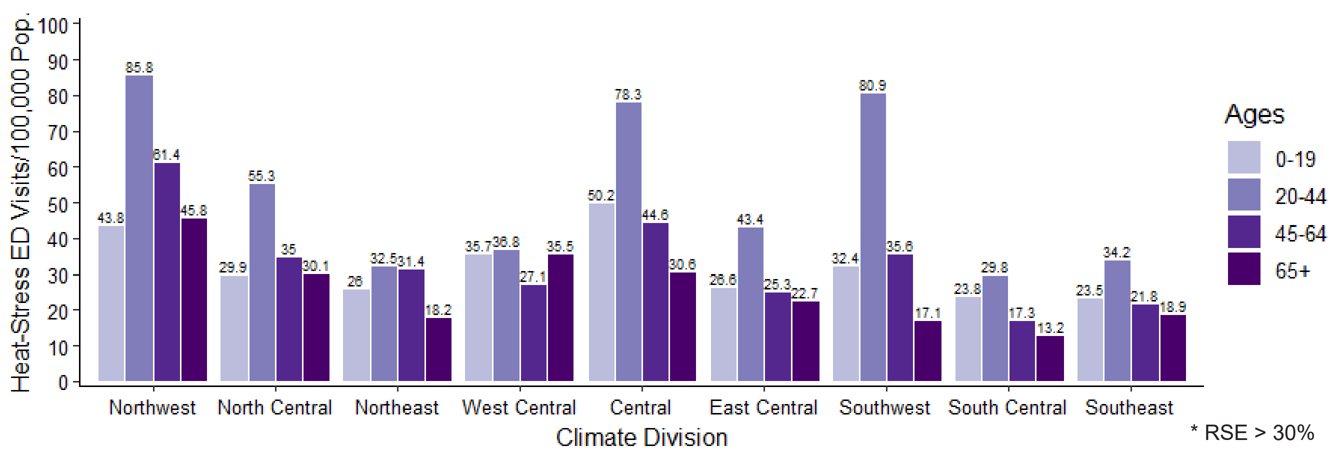
Overall, rates of ED visits for males were higher than females for all age groups. Figures 3 and 4 show the age-adjusted rates of ED visits for males and females stratified by age group. The highest rates for males were in the Northwest and Central climate divisions with over 1,000 ED visits per 100,000 population, while the lowest rates were in the South Central and Northeast with less than 550 visits per 100,000 population. For males, the 20-44 year-old age group had the highest rate of ED visits (range: 245-629 ED visits/100,000 population) with the ages 45-64 being the next highest (range: 112-226 ED visits/100,000 population). For

Figure 3. Age Adjusted Male ED visits for Heat-Stress Illness/100,000 Pop. (2010-2016)



ED = emergency department Pop. = population RSE = relative standard error

Figure 4. Age Adjusted Female ED visits for Heat-Stress Illness/100,000 Pop. (2010-2016)



ED = emergency department Pop. = population RSE = relative standard error

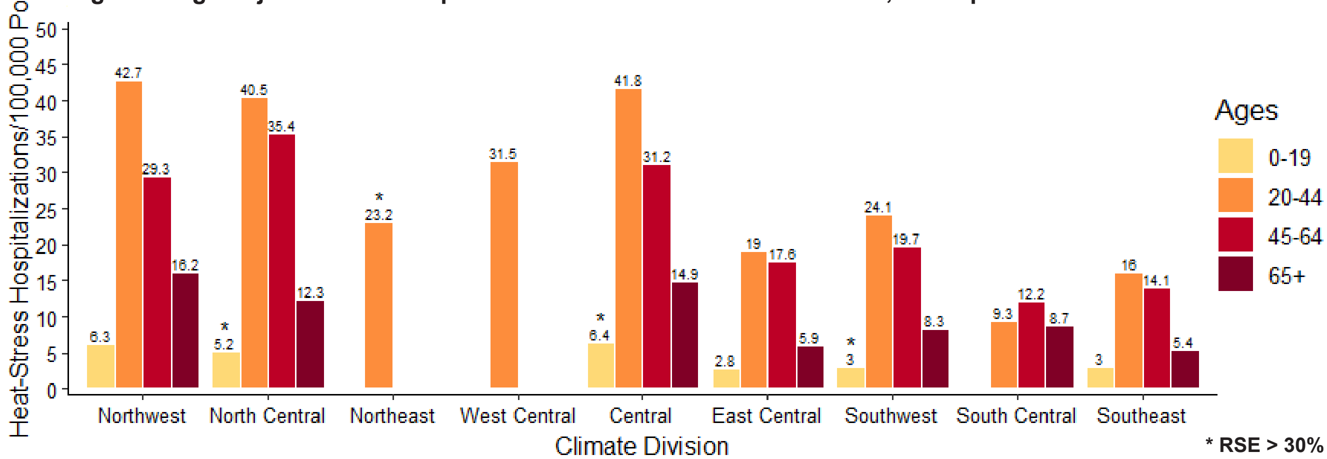
(Heat-Stress Illness and Mortality... continued from page 13)

females, the general trends stayed the same, but the differences between the age groups were less pronounced than males. The highest rates were in the Northwest and Central climate divisions with over 180 ED visits/100,000 population while the lowest rates were in the South Central and Southeast climate divisions with less than 100 ED visits/100,000 population. For females, the 20-44 age group had the highest rate of ED visits (range: 34.2-85.8 ED visits/100,000 population) while all other age groups had similar rates of ED visits in each climate division (range: 13.2-61.4 ED visits/100,000 population).

Hospitalizations

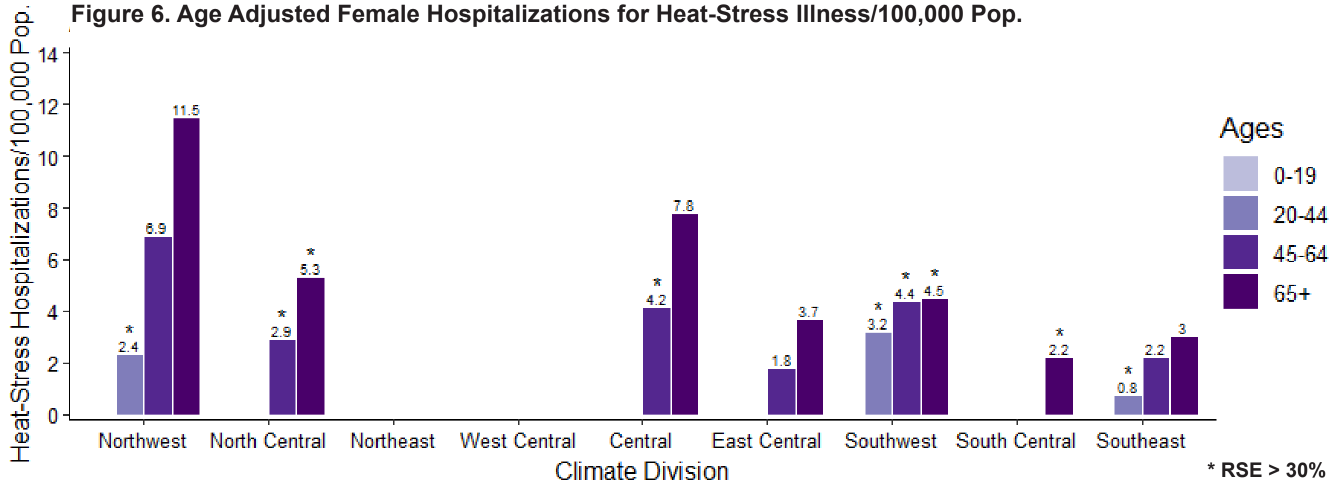
As with ED visits, rates of male hospitalizations were higher than female hospitalizations. Figures 5 and 6 show the age-adjusted rates of hospitalizations for males and females stratified by age group. The highest rates for males were in the Northwest and Central climate divisions, with > 90 hospitalizations/100,000 population, while the lowest rates were in the South Central and Southeast climate divisions, with < 30 hospitalizations/100,000 population. Males aged 20-44 and 45-64 had the most hospitalizations (range: 12.2-42.7 hospitalizations/100,000 population). Males aged 0-19 had the lowest rate of hospitalizations (range: 2.8-6.4 hospitalizations/100,000 population). For females the highest rates were in the Northwest and Central climate divisions with over 10 hospitalizations/100,000 population while the lowest rates were in Northeast and West Central (suppressed). Compared to ED visits, female hospitalizations shifted toward the older age groups with women aged 65+ having the highest rates of hospitalization (range: 3-11.5 hospitalizations/100,000 population). Similarly to males, the lowest rate of hospitalization was in females aged 0-19 (range 0.8-2.4 hospitalizations/100,000 population).

Figure 5. Age Adjusted Male Hospitalizations for Heat-Stress Illness/100,000 Pop.



Pop. = population RSE = relative standard error

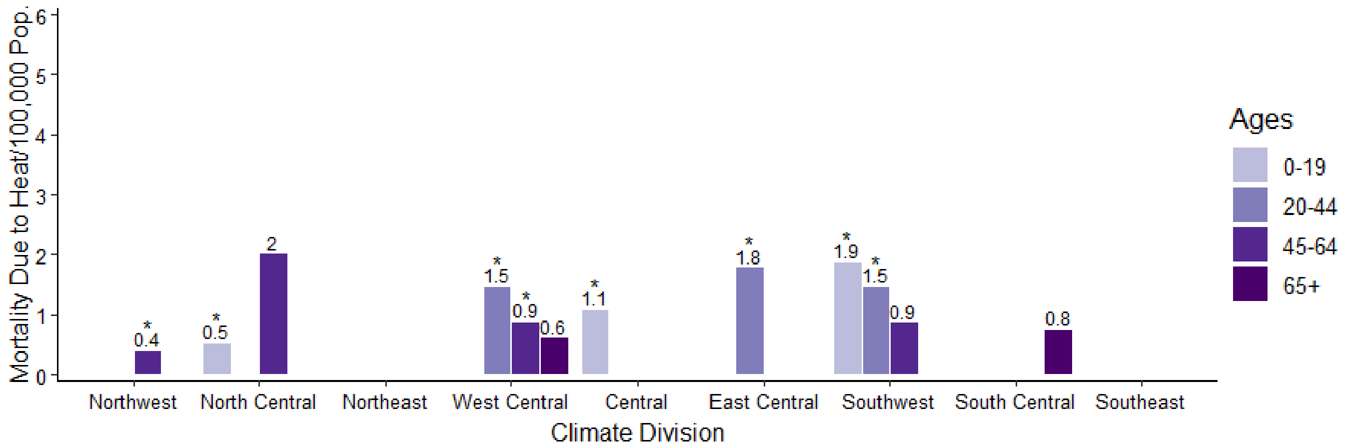
Figure 6. Age Adjusted Female Hospitalizations for Heat-Stress Illness/100,000 Pop.



Pop. = population RSE = relative standard error

(Heat-Stress Illness and Mortality... continued from page 14)

Figure 7. Age Adjusted Mortalities due to Heat/100,000 Pop. (2010-2016)



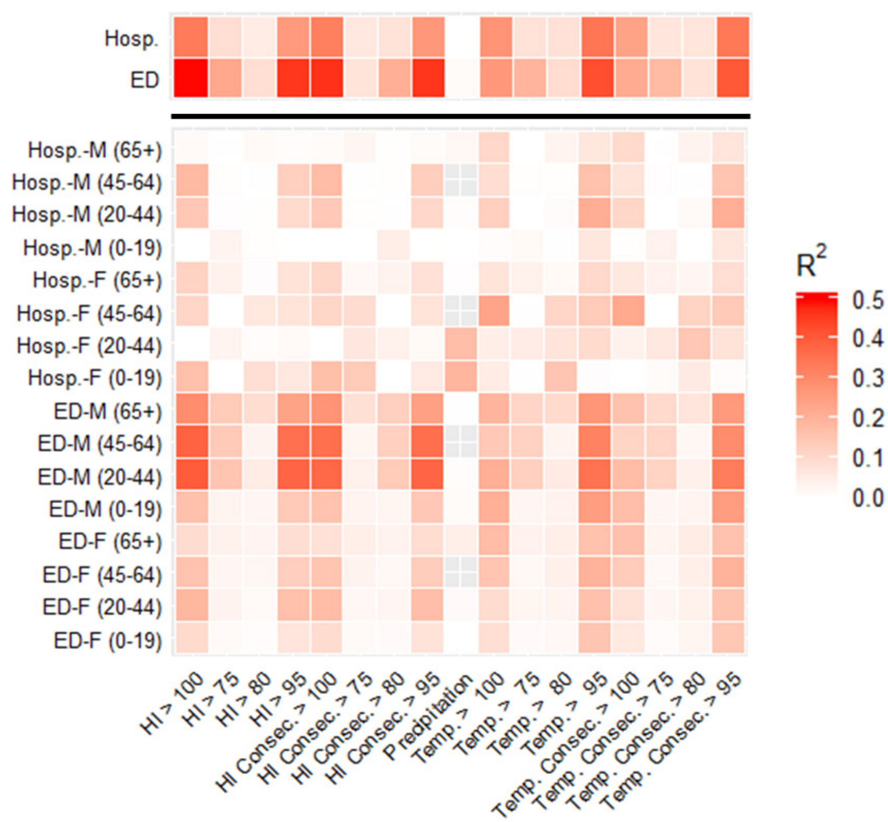
Pop. = population

Mortality
Data for mortality due to heat were not stratified by sex due to the low number of deaths for which heat was recorded as a contributing factor. As seen in Figure 7, the Southwest and West Central climate divisions had the most deaths due to heat (4.3 and 3 /100,000 population, respectively). The data did not trend towards any specific age group. In the North Central climate division, deaths were higher in people aged 65+, while in the West Central and Southwest climate divisions, deaths were higher among people < 44 years of age.

Linear Regression
Regression analyses were conducted to understand the linear relationship between heat index/temperature thresholds and precipitation (as independent variables) and the rates of ED visits/hospitalizations (dependent variables). The strength of the relationship is shown by the R^2 value; the closer the R^2 value is to 1, the more related the two variables are.

The heat plot on Figure 8 summarizes the correlation coefficients (R^2 values) of the series of regression analyses conducted using all the independent and dependent variables. The naming convention on vertical (y) axis is as follows: Medical Intervention-Gender (Age Group). The horizontal (x) axis contains days over a specific temperature or heat index threshold or the amount of precipitation (HI = Heat Index, Temp. = Air Temperature, Consec. = Consecutive Days over threshold, Precipitation = Volume of Rain/month). The more red the square is, the higher the R^2 value is, indi-

Figure 8. Heat Plot showing All Genders and Ages Broken Out by Type of Medical Intervention.



(Heat-Stress Illness and Mortality... continued from page 15)

cating a stronger correlation between the variable on the y-axis and the variable on the x-axis.

Based on these results, daytime 'highs' (i.e., afternoon temperatures 95-100°F) may be more beneficial for predicting the rate of heat-stress illnesses than nighttime 'lows' (i.e., the nighttime temperatures below 75-80°F). About 50% of the ED visits for heat-stress illness were explained by the total number of summer days that the heat index was over 100°F ($R^2 = 0.497$). In contrast, only 22.5% of the ED visits could be explained by nighttime 'lows', which did not fall below 75°F ($R^2 = 0.225$). Overall, little difference was noted in the level of correlation between ED visits and daytime 'highs' or nighttime 'lows', whether the total number of days or a consecutive number of days over a temperature threshold was considered.

Regressions conducted using data aggregated for all ages and both genders produced higher R^2 values (i.e. better predictive capability) than when the data were stratified by age and sex. Aggregated data may have a higher R^2 value because there is more data available for statistical analysis, and thus outliers have less of an impact on the overall accuracy of the regression. Including more years of data, and thereby more cases, may increase the R^2 values for data that are stratified by age and sex. In terms of age and sex, temperature thresholds were only able to weakly predict ED visits for heat stress illness among males of age 20-44 and 45-65. Temperature thresholds could not be used to predict ED visits or hospitalizations among women of any age group.

Of all the independent factors tested, precipitation had the least capacity to explain ED visits or hospitalizations, regardless of gender, age or the type of visit (ED/hospital).

Discussion

Rates for ED visits and hospitalizations for both males and females tend to be higher in the Northwest, Central and Southwest climate divisions. These climate divisions vary in terms of temperatures and it is likely that human behavior and access to care have large impacts on the higher rates in these areas. Working aged (20-64 years old) men and women have the highest number of ED visits while the age groups having the most hospitalizations expanded to include a higher proportion of older populations (both men and women). The higher number of ED visits in working-age adults may be related to exposures that occur during work or sports activities and represent less severe cases of heat-stress illness than the hospitalizations, which may occur more often in geriatric populations and among individuals whose heat tolerance is compromised.

With regards to heat-related mortality, there were too few cases for stable trends to emerge (rates are considered unstable with numbers less than 20); with more years of data, a trend may become more apparent. It is worth noting, however, that the current data most likely underestimates the number of heat-related cases of mortality. Chronic conditions and heat may interact to lead to heat-related deaths that do not get coded as such on the death certificate. For example, a death certificate may state that someone died of cardiovascular disease; however, the death may have occurred during a heat wave and heat may have played a role in exacerbating the disease and leading to death, but a heat-related ICD code may not make it onto the death certificate. Because of situations such as these, the true case counts for heat-related mortality may be greater than what the data portray.

The regression analyses are useful for identifying the factors that could determine messaging for heat-stress illnesses. As determined by the correlation coefficients (R^2 values), the number of days over a 'daily high' temperature threshold can better explain ED visits and hospitalizations than the number of days over a 'daily low' threshold. It was noted that daytime 'high' temperatures of 95°F and heat index of 100°F were best associated with the rate of ED visits for heat stress. If nighttime 'lows' are being considered, advisories for nights where the temperature will not fall below 75°F would be more appropriate than for nights with temperatures >= 80°F.

Data Limitations

The data limitations for heat-stress illness dataset may be found at the LDH Tracking website: http://www.ldh.la.gov/assets/oph/Center-EH/envepi/EPHT/Infotab-Metadata/Heat_Stress_5-1-2019.pdf

Heat-Stress Illness Prevention

Heat-stress illness can affect any age group, even when temperatures do not cross thresholds usually associated with spikes in heat-stress illness. Regardless of the temperature outside, during the warmer months (May-September), it is important for the residents of Louisiana to prepare themselves for heat exposure. Using the appropriate heat-advisory thresholds for heat-stress illness can help public health agencies and emergency medical facilities prepare for, and respond to, increases in heat-stress illness and reduce the burden of heat-stress illness.

To prevent heat-stress illness, it is important to take precautions. Wearing appropriate clothing, planning outdoor activities for the coolest parts of the day, pacing yourself, and drinking plenty of fluids including electrolytes (not sugary drinks or alcohol) are critical to preventing heat-stress illness. Taking breaks in cool places and using fans is essential if the activity is prolonged; however, when temperatures are in the high-90s, fans are no longer sufficient, and air conditioning should be used. If vigorous activity occurs over several days, such as football camps or in the case of outdoor workers, then individuals should be acclimated to exerting themselves at high temperatures over one to two weeks. To effectively acclimatize individuals to working at higher temperatures they should be exposed to at least two hours of heat per day. If work is stopped for a week or more then individuals lose their heat tolerance and should be re-acclimatized (CDC NIOSH).

Teaming Up with Local and State Agencies to Protect Louisiana's Residents and Visitors from Extreme Heat

Emán Williams, M.S.P.H., M.A.

SEET has been collaborating for the past four years with internal and external partners to raise awareness about extreme heat and heat-related illnesses and to promote heat safety to Louisiana's residents. In 2015, SEET staff partnered with Louisiana Cancer Prevention and Control Programs (LCP) to develop a heat safety message targeting parents, older adults and their care providers which was published on LCP's Facebook channel. Recognizing the need to raise awareness among childcare providers about heat safety issues related to children left unattended in hot vehicles, SEET teamed up with the Louisiana Department of Education's (LDOE) Head Start Collaborative to publish an e-newsletter article for LDOE's Early Childhood newsletter and to present at the 2017 Louisiana Head Start Association Conference. During the 2018 Healthy Swimming and Safety Week observance, SEET teamed up with the Centers for Disease Control and Prevention's Environmental Public Health Tracking Program (CDC) Tracking, several CDC Tracking grantees and Louisiana Department of Health (LDH) Programs, the Governor's Office of Elderly Affairs and the New Orleans Health and Plaquemines Health Departments to launch a swimming and heat safety campaign. SEET used a variety of communication channels to promote swimming safety, swimming as an option for staying cool and heat safety to parents of children under 14 years of age, childcare providers, individuals who are experiencing homelessness, older adults and age-friendly organizations.

Last summer, SEET also worked with the communications directors of 10 state agencies to execute a heat awareness campaign. SEET served as a catalyst for Louisiana's award winning Beat the Heat LA campaign. This integrated awareness event, which ran from July 2, 2018 to August 10, 2018, included a campaign hashtag, #BeatTheHeatLA, and video public service announcements featuring Governor Edwards, LDH Secretary Dr. Rebecca Gee and other officials. Additionally, heat safety messages were publicized via electronic highway board messages, social media post, podcast and communication channels. The Beat the Heat campaign was successful because of the agencies' willingness to pool and leverage their existing resources. In the spring of 2019, LDH's Bureau of Media and Communications entered the Beat the Heat LA campaign into a communications contest and was awarded the Public Relations Association of Baton Rouge's Red Stick Award.

This summer, SEET published an article titled "Help Children Beat the Heat" in the May/June 2019 edition of the LDH's Bureau of Family Health's Partners for Healthy Babies e-newsletter. The Partners for Healthy Babies newsletter is a bi-monthly publication that is disseminated to several hundred healthcare providers and public health practitioners throughout the state.

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Sanitary Code - State of Louisiana
Part II - The Control of Disease

LAC 51:II.105: The following diseases/conditions are hereby declared reportable with reporting requirements by Class:

<u>Class A Diseases/Conditions - Reporting Required Within 24 Hours</u>

Diseases of major public health concern because of the severity of disease and potential for epidemic spread-report by telephone immediately upon recognition that a case, a suspected case, or a positive laboratory result is known; [in addition, all cases of rare or exotic communicable diseases, unexplained death, unusual cluster of disease and all outbreaks shall be reported.

Acinetobacter spp., carbapenem-resistant
Acute Flaccid Paralysis including Acute Flaccid Myelitis
Amoeba (free living) infection (including *Acanthamoeba, Naegleria, Balamuthia* & others)
Anthrax
Avian or Novel Strain Influenza A (initial detection)
Botulism
Brucellosis
Candida auris, as well as common misidentifications of *C. auris* (e.g., *C. haemolunii*, *C.duobushaemolunii*, *C. famata*, *C. lusitaniae*, *C. sake*, *C. parapsilosis*, *C. catenulata*, *C. guilli-ermondii*, and *Rhodotorula glutinis*)
Cholera
Clostridium perfringens (foodborne infection)
Diphtheria
Enterobacteriaceae, carbapenem-resistant
Fish/Shellfish Poisoning (domoic acid, neurotoxic shellfish poisoning, ciguatera, paralytic shellfish poisoning, scombroid)
Foodborne Illness
Haemophilus influenzae (invasive infection)
Influenza-associated Mortality
Measles (Rubeola imported or indigenous)
Melioidosis (*Burkholderia pseudomallei*)
Neisseria meningitidis (invasive infection)
Outbreaks of Any Infectious Disease
Pertussis
Plague (*Yersinia pestis*)
Poliomyelitis (paralytic & non-paralytic)
Pseudomonas aeruginosa, carbapenem-resistant
Q Fever (*Coxiella burnetii*)
Rabies (animal and human)
Ricin Poisoning
Rubella (congenital syndrome)
Rubella (German Measles)
Severe Acute Respiratory Syndrome-associated Coronavirus (SARS-CoV)
Smallpox
Staphylococcus aureus, Vancomycin Intermediate or Resistant (VISA/VRSA)
Staphylococcal Enterotoxin B (SEB) Pulmonary Poisoning
Tularemia (*Francisella tularensis*)
Viral Hemorrhagic Fever (Ebola, Lassa, Marburg, Crimean Congo, etc.)
Yellow Fever

<u>Class B Diseases/Conditions - Reporting Required Within 1 Business Day</u>

Diseases of public health concern needing timely response because of potential of epidemic spread-report by the end of the next business day after the existence of a case, a suspected case, or a positive laboratory result is known.

Anaplasmosis
Arthropod-Borne Viral Infections (West Nile, Dengue, St, Louis, California, Eastern Equine, Western Equine, Chikungunya, Usutu, Zika & others)
Aseptic Meningitis
Babesiosis
Chagas Disease
Chancroid
Cryptosporidiosis
Cyclosporiasis
Escherichia coli, Shiga-toxin producing (STEC), including *E. coli* O157:H7
Granuloma Inguinale
Hantavirus (infection or Pulmonary Syndrome)
Hemolytic-Uremic Syndrome
Hepatitis A (acute illness)
Hepatitis B (acute illness and carriage in pregnancy)
Hepatitis B (perinatal infection)
Hepatitis C (acute illness)
Hepatitis C (perinatal infection)
Hepatitis E
Herpes (neonatal)
Human Immunodeficiency Virus [(HIV), infection in pregnancy][2,6]
Human Immunodeficiency Virus[(HIV), perinatal exposure][2,6]
Legionellosis
Listeriosis
Malaria
Mumps
Salmonellosis
Shigellosis
Syphilis[1]
Syphilis [(*Treponema pallidum*), infection in pregnancy][1,6]
Syphilis [(*Treponema pallidum*), perinatal exposure][1,6]
Tetanus ,
Tuberculosis[3] (due to *M. tuberculosis*, *M. bovis*, or *M. africanum*)
Typhoid Fever
Vibrio infections (other than cholera)
Zika Virus-associated Birth Defects

<u>Class C Diseases/Conditions - Reporting Required Within 5 Business Days</u>

Diseases of significant public health concern-report by the end of the workweek after the existence of a case, suspected case, or a positive laboratory result is known.

Acquired Immune Deficiency Syndrome[3] (AIDS)
Anaplasma Phagocytophilum
Aspergillosis
Blastomycosis
Campylobacteriosis
Chlamydial infection[1]
Coccidioidomycosis
Cryptococcosis (C. neoformans and C. gattii)
Ehrlichiosis (human granulocytic, human monocytic, *E. chaffeensis* and *E. ewingii*)
Enterococcus, Vancomycin Resistant [(VRE), invasive disease]
Giardiasis
Gonorrhea[1] (genital, oral, ophthalmic, pelvic inflammatory disease, rectal)
Guillain-Barré Syndrome
Hansen's Disease (leprosy)
Hepatitis C ((infection, other than as in Class B)
Histoplasmosis
Human Immunodeficiency Virus2 (HIV (infection other than as in Class B)
Human T Lymphocyte Virus (HTLV I and II infection)
Leptospirosis
Lyme Disease
Lymphogranuloma Venereum[1]
Meningitis, Eosinophilic (including those due to *Angiostrongylus* infection)
Nontuberculous Mycobacteria
Nipah Virus Infection
Non-gonococcal Urethritis
Ophthalmia neonatorum
Psittacosis
Spotted Fevers [*Rickettsia* species including Rocky Mountain Spotted Fever (RMSF)]
Staphylococcus aureus (MRSA), Invasive Infection
Staphylococcal Toxic Shock Syndrome
Streptococcal Disease, Group A (invasive disease)
Streptococcal Disease, Group B (invasive disease)
Streptococcal Toxic Shock Syndrome
Streptococcus pneumoniae, invasive disease
Transmissible Spongiform Encephalopathies (Creutzfeldt-Jacob Disease & variants)
Trichinosis
Varicella (chickenpox)
Yersiniosis

<u>Class D Diseases/Conditions - Reporting Required Within 5 Business Days</u>

Cancer
Carbon Monoxide Exposure and/or Poisoning[5]
Complications of Abortion
Congenital Hypothyroidism[4]
Galactosemia[4]
Heavy Metal (arsenic, cadmium, mercury) Exposure and/or Poisoning (all ages)[5]
Hemophilia[4]
Lead Exposure and/or Poisoning (all ages)[4, 5]
Pesticide-Related Illness or Injury (all ages)[5]
Phenylketonuria[4]
Pneumoconiosis (asbestosis, berylliosis, silicosis, byssinosis, etc.)[5]
Radiation Exposure, Over Normal Limits[5]
Reye's Syndrome
Severe Traumatic Head Injury
Severe Undernutrition (severe anemia, failure to thrive)
Sickle Cell Disease[4] (newborns)
Spinal Cord Injury
Sudden Infant Death Syndrome (SIDS)

Case reports not requiring special reporting instructions (see below) can be reported by mail or facsimile on Confidential Disease Report forms (2430), fascimile (504) 568-8290, telephone (504) 568-8313, or (800) 256-2748 for forms and instructions.

[1]Report on STD-43 form. Report cases of syphilis with active lesions by telephone, within one business day, to (504) 568-8374.

[2]Report to the Louisiana STD/HIV Program: Visit www.hiv.dhh.louisiana.gov or call 504-568-7474 for regional contact information.

[3]Report on form TB 2431 (8/94). Mail form to TB Control Program, DHH-OPH, P.O. Box 60630, New Orleans, LA. 70160-0630 or fax both sides of the form to (504) 568-5016

[4]Report to the Louisiana Genetic Diseases Program and Louisiana Childhood Lead Poisoning Prevention Programs: www.genetics.dhh.louisiana.gov or fascimile (504) 568-8253, telephone (504) 568-8254, or (800) 242-3112

[5]Report to the Section of Environmental Epidemiology and Toxicology, Occupational Health and Injury Surveillance Program: www.seet.dhh.louisiana.gov or call (504) 568-8150 or (888) 293-7020 or fax (504) 568-8149

[6]Report to the Louisiana STD/HIV Program on HIV/Syphilis during Pregnancy Reporting Form: Visit www.hiv.dhh.louisiana.gov or call 504-568-7474

Reference Cultures/Specimens to State Laboratory: Visit http://ldh.la.gov/assets/oph/Center-PHCH/Center-CH/infectious-epi/IsolatesToSendToStateLab_2019.pdf.

Additional reporting requirements exclusively for laboratory facilities may be found in LAC 51:II §107. The full text of the Sanitary Code may be found in Title 51 of the Louisiana Administrative Code at website https://www.doa.la.gov/Pages/osr/lac/books.aspx.