

Heat-Related Morbidity in North Carolina: Who's at Risk?

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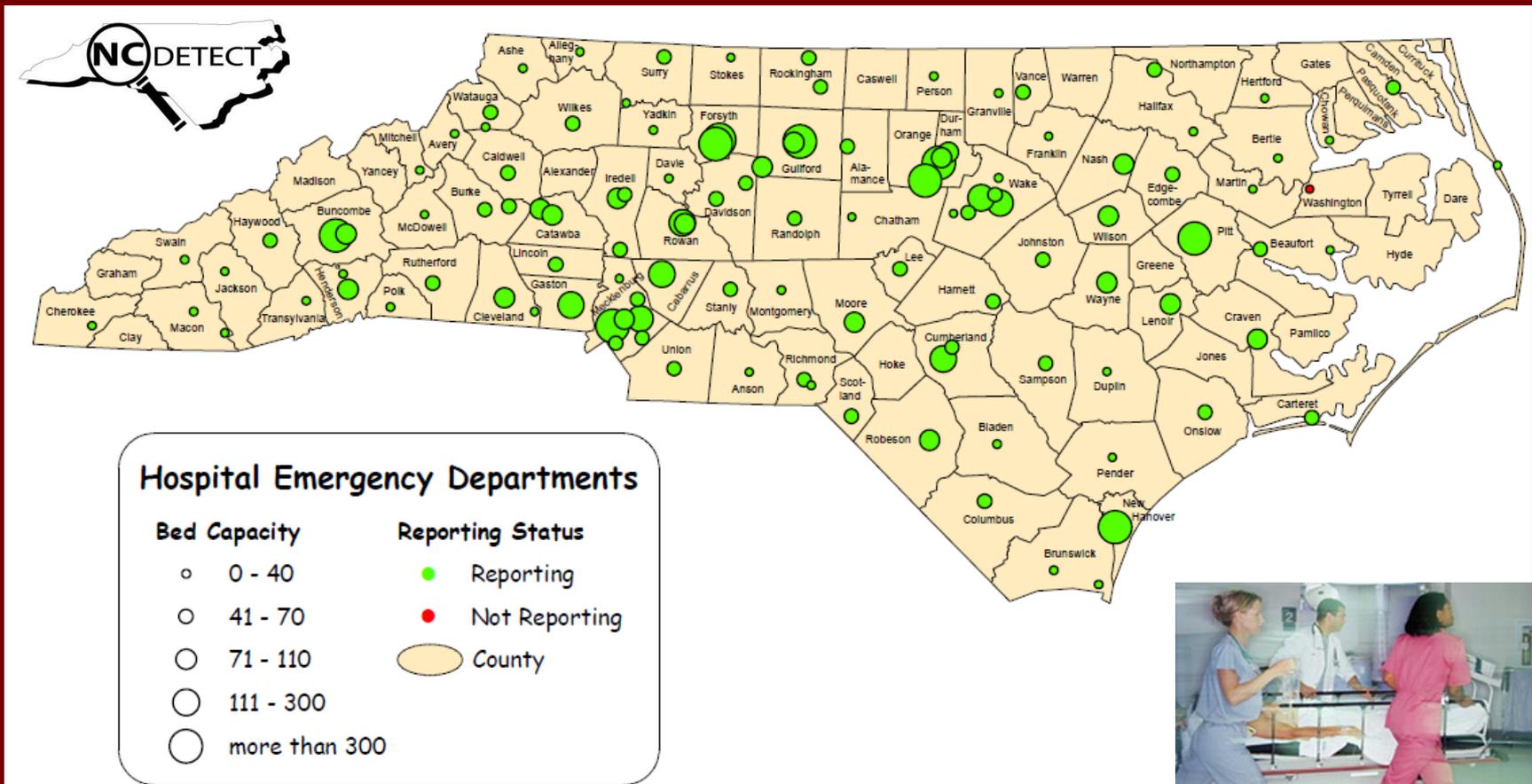
*2nd Symposium on Environment and Health
91st Annual Meeting of the American Meteorological Society
Seattle, WA 25 January 2011*

Research Questions

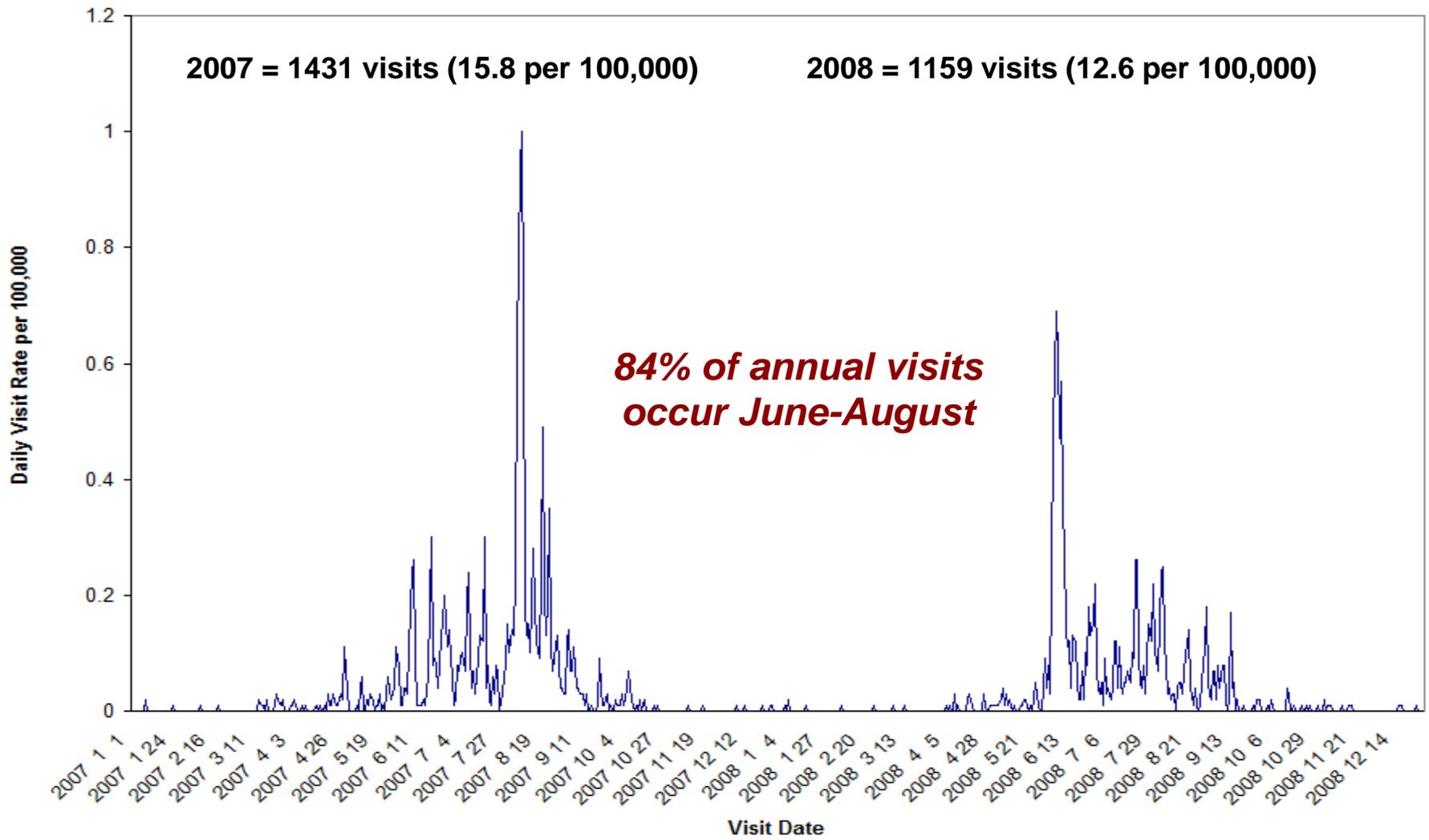
- What are the spatial and temporal patterns of heat-related illness (HRI) across North Carolina? How do these patterns vary between urban and rural counties?
- What age groups are most at risk for HRI? Are these groups more likely to reside in urban or rural counties?
- How many excess emergency department (ED) visits occur during heat wave periods compared to non-heat wave periods? Which primary health conditions are elevated during heat wave periods? How do these patterns vary among age groups across North Carolina?

North Carolina Disease Event Tracking and Epidemiologic Tool (NC DETECT)

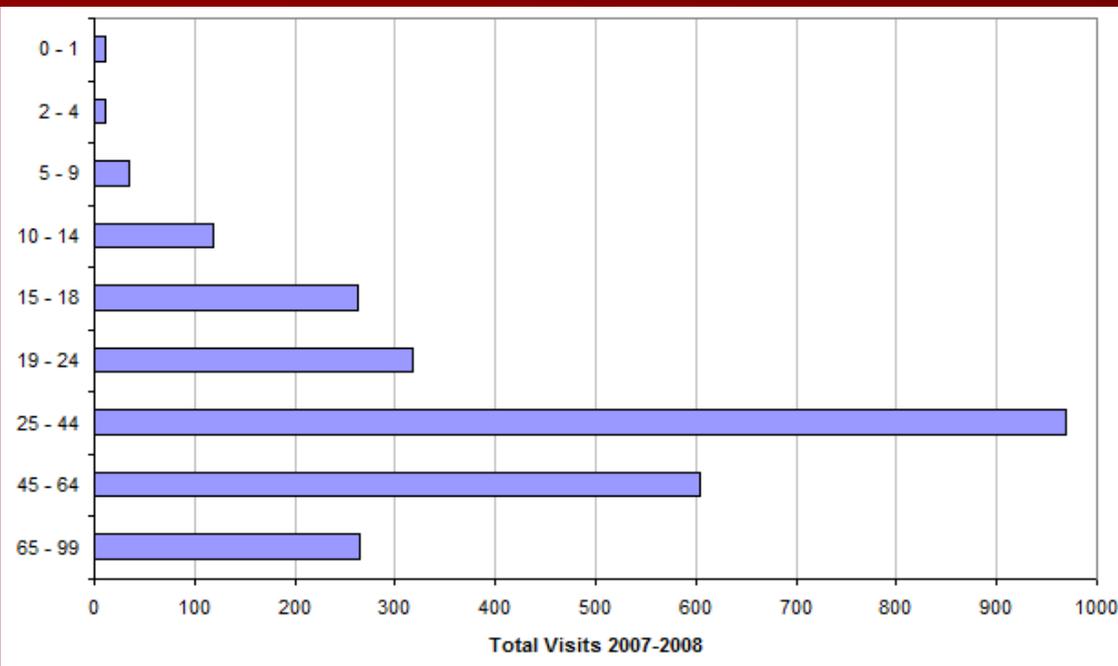
Follows a state-wide mandate for near-real time ED data



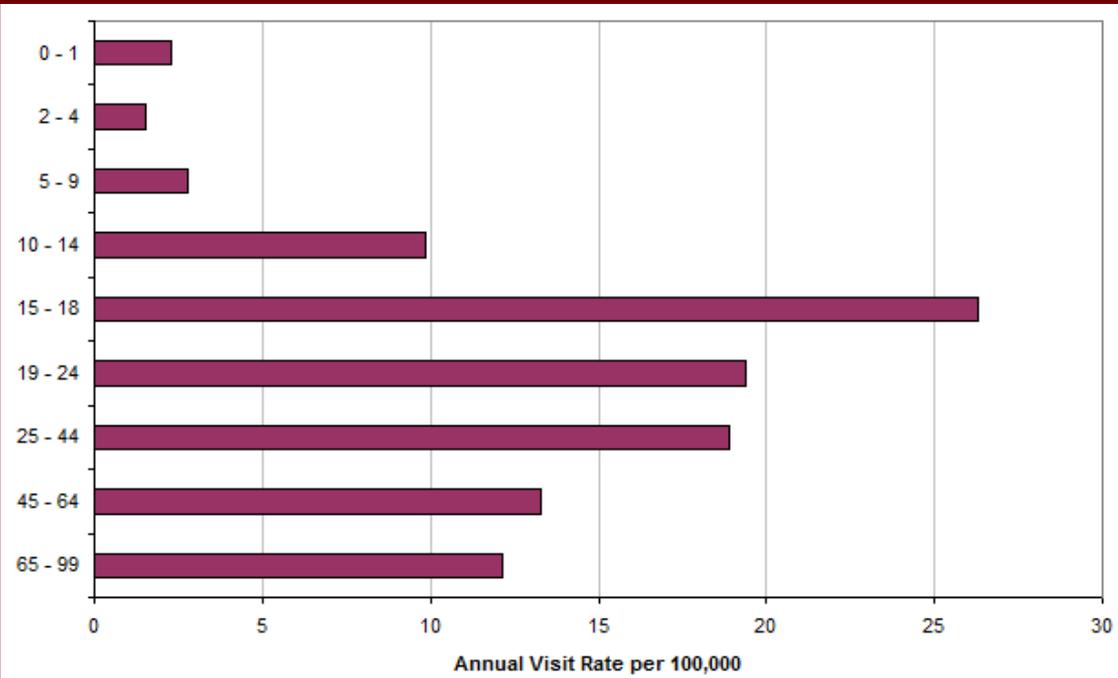
Daily time series of statewide heat-related* ED visits: 2007-2008



*International Classification of Diseases, 9th Revision (ICD-9), Codes 992.0-992.9



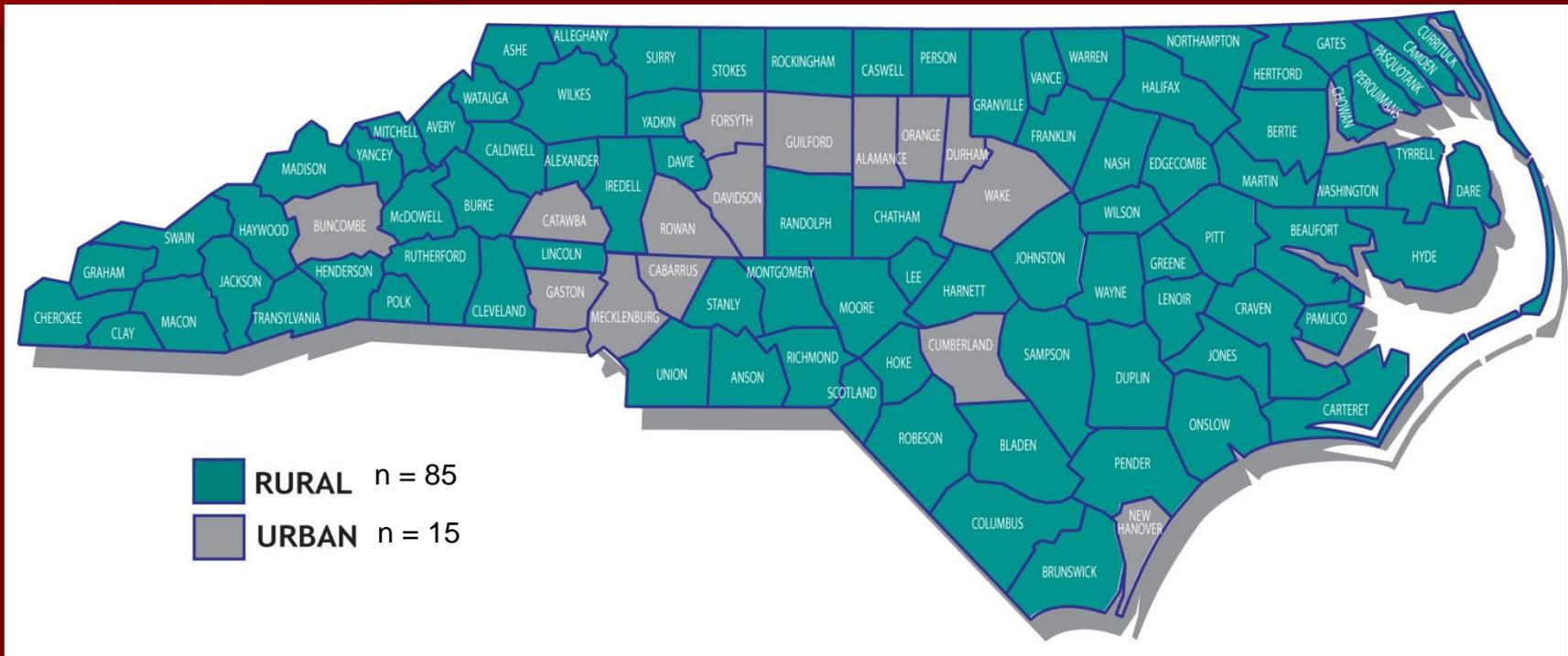
Total number of statewide ED visits for HRI from 2007-2008 by age group



***Average annual rate* of ED visits for HRI by age group**

County Classification: Urban vs. Rural

*Rural counties: ≤ 250 people per mile² (based on 2000 census)

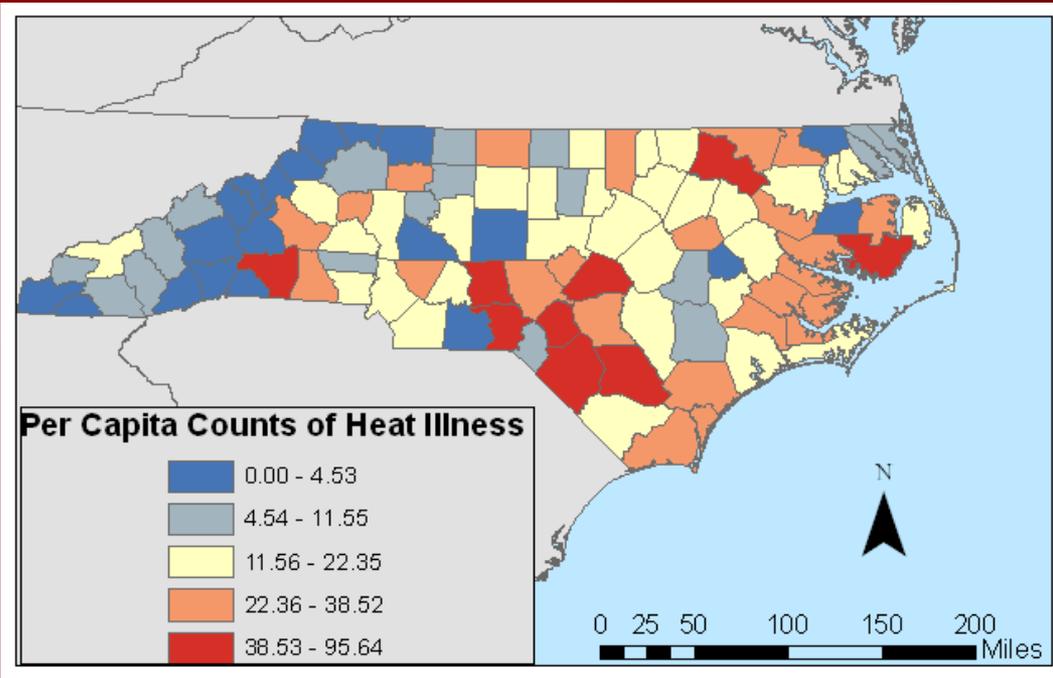


Total Population:

Rural = 4,507,084

Urban = 4,550,495

*as defined by the NC Rural Economic Development Center



Rate of ED visits (per capita) for HRI by county from 2007 to 2008

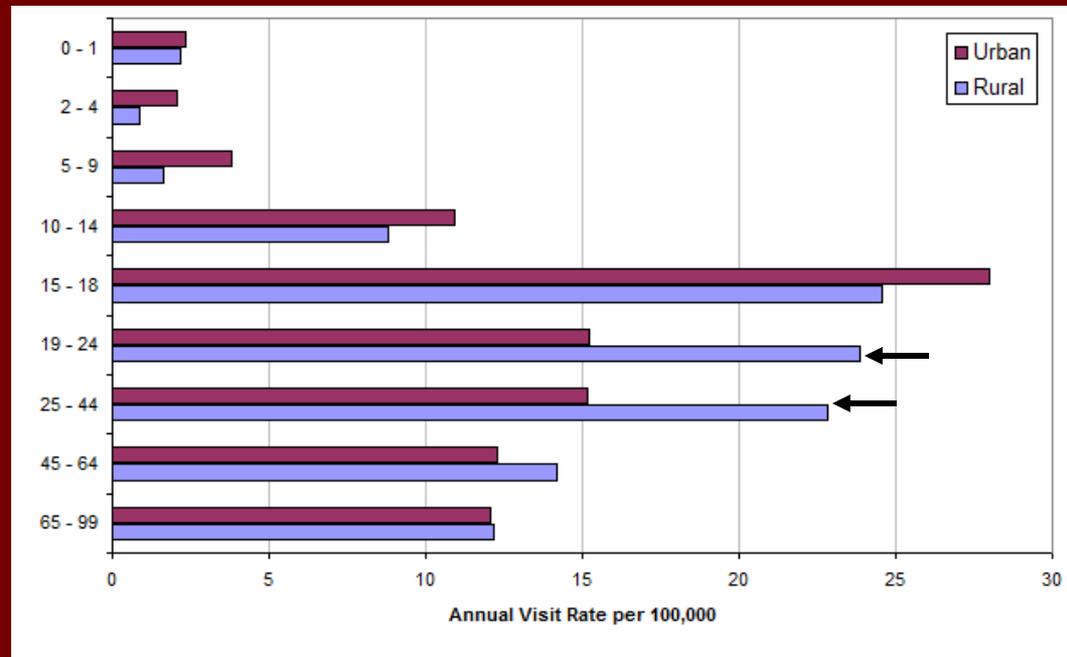
Total Visits:

Urban 1186
Rural 1404 (+218)

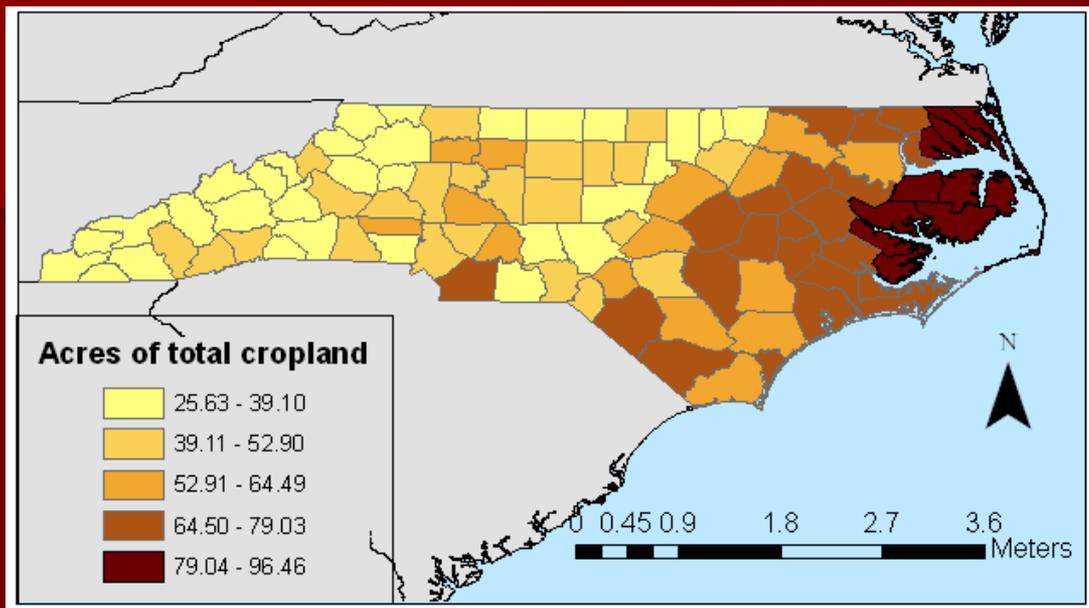
Annual Visit Rate (per 100,000):

Urban 13.0
Rural 15.6 (+2.6)

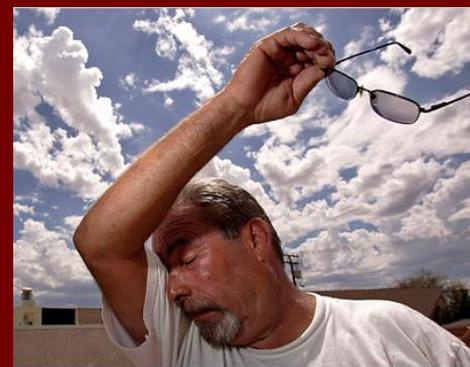
Age distribution of per capita ED visits for HRI between urban and rural counties



Possible at-risk groups

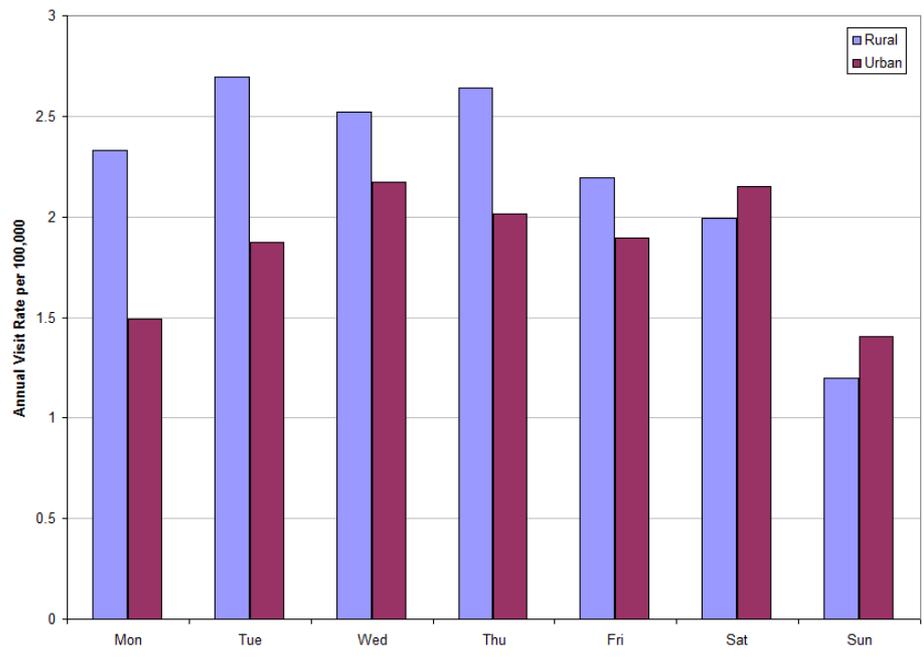


Agricultural workers



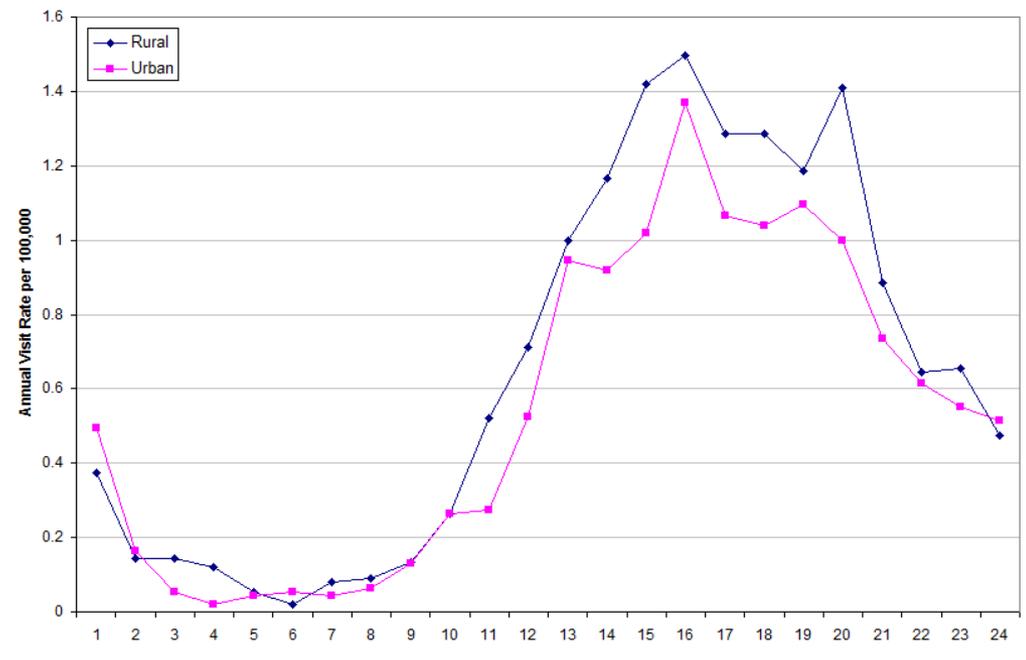
Young Athletes





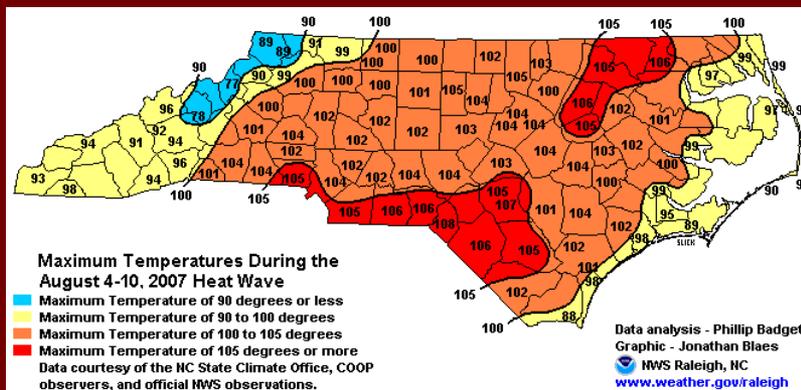
Day of week distribution of per capita ED visits for HRI between rural and urban counties

Hour of day (LST) distribution of per capita ED visits for HRI between rural and urban counties

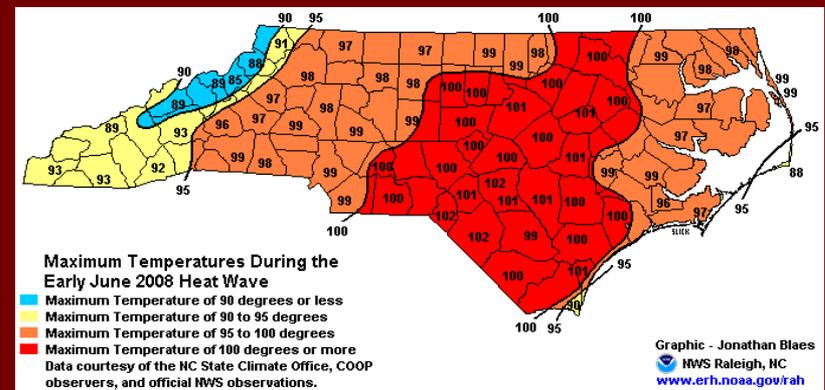


How Do Heat Waves Impact Morbidity Across North Carolina?

Two heat waves occurred during the study period:



4-11 August 2007



4-11 June 2008

These 16 heat wave days comprise only **2%** of all days in the study period, but are responsible for **27%** of all the statewide ED visits for HRI

To determine excess morbidity during the heat wave periods, we compared the visit rates to a series of **non-heat wave (reference) periods**

Selection of Reference Periods*

- Same duration, month, and same distribution of days of the week
- Utilize per capita rates to account for annual population changes
- Do not include period immediately after heat wave (i.e. “harvesting”)
- Calculate excess visit rates during heat wave periods:
 - **Excess = heat wave period – reference period**

<u>Reference Period</u>	<u>Mean Max T°</u>	<u>Reference Period</u>	<u>Mean Max T°</u>
2-9 August 2008	91.3	6-13 June 2007	85.5
9-16 August 2008	84.0	13-20 June 2007	82.6
16-23 August 2008	85.4	20-27 June 2007	87.4
25 Aug-1 Sept 2007	88.9	18-25 June 2008	85.9
Heat Wave (4-11 Aug 07)	95.1	Heat Wave (4-11 Jun 08)	93.5

*Refer to Semenza et al. (1999) and Knowlton et al. (2006)

Excess Per Capita ED Visits for Heat-Related Illness During the August 2007 Heat Wave Period

URBAN				RURAL			
	Heat-Wave Period	Reference Periods	Excess		Heat-Wave Period	Reference Periods	Excess
All Urban	3.47	0.61 (0.3-0.9)	2.86	All Rural	4.43	0.73 (0.3-1.1)	3.70
<i>Age Group</i>				<i>Age Group</i>			
0 – 1	0.00	0.19 (0.0-0.8)	-0.19	0 – 1	0.00	0.00 (0.0-0.0)	---
2 – 4	0.52	0.00 (0.0-0.0)	---	2 – 4	0.00	0.00 (0.0-0.0)	---
5 – 9	1.92	0.00 (0.0-0.0)	---	5 – 9	0.33	0.08 (0.0-0.3)	0.25
10 – 14	1.36	0.41 (0.0-0.7)	0.95	10 – 14	1.66	0.33 (0.0-0.7)	1.33
15 – 18	7.44	1.04 (0.4-1.9)	6.40	15 – 18	6.61	1.64 (0.7-2.6)	4.97
19 – 24	3.30	0.72 (0.2-1.2)	2.58	19 – 24	6.59	1.02 (0.5-1.9)	5.54
25 – 44	4.36	0.90 (0.4-1.4)	3.46	25 – 44	8.17	1.00 (0.2-1.8)	7.17
45 – 64	3.90	0.57 (0.2-0.8)	3.33	45 – 64	3.25	0.80 (0.2-1.4)	2.45
65+	2.34	0.51 (0.0-1.2)	1.83	65+	2.73	0.36 (0.2-0.5)	2.37

Excess Per Capita ED Visits for **Selected Causes of Morbidity** During the August 2007 Heat Wave Period

Primary Diagnosis	URBAN			RURAL		
	Heat-Wave Period	Reference Periods	Excess	Heat-Wave Period	Reference Periods	Excess
Diabetes	6.86	6.48 (5.9-6.9)	0.38	9.68	9.88 (9.1-10.1)	-0.20
Disorder of fluid electrolytes	8.36	6.43 (6.1-6.7)	1.93	9.54	6.95 (6.4-7.8)	2.59
Obesity	0.31	0.13 (0.1-0.2)	0.18	0.25	0.34 (0.2-0.5)	-0.09
Disorders of the nervous system	13.66	15.32 (14.7-15.7)	-1.66	15.75	17.93 (16.4-18.9)	-2.18
Cardiovascular Disease	22.44	21.91 (20.2-23.3)	0.53	25.65	24.48 (23.9-25.6)	1.17
Cerebrovascular Disease	4.57	4.85 (4.3-5.4)	-0.28	4.45	4.87 (4.5-5.2)	-0.42
Respiratory Disease	52.09	52.40 (49.5-55.4)	-0.31	57.30	56.59 (52.1-59.7)	0.71
Renal Failure	3.79	3.51 (3.1-4.1)	0.28	3.29	3.31 (2.8-3.6)	-0.02
Injuries and Poisonings	171.64	177.08 (166.9-183.1)	-5.44	191.78	187.34 (182.0-191.2)	4.44

Excess Per Capita ED Visits for Heat-Related Illness During the June 2008 Heat Wave Period

URBAN				RURAL			
	Heat-Wave Period	Reference Periods	Excess		Heat-Wave Period	Reference Periods	Excess
All Urban	3.39	0.63 (0.4-0.9)	2.76	All Rural	4.01	0.82 (0.7-0.9)	3.19
<i>Age Group</i>				<i>Age Group</i>			
0 – 1	0.00	0.39 (0.0-1.5)	-0.39	0 – 1	0.83	0.00 (0.0-0.0)	0.83
2 – 4	1.04	0.26 (0.0-0.5)	0.78	2 – 4	0.00	0.00 (0.0-0.0)	---
5 – 9	1.28	0.24 (0.0-0.3)	1.04	5 – 9	0.68	0.08 (0.0-0.3)	0.60
10 – 14	2.61	0.68 (0.3-1.1)	1.93	10 – 14	3.03	0.33 (0.0-0.7)	2.70
15 – 18	4.14	0.58 (0.0-1.2)	3.56	15 – 18	1.90	1.50 (0.8-2.3)	0.40
19 – 24	5.13	0.60 (0.5-0.7)	4.53	19 – 24	5.94	1.71 (1.0-2.3)	4.23
25 – 44	4.14	0.92 (0.5-1.4)	3.22	25 – 44	5.40	1.04 (0.7-1.4)	4.36
45 – 64	2.77	0.56 (0.3-1.0)	2.21	45 – 64	4.29	0.65 (0.5-0.7)	3.64
65+	4.73	0.53 (0.0-1.3)	4.20	65+	4.10	0.60 (0.5-1.3)	3.50

Excess Per Capita ED Visits for **Selected Causes** of Morbidity During the June 2008 Heat Wave Period

Primary Diagnosis	URBAN			RURAL		
	Heat-Wave Period	Reference Periods	Excess	Heat-Wave Period	Reference Periods	Excess
Diabetes	6.83	7.07 (6.5-7.4)	-0.24	9.79	9.24 (8.6-9.8)	0.55
Disorder of fluid electrolytes	7.77	6.14 (5.3-6.6)	1.63	9.56	7.56 (7.4-7.7)	2.00
Obesity	0.32	0.28 (0.2-0.4)	0.04	0.33	0.32 (0.2-0.4)	0.01
Disorders of the nervous system	14.54	13.44 (13.1-14.3)	1.10	17.08	17.05 (16.6-18.3)	0.03
Cardiovascular Disease	23.20	21.71 (20.4-22.7)	1.49	24.43	25.13 (24.5-26.2)	-0.70
Cerebrovascular Disease	4.91	4.39 (4.1-4.7)	0.52	4.69	4.70 (4.3-5.2)	-0.01
Respiratory Disease	58.28	53.92 (51.4-56.3)	4.36	64.26	59.50 (57.1-63.4)	4.76
Renal Failure	4.22	3.19 (2.7-4.0)	1.03	3.67	3.13 (2.9-3.3)	0.54
Injuries and Poisonings	176.62	166.58 (159.8-172.9)	10.04	193.93	182.97 (176.5-187.9)	10.96

Summary

- ED visit rates for HRI were 16% higher in rural counties.
- The highest ED visit rates for HRI were among teenagers, with slightly higher rates in urban counties. The lowest rates were among infants and children. ED visit rates were notably higher among young and middle-age adults in rural counties, particularly during the work week.
- ED visit rates for HRI were markedly higher during heat wave periods, with more excess visits in rural counties and generally among young and middle-aged adults. Teenagers in urban counties were more at risk during the late summer heat wave, while the elderly were more at risk during the early summer heat wave in urban counties.
- Other primary health conditions elevated during heat wave periods include electrolyte imbalance, cardiovascular and respiratory diseases, injuries, and trauma.

What are the next steps?

- Incorporate more data:
 - Summers 2009, 2010
 - Secondary diagnoses
 - EMS service calls
 - Triage notes
- Examine vulnerability at the community level
- Develop risk models incorporating detailed climatic and demographic information
- Work with NOAA, NWS, and our health partners to develop more sophisticated heat-health warning systems

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URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE RALEIGH NC
316 PM EDT WED AUG 4 2010
...HEAT ADVISORY IN EFFECT FOR MUCH OF CENTRAL NORTH CAROLINA...
NCZ008&gt;011-022&gt;028-039&gt;043-073&gt;078-083&gt;086-088-089-
050930-
/O.NEW.KRAH.HT.Y.0008.100805T1500Z-100805T2300Z/
GRANVILLE-VANCE-WARREN-HALIFAX-GUILFORD-ALAMANCE-ORANGE-DURHAM-
FRANKLIN-NASH-EDGEcombe-RANDOLPH-CHATHAM-WAKE-JOHNSTON-WILSON-
STANLY-MONTGOMERY-MOORE-LEE-HARNETT-WAYNE-ANSON-RICHMOND-SCOTLAND-
HOKE-CUMBERLAND-SAMPSON-
INCLUDING THE CITIES OF...OXFORD...HENDERSON...WARRENTON...
ROANOKE RAPIDS...GREENSBORO...HIGH POINT...BURLINGTON...
CHAPEL HILL...DURHAM...LOUISBURG...NASHVILLE...ROCKY MOUNT...
ASHEBORO...PITTSBORO...RALEIGH...SMITHFIELD...WILSON...
ALBEMARLE...TROY...SOUTHERN PINES...SANFORD...LILLINGTON...
GOLDSBORO...WADESBORO...ROCKINGHAM...LAURINBURG...RAEFORD...
FAYETTEVILLE...CLINTON
316 PM EDT WED AUG 4 2010
...HEAT ADVISORY IN EFFECT FROM 11 AM TO 7 PM EDT THURSDAY...
THE NATIONAL WEATHER SERVICE IN RALEIGH HAS ISSUED A HEAT
ADVISORY...WHICH IS IN EFFECT FROM 11 AM TO 7 PM EDT THURSDAY.
HOT TEMPERATURES AND HIGH HUMIDITY WILL PUSH HEAT INDEX VALUES UP TO
105 TO 109 DEGREES FOR A FEW HOURS THURSDAY.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
THIS COMBINATION OF HOT TEMPERATURES AND HIGH HUMIDITY WILL CREATE A
SITUATION IN WHICH HEAT ILLNESSES ARE POSSIBLE. PEOPLE IN THE AREA ARE
ADVISED TO DRINK PLENTY OF FLUIDS...STAY IN AN AIR-CONDITIONED ROOM AS
MUCH AS POSSIBLE...STAY OUT OF THE SUNSHINE...AND CHECK UP ON RELATIVES
AND NEIGHBORS... ESPECIALLY THOSE WITHOUT AIR CONDITIONING. HEAT OF
THIS MAGNITUDE CAN BE PARTICULARLY DEADLY FOR THE ELDERLY...THOSE WITH
ILLNESSES...AND FOR OUTDOOR WORKERS SUCH AS FARM LABORERS. IN
ADDITION... ATHLETES EXERCISING OUTDOORS SHOULD TAKE FREQUENT REST
PERIODS IN THE SHADE IN A WELL-VENTILATED AREA... AND DRINK PLENTY OF
WATER.
&&
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HARTFIELD
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Example of a public information statement on extreme heat issued by the Raleigh, NC, National Weather Service on 4 August 2010

Acknowledgement and Disclaimer

- The NC Public Health Data Group and NC DETECT, especially Anna Waller and Amy Ising
- The NC Public Health Data Group and NC DETECT do not take responsibility for the scientific validity or accuracy of methodology, results, statistical analyses, or conclusions presented.

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