



Heat Morbidity Surveillance Using Hospital Discharge Data

Multi-year Data (2008-2012)

Maricopa County Department of Public Health

Division of Disease Control

Office of Epidemiology

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Background

Throughout the year, Maricopa County experiences extremely hot temperatures that can have a negative impact on the health of its residents and visitors. Due to the extreme temperatures, the Maricopa County Department of Public Health (MCDPH) Office of Epidemiology has been using surveillance practices to track climatological data and heat-associated deaths in the county to gain a better understanding of the full impact.

Beginning in 2012, the Office of Epidemiology expanded these efforts to include heat related illness (HRI) surveillance which will assist in improving the Department's response to the chronic environmental heat experienced in Maricopa County. Additionally, by expanding the heat surveillance system, opportunities to learn more about the effects of heat in Maricopa County and ways to best use heat surveillance will become more evident.

Methodology

Hospital discharge data (HDD) contains emergency department (ED) and inpatient (IP) hospital visits for all non-federal (Veteran's Affairs, Indian Health Service) hospitals in Maricopa County. Heat related illness visits were identified using selected International Classification of Diseases-9th Revision (ICD-9) codes. Selection of ICD-9 codes was made using a combination of literature review searches of other heat morbidity surveillance systems along with the definition provided by the Council of State and Territorial Epidemiologists (CSTE) for hospitalizations due to heat. **Figure 1** lists the ICD-9 codes that were included and excluded in this query. Selected visits were then put into four categories according to the following criteria:

- **Heat Related Illness:** the presence of one or more of the inclusion ICD-9 codes (see Figure 1) listed in any of the diagnosis or injury variables in the HDD.
 - The SAS program scans a record to see if it contains a code for a primary diagnosis (DX) of heat. If it does, the record is coded as having a primary DX heat. If not, the program will then scan the record to see if any of the 24 secondary codes are heat related. If yes, then the person is coded as having a secondary diagnosis of heat related illness. If not, the program then checks the 6 injury codes to see if the record was coded as having a heat related injury and if yes, the person is coded as having a heat related illness. If no, the record is coded as not having any type of heat related illness and is dropped from analysis.
- **Primary DX Heat:** Cases where the primary reason for hospitalization or emergency department (ED) visit is heat related.
- **Secondary DX Heat:** Cases where heat is listed as one of the up to 24 secondary causes for hospitalization or ED visit.
- **Heat Injury:** Heat is mentioned as the cause of injury for the hospitalized person. There are up to 6 injury diagnoses per record in addition to the primary diagnosis.

Figure 1: Heat Related Hospital Discharge Data ICD-9 Codes

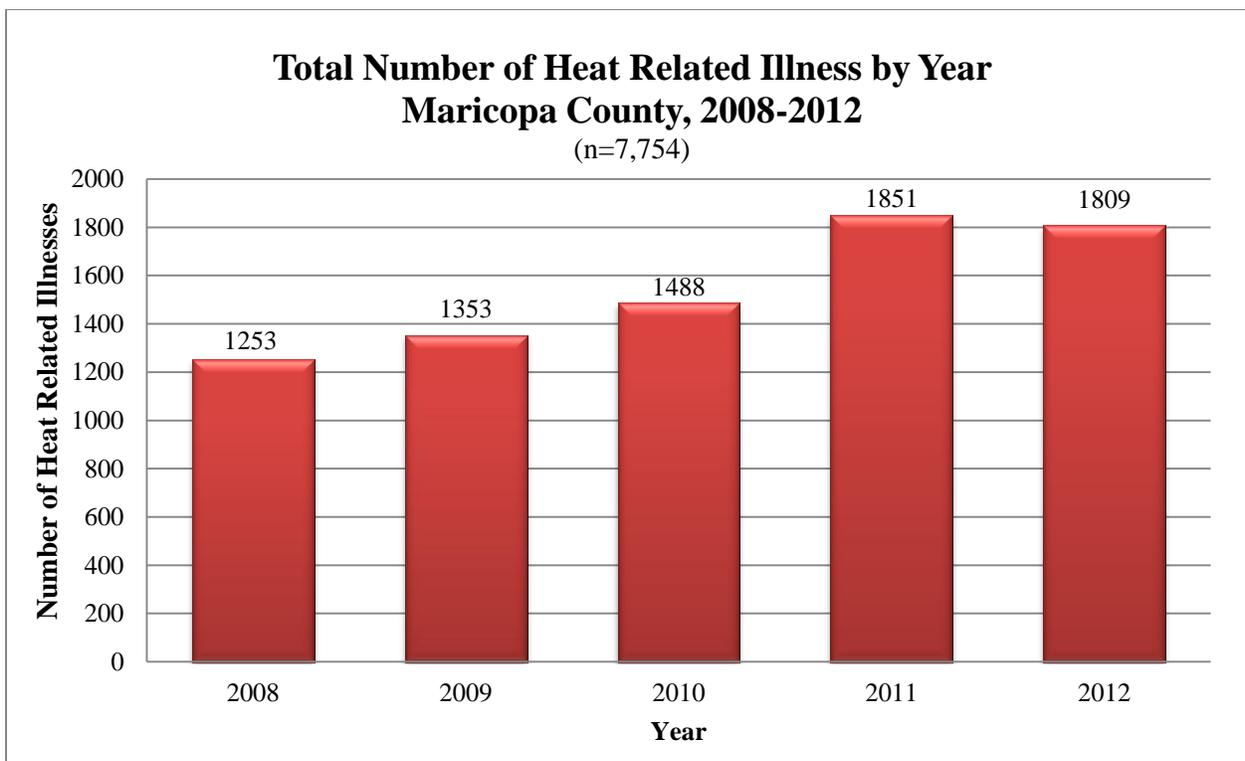
INCLUDED	
992	Effects of heat and light
992.0	Heat stroke and sunstroke Heat apoplexy Heat pyrexia Ictus solaris Siriasis Thermoplegia
780.01-780.09	Codes to identify associated complications of heat stroke such as: Coma Alterations of consciousness
995.93-995.94	Systemic inflammatory response syndrome
992.1	Heat syncope Heat collapse
992.2	Heat cramps
992.3	Heat exhaustion, anhydrotic Heat prostration due to water depletion Excludes that associated with salt depletion (992.4)
992.4	Heat exhaustion due to salt depletion Heat prostration due to salt (and water) depletion
992.5	Heat exhaustion, unspecified Heat prostration NOS
992.6	Heat fatigue, transient
992.7	Heat edema
992.8	Other specified heat effects
992.9	Unspecified effects of heat and light
E900	Excessive heat
E900.0	Due to weather conditions Excessive heat as the external cause of: Ictus solaris Siriasis Sunstroke
EXCLUDED	
940.0-949.5	Burns
705.0-705.9	Diseases of sweat glands due to heat
995.86	Malignant hyperpyrexia following anesthesia
692.71, 692.76-692.77	Sunburn
E900.1	Of man-made origin (heat in boiler room, drying room, factory, furnace room, generated in transport vehicle, kitchen)
E900.9	Of unspecified origin
276.5	Volume depletion
276.50	Volume depletion, unspecified
276.51	Dehydration
705.1	Hypovolemia - Depletion of volume of plasma
276.52	Prickly heat
708.2	Urticaria due to cold and heat

Results

All results represent occurrences of heat related illness in Maricopa County hospitals (n=7,754); many of these individuals are non-residents of Maricopa County. However, rates were calculated using Maricopa County residents only and exclude any out of jurisdiction cases or cases with unknown county of residence.

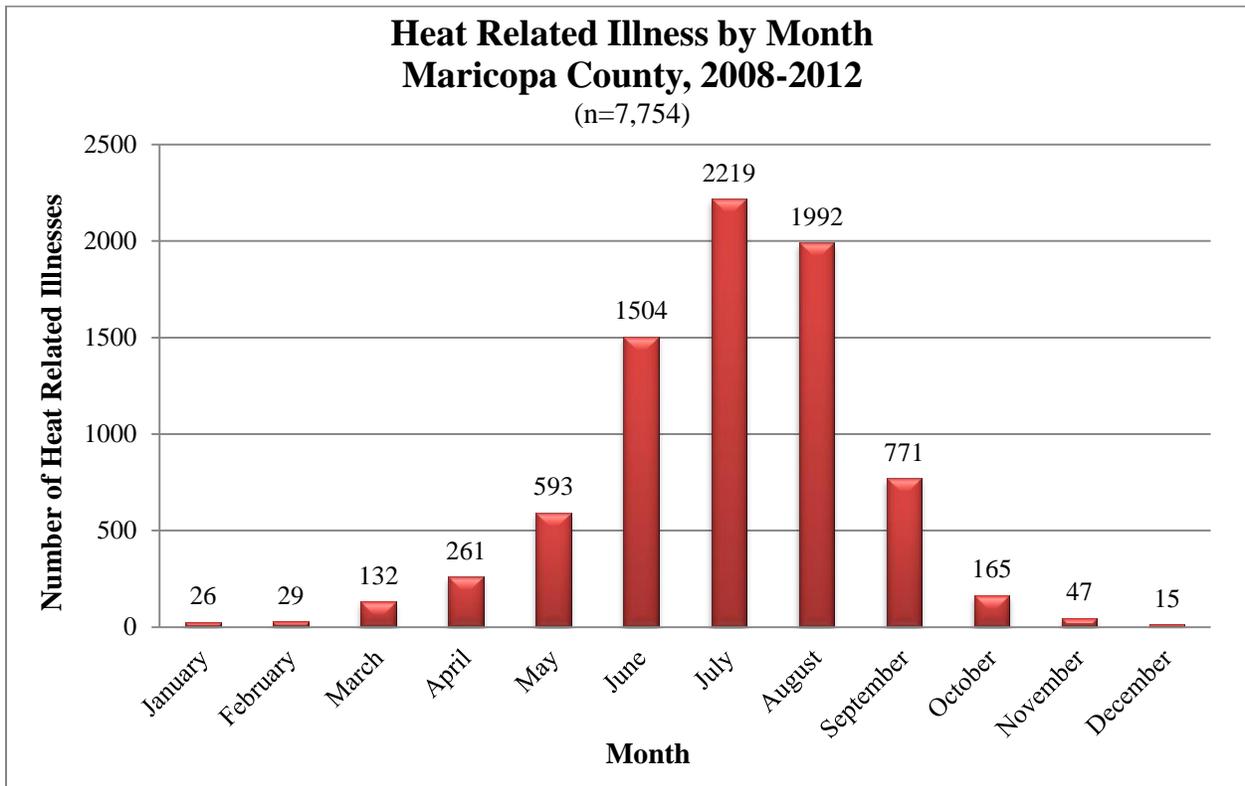
Introduction

Graph 1



The number of heat related illnesses increased steadily from 2008-2012, with the highest percentage of heat related illnesses occurring in 2011 (24%).

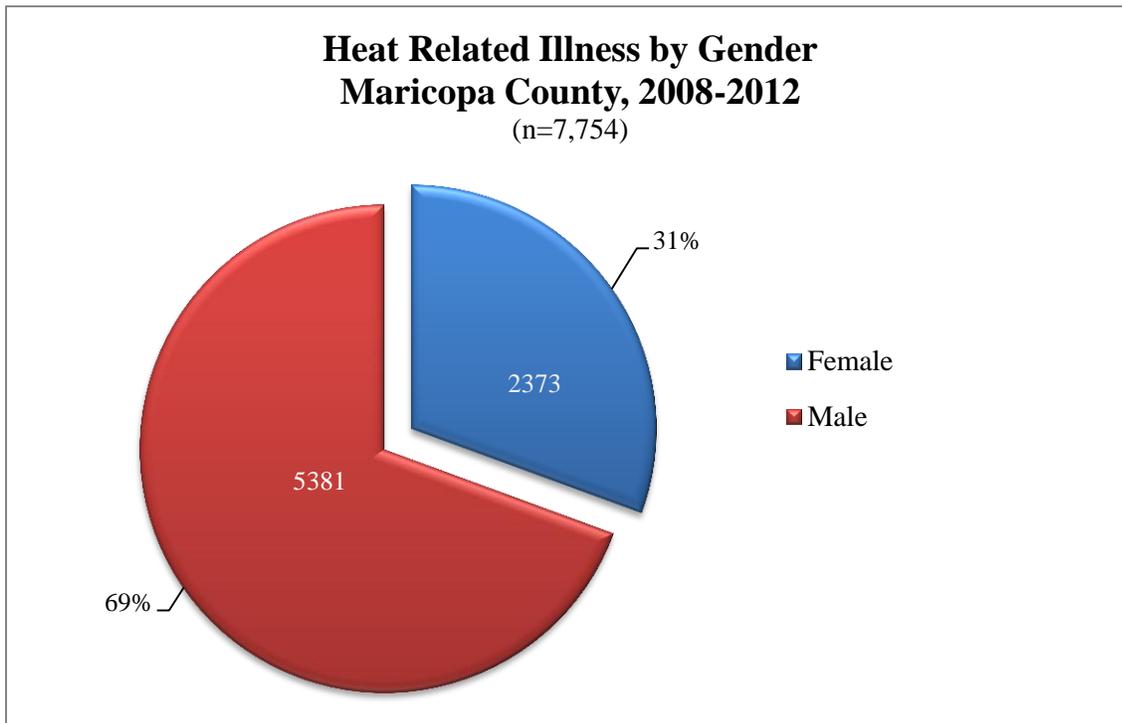
Graph 2



From 2008-2012, the number of heat related illnesses dramatically increased during the months of June through August, with the month of July experiencing the highest percent of heat related illnesses (29%).

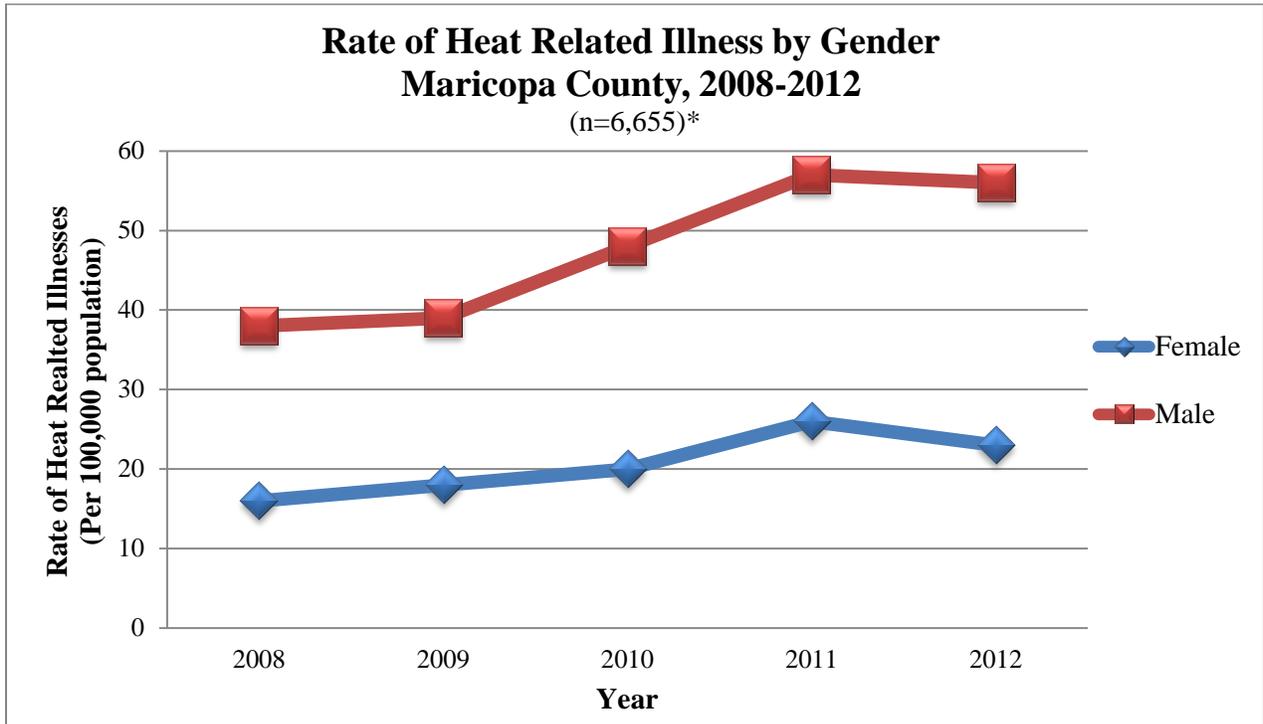
Demographics

Graph 3



From 2008-2012, more males were affected by heat related illness than females (69% vs. 31%). The ratio of heat related illness between males to females is 2.4:1, meaning males are two times more likely to experience heat related illness than females, putting them at greater risk.

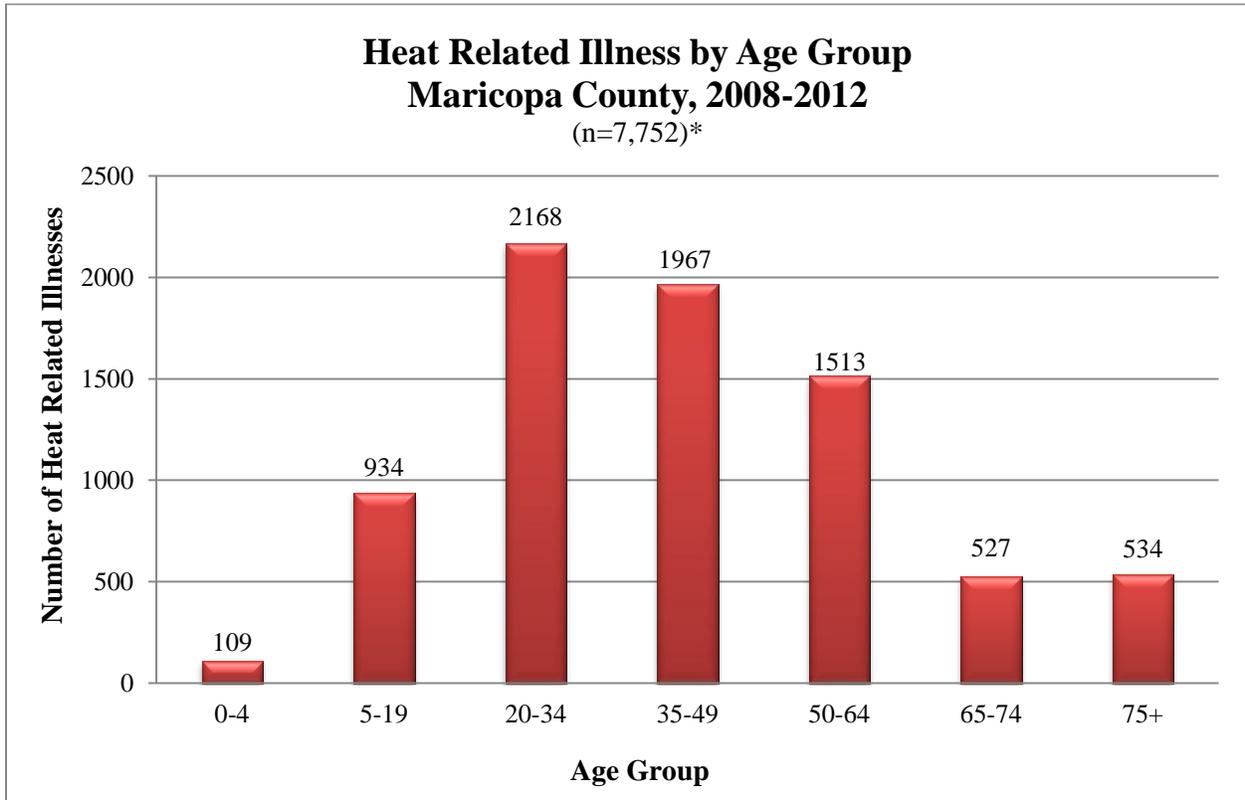
Graph 4



*Rates for Maricopa County residents only; non-Maricopa County residents and unknown values excluded

From 2008-2012, the rate of heat related illnesses were consistently higher in males than females, with the highest rates for both males and females occurring during 2011.

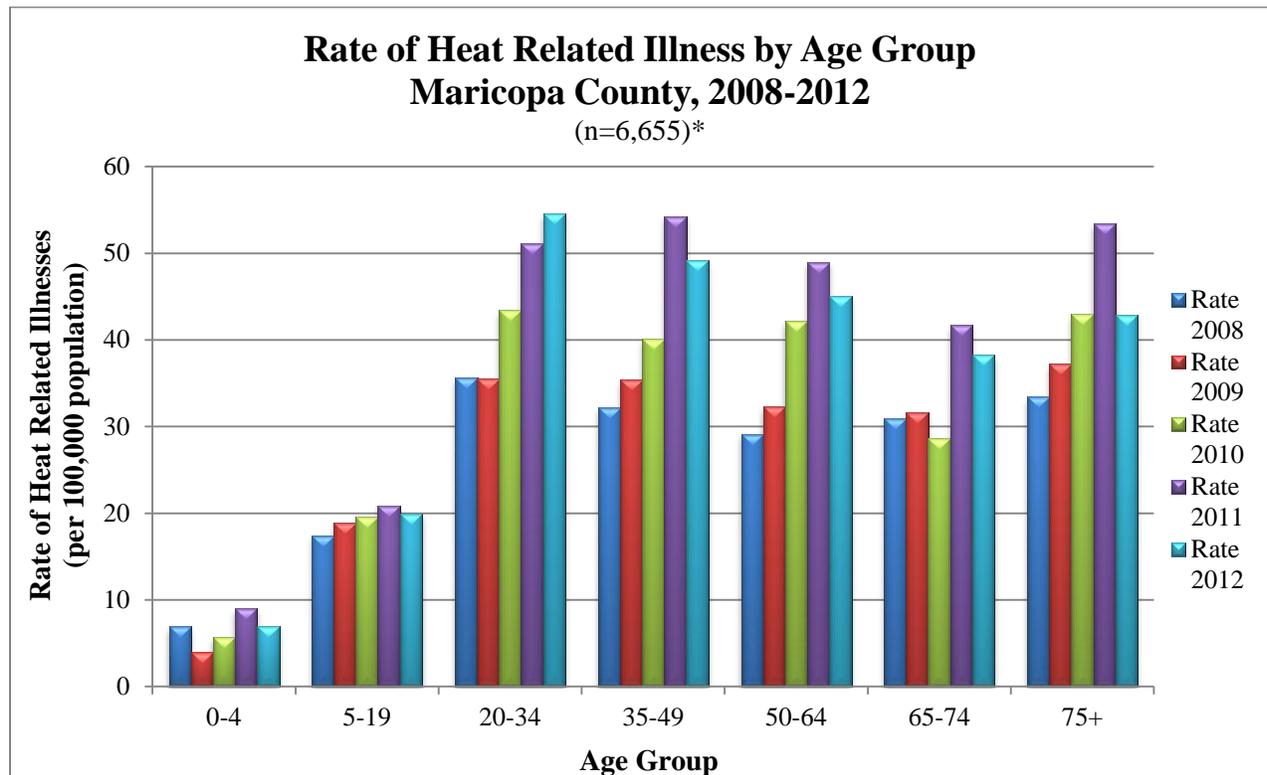
Graph 5



*Unknown values excluded

Over half the heat related illnesses from 2008-2012 were experienced by individuals between the ages of 20-49 (53%), with the highest percent of illnesses between the ages of 20-34 (28%).

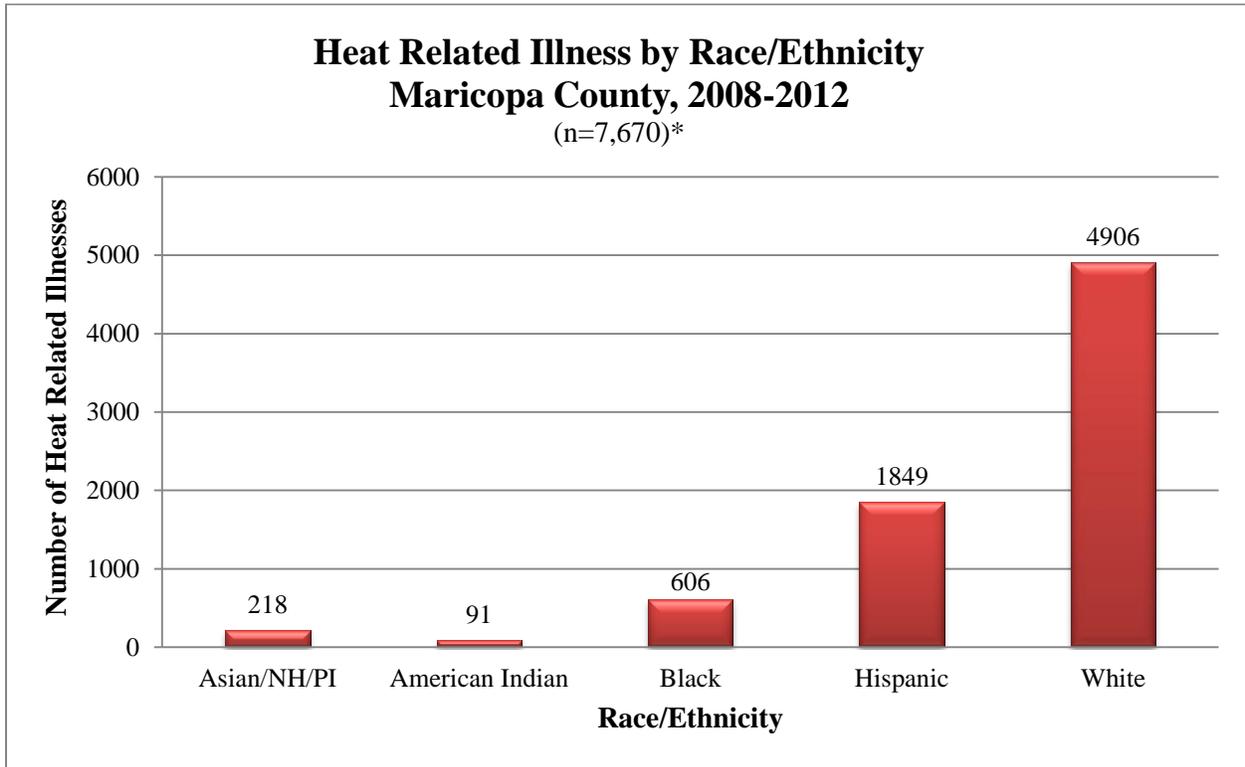
Graph 6



*Rates for Maricopa County residents; non-Maricopa County residents and unknown values excluded

From 2008-2012, the rate of heat related illnesses were consistently higher between the ages of 20-64, with the highest rates occurring in 2011 and 2012. Similar to Graph 5, the number of heat related illnesses and the rate of heat related illness is highest amongst 20-34 year olds. The biggest difference between Graph 5 and Graph 6 is the 75+ age group. In the 75+ age group, the total number of heat related illnesses is low, but the rate at which heat related illnesses occurs amongst the 75+ age group is high. It also should be noted that in 2011 there is a spike in the rate of heat related illnesses amongst the 75+ age group.

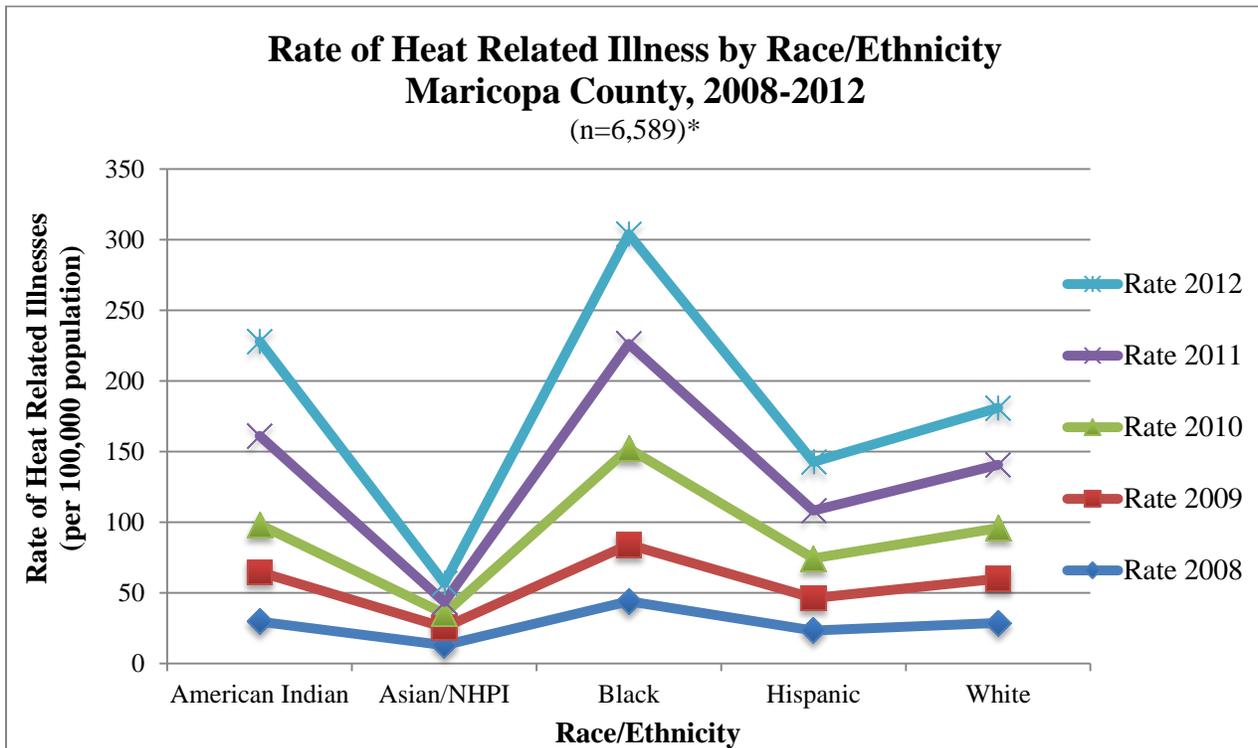
Graph 7



*Unknown values excluded, **NH (Non-Hispanic), ***PI (Pacific Islander)

From 2008-2012, Whites experienced the highest percent (63%) of heat related illnesses, followed by Hispanics (24%).

Graph 8

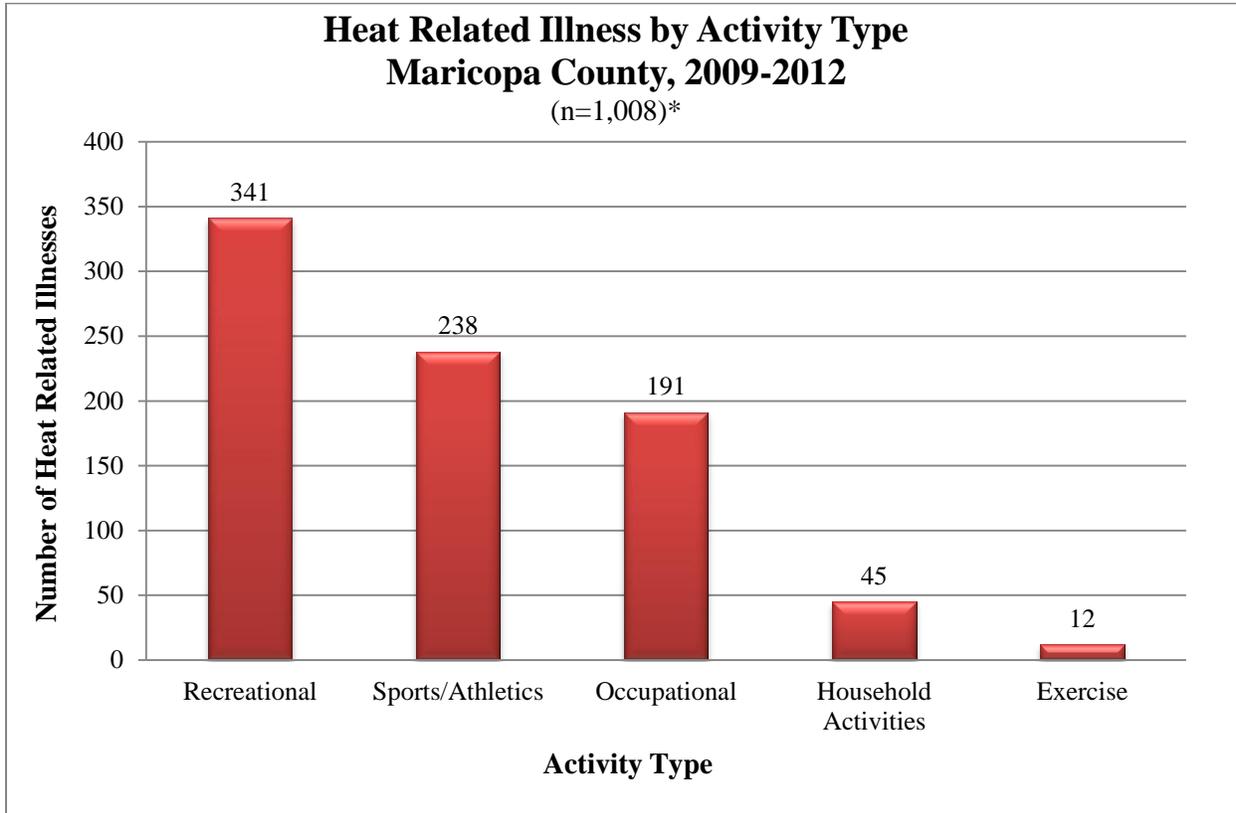


*Rates for Maricopa County residents; non-Maricopa County residents and unknown values excluded

While the total number of heat related illnesses are highest amongst Whites, the rate of incidence is higher amongst Blacks and American Indians. The rate of heat related illnesses amongst all races/ethnicities steadily increased each year, but most notably amongst Blacks and American Indians. Blacks had a rate of 44 heat related illnesses per 100,000 people in 2008, increasing to a rate of 78 heat related illnesses per 100,000 people by 2012. American Indians had a rate of 19 heated related illnesses per 100,000 people in 2008, increasing to a rate of 67 heat related illnesses per 100,000 people by 2012.

Injury Characteristics

Graph 9

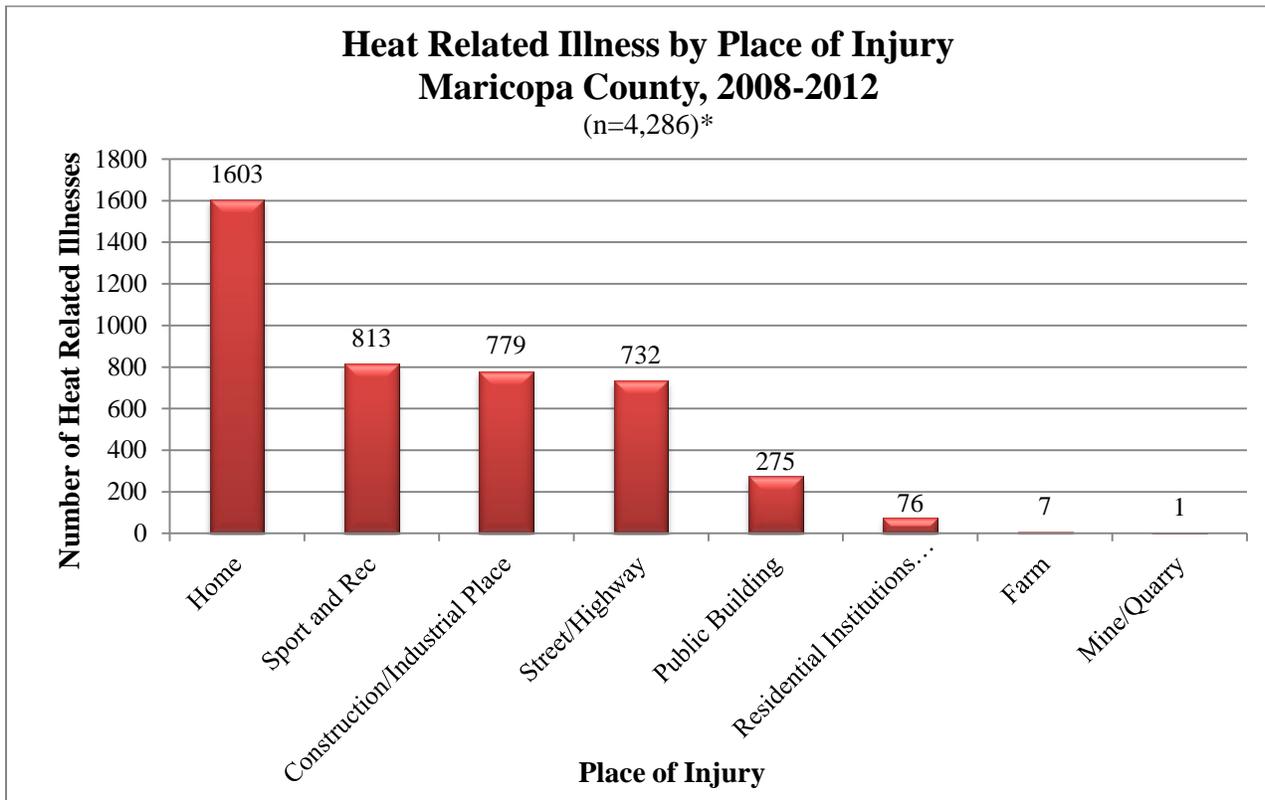


*Unknown values excluded

**Excludes 2008 data as no activity was listed

From those cases in 2009-2012 where injury activity was known, heat related illnesses most often occurred when someone was performing a recreational (34%) activity, followed by a sport/athletics (24%) activity.

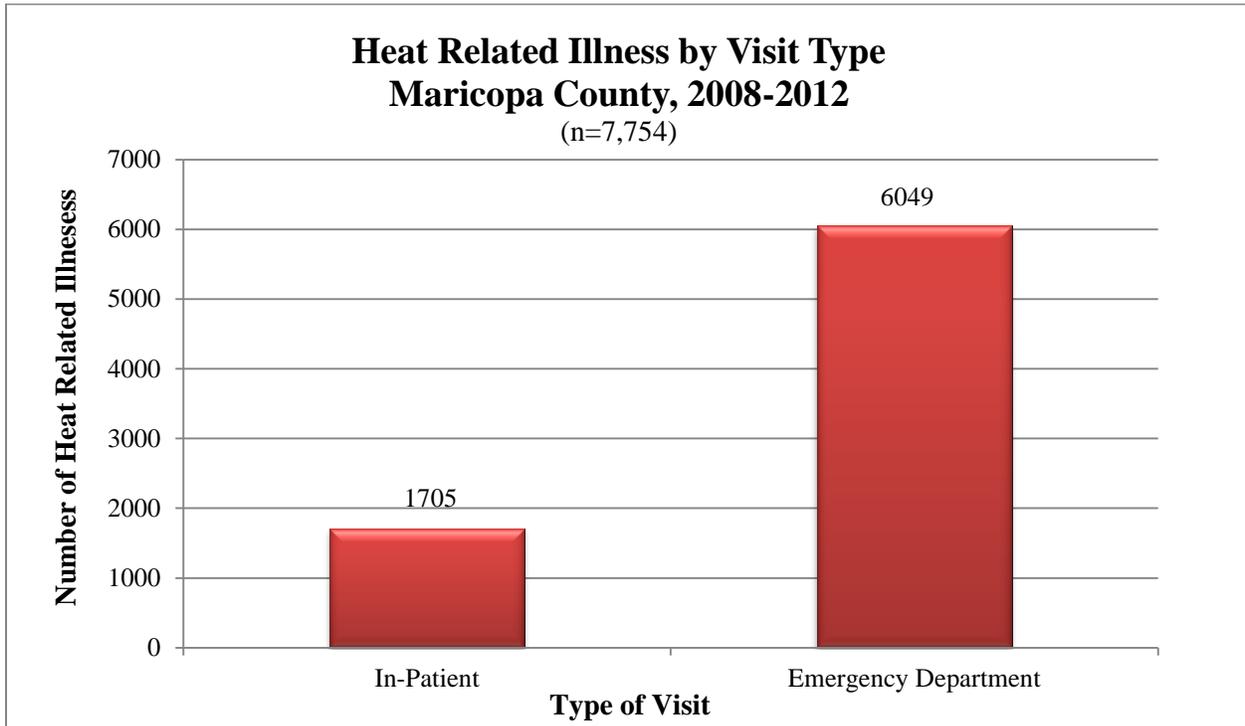
Graph 10



*Unknown values excluded

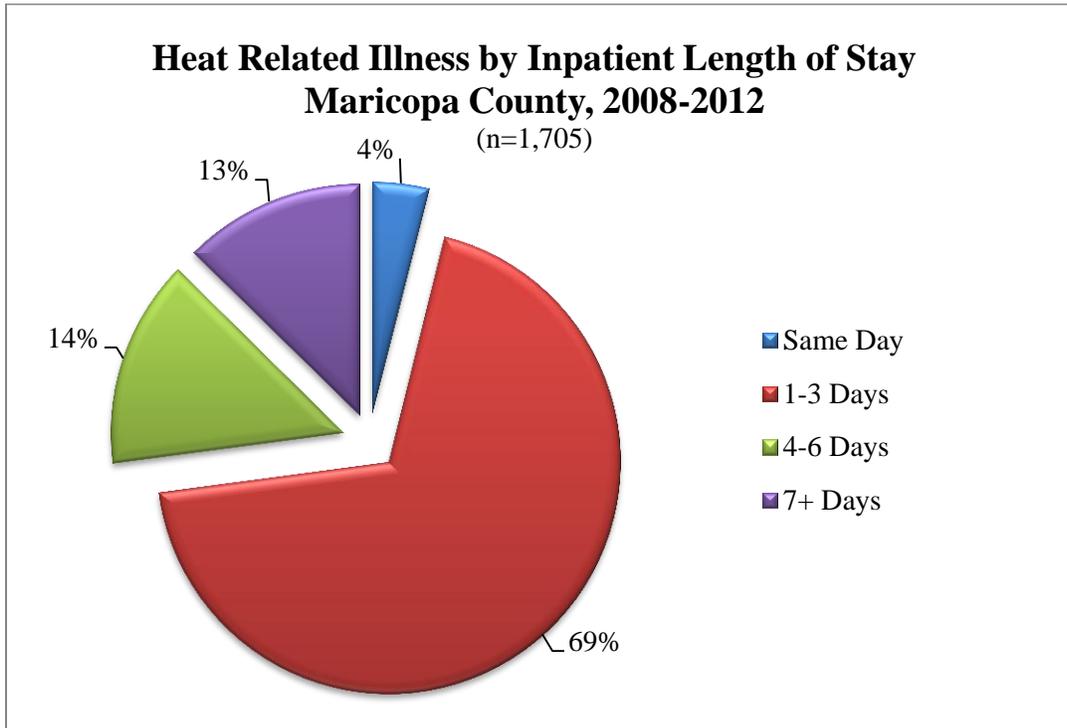
From those cases in 2008-2012 where place of injury was known, a large proportion of heat related illnesses occurred at the home (37%). Different from Graph 9, this graph looks at where the injury took place vs. what type of activity was taking place at the time of the injury. The activity taking place does not necessarily correlate with the place of injury. This graph also details 2008-2012 data, whereas Graph 9 only depicts 2009-2012 data.

Graph 11



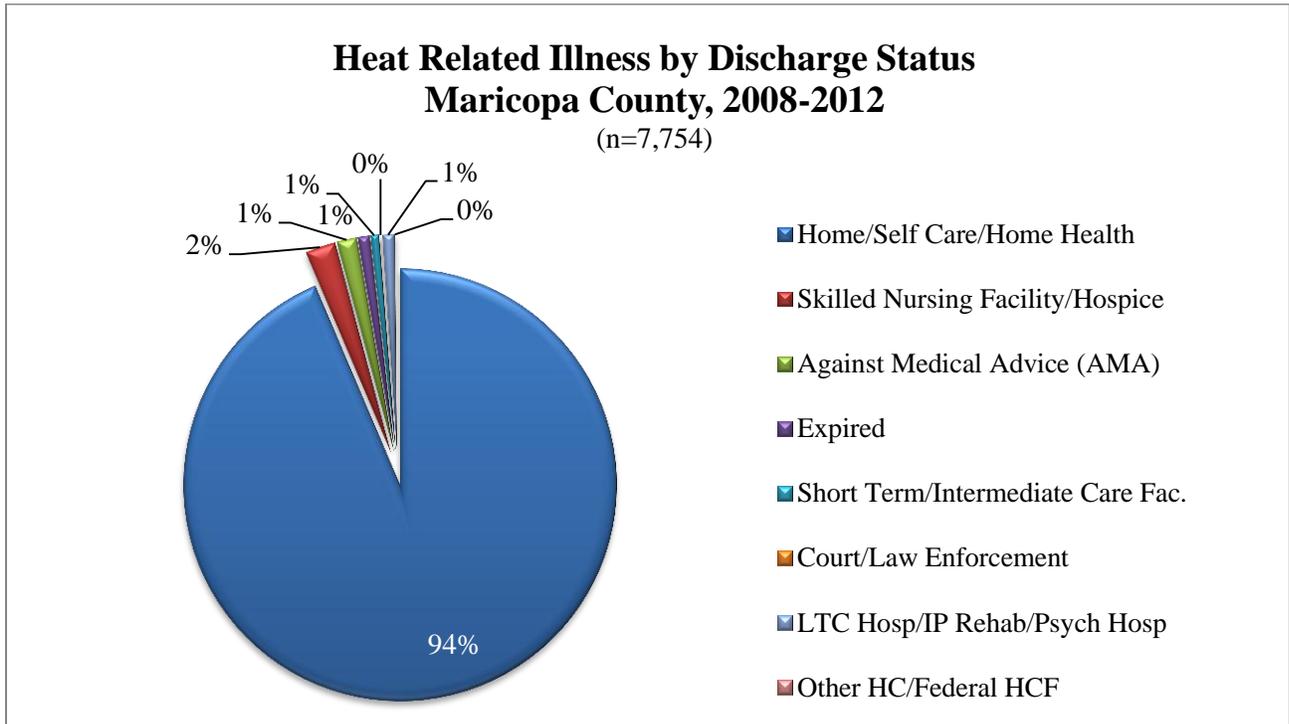
From 2008-2012 more patients were seen for heat related illness in the emergency department than in-patient (78% and 22%, respectively).

Graph 12



For patients admitted to the hospital from 2008-2012 for heat related illness, 69% required hospitalization for 1-3 days, and approximately 27% of patients stayed in the hospital for 4 days or more. The median length of stay was two days. Of the 4% of patients listed as being ‘discharged’ from inpatient on the same day as being admitted, 100% (n=66) were transferred to other facilities where more advanced care was needed.

Graph 13



After being seen in the hospital for a heat related illness (either in the ED or in-patient) 94% of patients were discharged to home or other self-care entity. Approximately 1% of the heat related illnesses that were seen in the hospital resulted in death.

Limitations

While the HDD provides valuable information regarding heat related illnesses in Maricopa County, it has some limitations. Reviewing hospital discharge data is a retrospective surveillance method and does not provide real-time updates about the current state of heat related illness in the county which restricts the public health response to a heat related event. There are also numerous differences in the way ICD-9 codes are assigned by healthcare providers and the interpretation of keywords may vary for the same condition. Additionally, the time it takes to review Hospital Discharge Data (HDD) for patients with multiple admissions and to ensure that certain cases meet the case definition for HRI can be quite extensive.

Conclusions

The number of hospital visits due to heat related illnesses (HRI) from 2008-2012 has steadily increased over the period. Highlights of the analysis include:

- Between the years of 2008-2012, the most occurrences of HRI happened in 2011 at 24%.
- The month of July consistently had the highest number of HRI overall, however, in 2011 and 2012, August had the highest number of HRI.
- More males experience heat related illness compared to females, with a ratio of 2.4:1 (males to females).
- The highest number of hospital visits due to HRI occurred in those aged 20-34 years of age.
- While the total count of HRIs is greatest amongst White individuals, the rate of HRI per 100,000 population is highest amongst Blacks.
- The majority of all HRI visits were the result of a recreational or sport activity.
- A large portion of HRI occurred in a home and most patients were discharged to home or other self-care entity.
- Of all the patients that presented to the hospital for HRI, 22% were admitted as in-patient.
- Of those patients that were required to stay in-patient, over half of them had a length of stay of 1-3 days; however some patients were admitted for longer than a week.

Despite its limitations, hospital discharge data is a very useful tool for heat morbidity surveillance in Maricopa County. The volume of cases that can be reviewed from facilities across the county and the amount of data from each case that can be collected is very useful, especially for gathering information about potential risk factors for HRI. Future outreach efforts to mitigate the effects of HRI could be tailored to different areas based on the characteristics of cases seen at the various facilities.

This data is also very useful for long-term heat morbidity surveillance. The data is very thorough and can be analyzed for an array of factors over a long period of time for the entire county. Even though it cannot provide real-time data, it can show changes over time from year to year.

APPENDIX

Multi-year Tables

Table 1. Heat Related Illness by Month, Maricopa County, 2008-2012

Month	YEAR					Total	
	2008	2009	2010	2011	2012	N	%
January	4	10	0	9	3	26	0.3
February	4	11	0	2	12	29	0.4
March	21	42	12	31	26	132	1.7
April	38	45	22	62	94	261	3.4
May	73	168	84	87	181	593	7.7
June	317	142	286	348	411	1504	19.4
July	342	503	524	480	370	2219	28.6
August	274	277	322	580	539	1992	25.7
September	131	117	187	193	143	771	9.9
October	32	25	39	47	22	165	2.1
November	13	12	9	6	7	47	0.6
December	4	1	3	6	1	15	0.2
Total	1253	1353	1488	1851	1812	7754	100.0

Table 2. Heat Related Illness by Gender, Maricopa County, 2008-2012

Gender	YEAR					Total	
	2008	2009	2010	2011	2012	N	%
Female	368	422	460	594	529	2373	31
Male	885	931	1028	1257	1280	5381	69
Total	1253	1353	1488	1851	1809	7754	100.0

Table 3. Heat Related Illness by Age Group, Maricopa County, 2008-2012

Age Group	YEAR					Total	
	2008	2009	2010	2011	2012	N	%
0-4	24	18	19	28	20	109	1.4
5-19	174	184	177	202	197	934	12.0
20-34	351	372	408	489	548	2168	28.0
35-49	311	349	373	488	446	1967	25.4
50-64	223	240	310	378	362	1513	19.5
65-74	86	89	90	133	129	527	6.8
75+	83	101	110	133	107	534	6.8
Unknown	1	0	1	0	0	2	0.0
Total	1253	1353	1488	1851	1812	7754	100.0

Table 4. Heat Related Illness by Race/Ethnicity, Maricopa County, 2008-2012

Race/Ethnicity	YEAR					Total	
	2008	2009	2010	2011	2012	N	%
American Indian	26	32	34	63	63	218	2.8
Asian/NHPI	16	19	15	17	24	91	1.2
Black	84	82	129	151	160	606	7.8
Hispanic	319	325	346	422	437	1849	23.8
White	788	870	950	1185	1113	4906	63.3
Unknown	20	25	14	13	12	84	1.1
Total	1253	1353	1488	1851	1809	7757	100.0

Table 5. Heat Related Illness by Activity Type, Maricopa County, 2009-2012

Activity	Year				Total	
	2009	2010	2011	2012	N	%
Recreational	8	94	116	123	341	33.8
Sports/Athletics	6	56	93	83	238	23.6
Exercise	1	3	3	5	12	1.2
Household Activities	0	12	19	14	45	4.5
Occupational	1	57	72	61	191	18.9
Other	5	54	58	64	182	18.0
Total	21	276	361	350	1009	100.0

*Excludes 2008 data as no activity was listed

Table 6. Heat Related Illness by Place of Injury, Maricopa County 2008-2012

Place of Injury	Year					Total	
	2008	2009	2010	2011	2012	N	%
Home	221	297	319	419	347	1603	20.7
Farm	1	2	0	4	0	7	0.1
Mine/Quarry	0	0	0	1	0	1	0.0
Construction/Industrial Place	114	134	166	191	174	779	10.1
Sport and Rec	111	176	168	175	183	813	10.5
Street/Highway	81	119	159	172	201	732	9.4
Public Building	40	51	58	62	64	275	3.6
Residential Institutions (Hospitals)	6	17	14	15	24	76	1.0
Other Place	239	293	308	440	364	1644	21.2
Not Specified	440	264	296	372	452	1824	23.5
Total	1253	1353	1488	1851	1809	7754	100.0

Table 7. Heat Related Illness by Visit Type, Maricopa County, 2008-2012

Year	Visit Type		Total	
	IP	ED	N	%
	N	N		
2008	238	1015	1253	16.2
2009	320	1033	1353	17.4
2010	352	1136	1488	19.2
2011	402	1449	1851	23.9
2012	393	1416	1809	23.3
Total	1705	6052	7754	100.00

Table 8. Heat Related Illness by Activity Type and Visit Type, Maricopa County, 2008-2012

Activity	Visit Type		Total
	IP	ED	
Recreational	53	288	341
Sports/Athletics	33	205	238
Exercise	2	10	12
Household Activities	3	42	45
Occupational	73	118	191
Other	50	131	181
Total	214	794	1008

Table 9. Heat Related Illness by Place of Injury and Visit Type, Maricopa County, 2008-2012

Place of Injury	Visit Type		Total
	IP	ED	
Home	508	1095	1603
Farm	4	3	7
Mine/Quarry	0	1	1
Construction/Industrial Place	122	657	779
Sport and Rec	81	732	813
Street/Highway	189	543	732
Public Building	48	227	275
Residential Institutions (Hospitals)	43	33	76
Other Place	288	1356	1644
Total	1283	4647	5930

Table 10. Heat Related Illness by Source of Admission and Visit Type, Maricopa County, 2008-2012

Admission Source	Visit Type				Total	
	ED		IP		No.	%
	No.	%	No.	%		
Non-Health Care Facility Point of Origin	3817	63.12	1073	62.93	4890	63.06
Emergency Room	2211	36.53	550	32.26	2761	35.61
Transfer from a Hospital (different facility)	1	0.02	55	3.23	56	0.72
Clinic	12	0.20	7	0.41	19	0.25
Transfer from another Health Care Facility	2	0.03	14	0.82	16	0.21
Court/Law Enforcement	2	0.03	4	0.23	6	0.08
Information not available	4	0.07	1	0.06	5	0.06
Transfer from one Distinct Unit to another Resulting in a Separate Claim to Payer	0	0	1	0.06	1	0.01
Total	6049	100.0	1705	100.0	7754	100.00

Table 11. Heat Related Illness by Discharge Status and Visit Type, Maricopa County, 2008-2012

Discharge Status	Visit Type		
	ED N	IP N	All N
Home/Self Care	5908	1279	7187
Skilled Nursing Fac.	3	156	159
AMA	71	43	114
Expired	9	59	68
Home Health	5	61	66
Short Term Fac.	27	14	41
Psych Hosp	12	24	36
Court/Law Enforcement	8	11	19
IP Rehab	0	16	16
Hospice-Facility	0	16	16
LTC Hosp	0	10	10
Intermediate Care Fac.	3	3	6
Other Healthcare Fac Type	2	3	5
Other HC	1	4	5
Home w/Hospice	0	5	5
Federal HCF	0	1	1
All	6049	1705	7754

Table 12. Heat Related Illness Inpatient Visits Length of Stay, Maricopa County, 2008-2012

Length of Stay	YEAR					Total	
	2008	2009	2010	2011	2012	N	%
Same Day	10	13	11	13	19	66	3.9
1-3 Days LOS	171	217	241	263	285	1177	69.0
4-6 Days LOS	32	47	54	73	41	247	14.5
7+ Days LOS	25	43	46	53	48	215	12.6
Total	238	320	352	402	393	1705	100.0

Table 13. Heat Related Illness Discharge Status, Maricopa County, 2008-2012

Discharge Status	Year					Total	
	2008	2009	2010	2011	2012		
	N	N	N	N	N	N	%
Home/Self Care/Home Health	1198	1265	1368	1736	1691	7258	93.6
Skilled Nursing Facility/Hospice	20	34	36	51	34	175	2.3
Against Medical Advice (AMA)	10	15	35	17	37	114	1.5
Expired	11	15	15	16	11	68	0.9
Short Term/Intermediate Care Fac.	3	7	8	11	18	47	0.6
Court/Law Enforcement	0	2	9	4	4	19	0.2
LTC Hosp/IP Rehab/Psych Hosp	7	13	15	15	12	62	0.8
Other HC/Federal HCF	4	2	2	1	2	11	0.1
Total	1253	1353	1488	1851	1809	7754	100

