MARICOPA COUNTY DEPARTMENT OF PUBLIC HEALTH
DIVISION OF DISEASE CONTROL
OFFICE OF EPIDEMIOLOGY AND DATA SERVICES

HEAT-ASSOCIATED DEATH OCURRENCES IN MARICOPA COUNTY
REPORT FOR 2009

May 26, 2011

Background

In July 2005, Maricopa County (MC) experienced exceptionally high temperatures that contributed to 32 deaths, 28 occurring over a 14 day span. Temperatures reached 116^0 F and three excessive heat warnings were issued during this month. To track these deaths, Maricopa County Department of Public Health (MCDPH) created a novel and effective approach for surveillance of heat-associated deaths and has continued to use this system annually. This enhanced heat surveillance begins in May and ends in October.

Method

Surveillance data is obtained through the following sources:

1. Weekly data from the Medical Examiner's Office of suspected heat related deaths including demographics and preliminary information regarding how the death occurred, and the circumstances of death.

2. The MCDPH Office of Vital Statistics database for death certificates utilizing the following International Classification of Disease Codes (ICD) shown below and key words: HEAT EXPOSURE, ENVIRONM, EXHAUSTION, SUN, HEAT STRESS, HEAT STROKE and HYPERTHER:

ICD 10 Code	Corresponding Definition
X30	Exposure to excessive natural heat
T67.X	Effects of heat and light
P810	Environmental hyperthermia of newborn

3. Local MC hospital and/or media reports

Once data is received, analysis of the information is required to identify only those deaths caused as a result of environmental heat. Environmental heat is heat generated by the climate (sun, humidity, etc.) rather than heat from man-made sources such as ovens or manufacturing equipment. Heat-associated deaths are categorized based on the classification criteria listed below:

Heat Caused (HC) deaths are those in which environmental heat was directly involved in the sequence of conditions causing deaths. These are cases that mention heat or heat exposure in Part I of the death certificate causes of death (diseases or conditions in the direct sequence causing death), for variables cause of death (*cod_a, cod_b, cod_c, or cod_d).* County of death: Maricopa.

Heat Related (HR) deaths are those in which environmental heat contributed to the deaths but was not in the sequence of conditions causing these deaths. These are cases that mention heat exposure in Part II of the death certificate causes of death (diseases and conditions contributing but not directly resulting in the death sequence), but not in any of the Part I variables (*cod_a, cod_b, cod_c, or cod_d*). County of death: Maricopa.

Part I of the death certificate:
cod a – immediate cause (final disease or condition resulting in death)
cod b, cod c, cod d – sequentially listed conditions if any leading to the cause listed on cod a.
Part II of the death certificate: Other significant conditions contributing to death but not resulting in the underlying cause given in part I.

Once classification is completed, the data are summarized for the production and dissemination of reports. Reports are generated weekly and posted to the MCDPH website which can be found at:

http://www.maricopa.gov/publichealth/Services/EPI/Reports/heat.aspx

Key Points

The following report is a summation of heat related and heat caused deaths in Maricopa County for the year 2009. Key points from the 2009 report are as follows:

- There were 74 confirmed heat-associated deaths
- 74.3% (55/74) of the cases were male
- There were no reported deaths in children less than five years old
- 20.3% (15/74) deaths occurred in individuals identified as homeless
- 35.1% (26/74) deaths occurred indoors at a private residence
- 9.5% (7/74) of the deaths that occurred were in homes with a non-functioning air conditioning unit or one that was not in use

Results

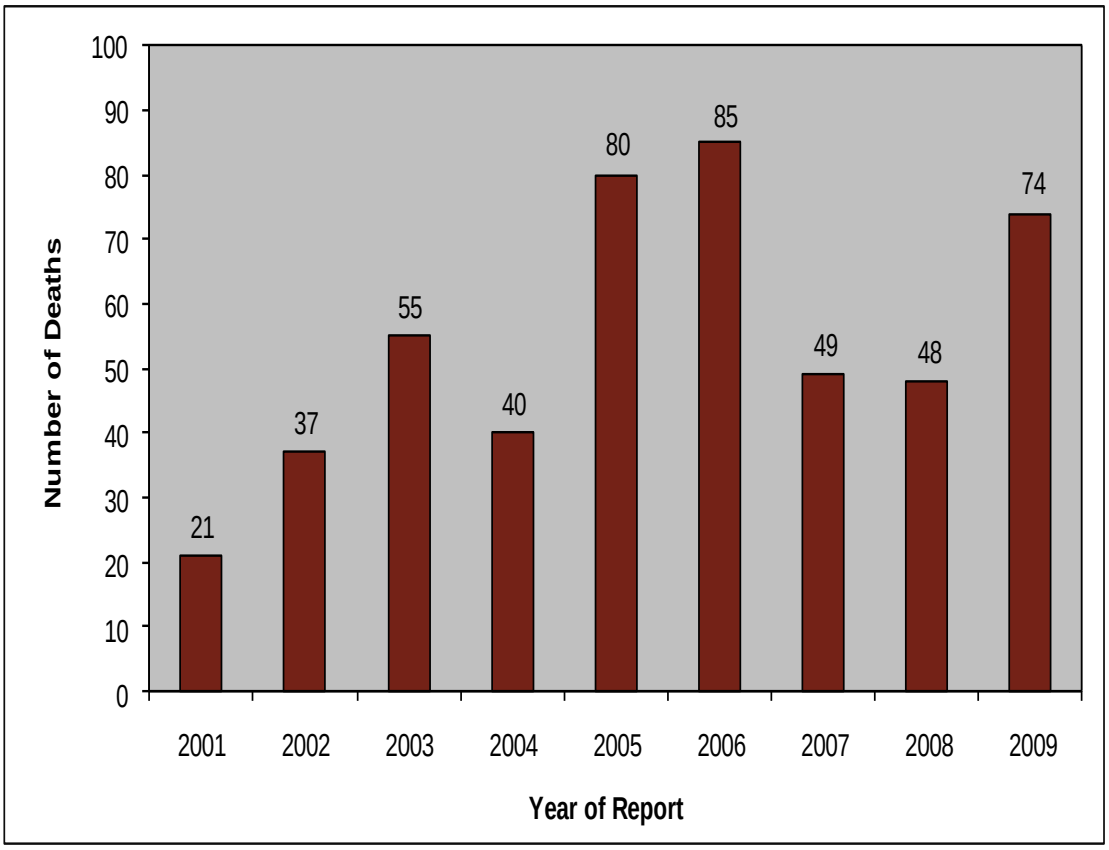
Table 1. On average, approximately one hundred suspect heat caused/heat related deaths (heat-associated deaths) were investigated each year from 2006 through 2009 totaling 440 cases over the four year period. Of these cases, 58% were confirmed as being heat-associated deaths. In 2009 alone, 65% of the investigated cases were confirmed as heat-associated deaths.

Table 1. Heat-associated Deaths Reported in Maricopa County: 2006-2009

Cases	2006	%	2007	%	2008	%	2009	%	TOTAL	%
Total Reported	103	100	129	100	95	100	113	100	440	100
Confirmed	85	83	49	39	48	51	74	65	256	58
Ruled Out	18	17	80	61	47	49	39	35	184	42
Pending	0	0	0	0	0	0	0	0	0	0

Graph 1. The number of heat-associated deaths reported in 2009 was 74, indicating the third highest year in nine years. The graph shows that after two years of decreasing, the number of cases increased by 54% in 2009 over the 2008 number.

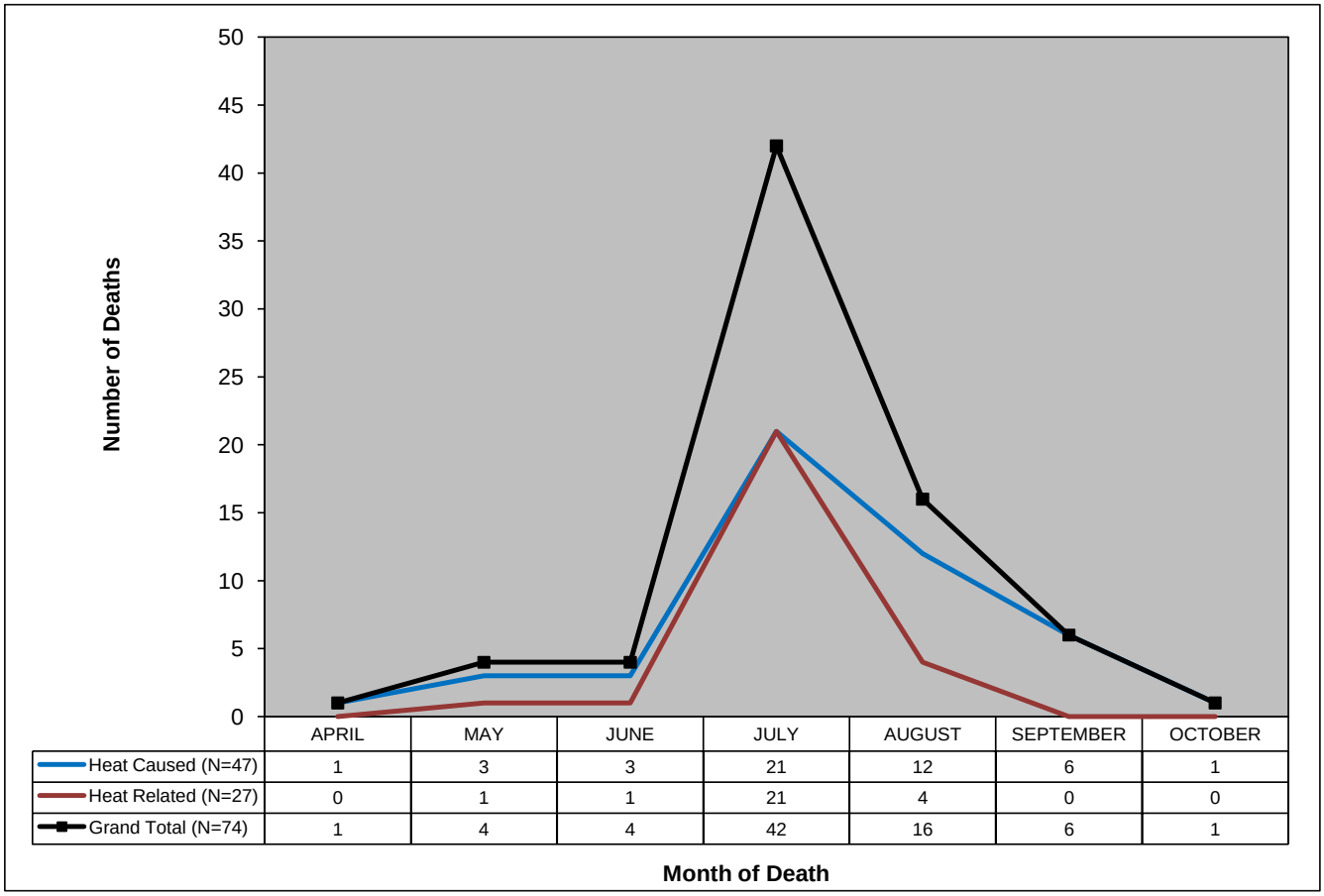
Graph 1. Heat-associated Deaths by Year, Maricopa County: 2001-2009



Data Sources: Maricopa County, Offices of Vital Registration (Public Health) and Medical Examiner; Arizona Department of Health Services, Office of Vital Registration.

Graph 2. In 2009, July was the most deadly month for heat-associated deaths with more than half of the 74 deaths occurring in this month. The number of deaths were equally divided between the classifications of heat related (21) and heat caused (21). In all other months the majority of confirmed cases reported were classified as heat caused (26, 81.3%).

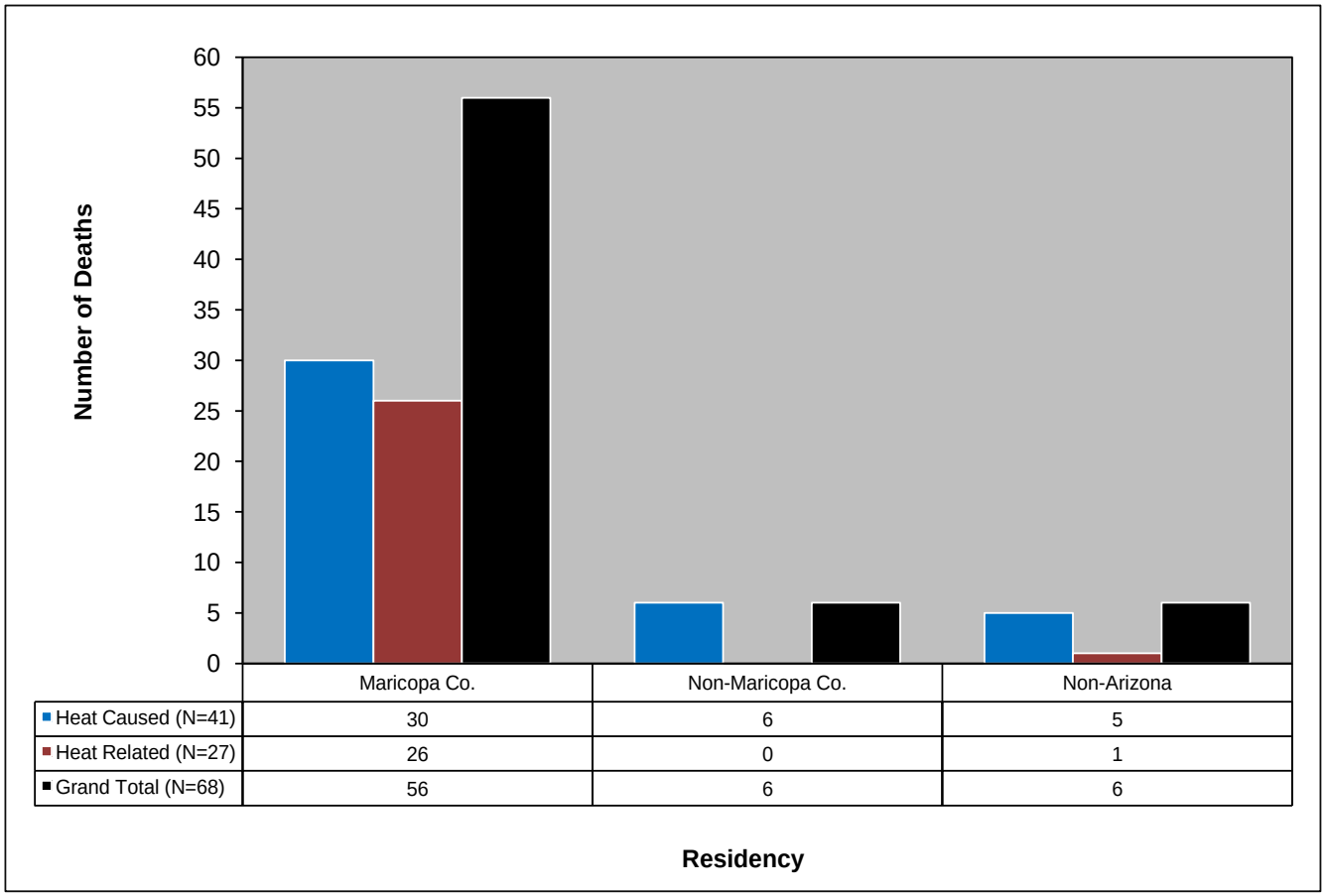
Graph 2. Heat-associated Deaths by Month, Maricopa County, 2009



	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
Heat Caused (N=47)	1	3	3	21	12	6	1
Heat Related (N=27)	0	1	1	21	4	0	0
Grand Total (N=74)	1	4	4	42	16	6	1

Graph 3. Residency was identified for 68 heat-associated deaths in 2009 (6 cases for which residency could not be established were excluded). Most of the cases (56, 82%) were Maricopa County residents. Nine percent of the 68 cases resided in Arizona, either outside of Maricopa County or their county of residence was unknown. Nine percent were not known to be residents of the state of Arizona.

Graph 3. Heat-associated Deaths by Residency* in Maricopa County, 2009

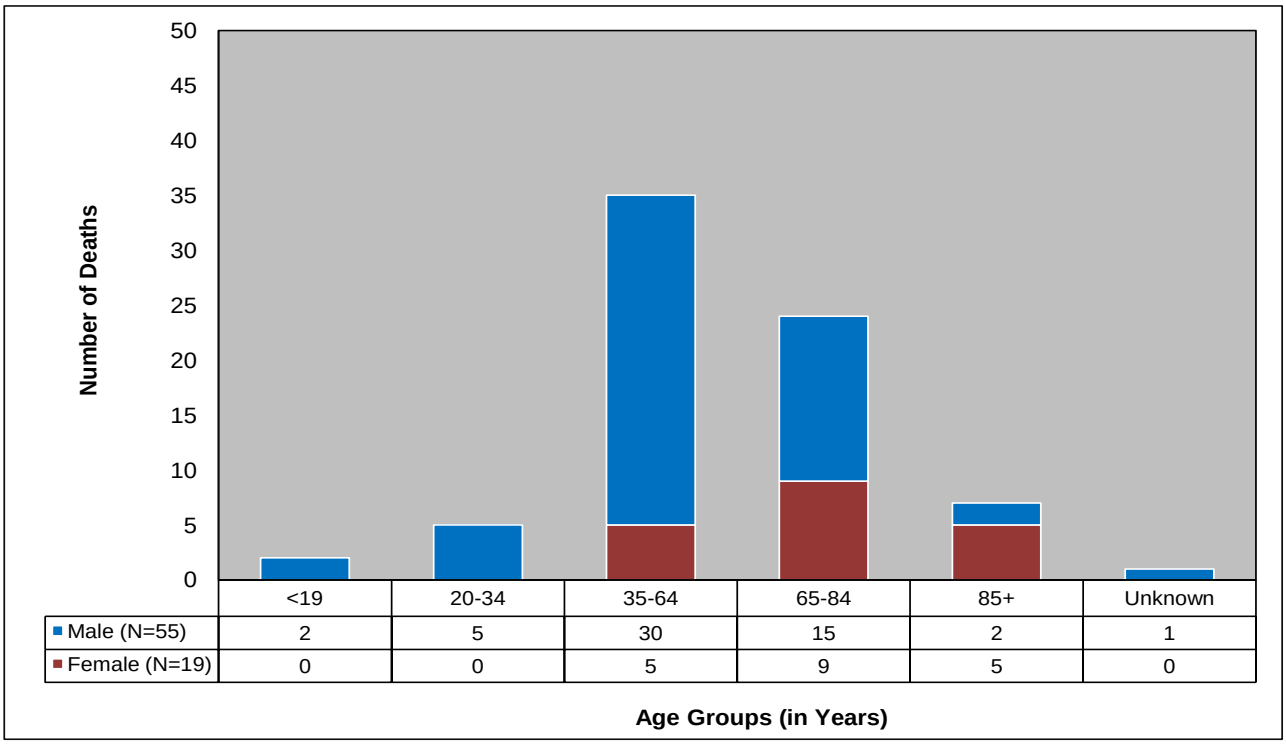


	Maricopa Co.	Non-Maricopa Co.	Non-Arizona
Heat Caused (N=41)	30	6	5
Heat Related (N=27)	26	0	1
Grand Total (N=68)	56	6	6

*Excludes six cases where residency could not be established
**Non-Maricopa residents include Pinal County (2), Pima County (1), and other unidentified AZ counties (3)
***Non-Arizona residents include US (3) (AK, CA, and NM) and non-US (3) (MX) residents

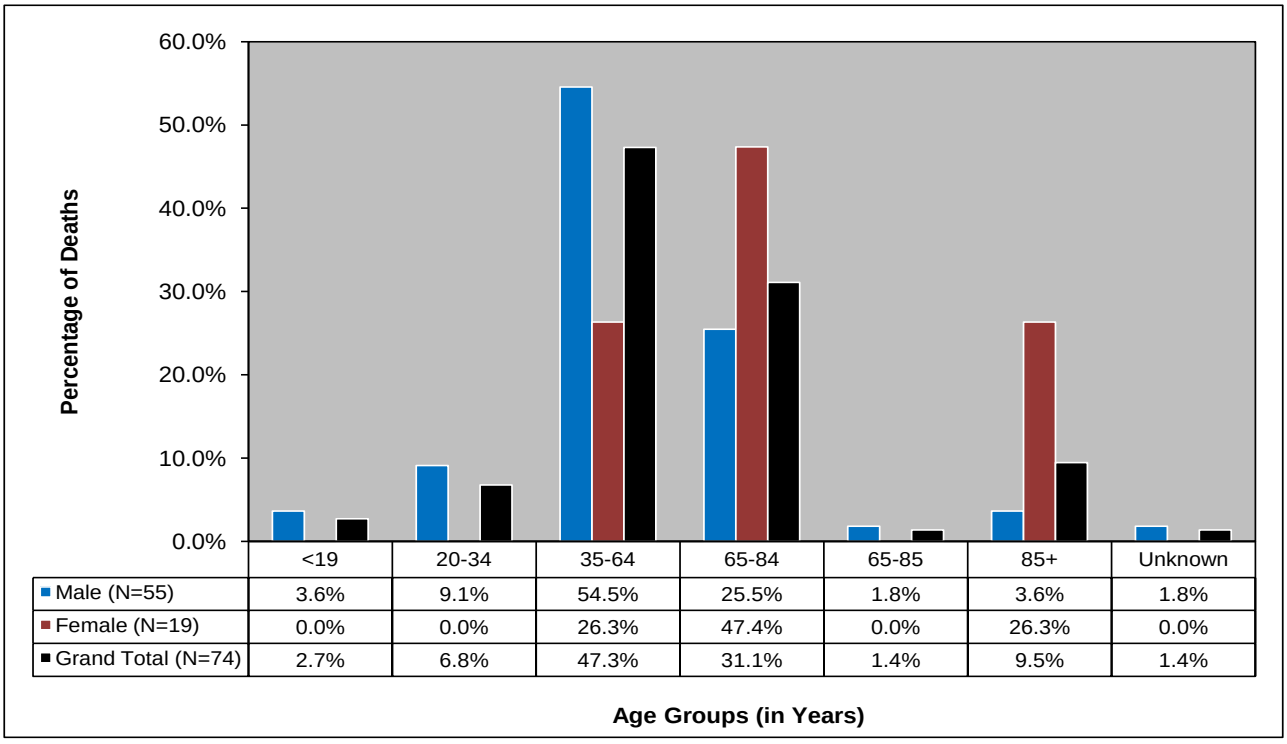
Graphs 4-5. The majority of heat-associated deaths identified were males (55, 74.3%). Most female cases were 65 and older, (14, 73.7% of female cases). In contrast, most male cases were under the age of 65 (37, 67.3% of male cases). [See Appendix, Table A]

Graph 4. Age at Death, Heat-associated Deaths by Gender, Maricopa County, 2009



	<19	20-34	35-64	65-84	85+	Unknown
Male (N=55)	2	5	30	15	2	1
Female (N=19)	0	0	5	9	5	0

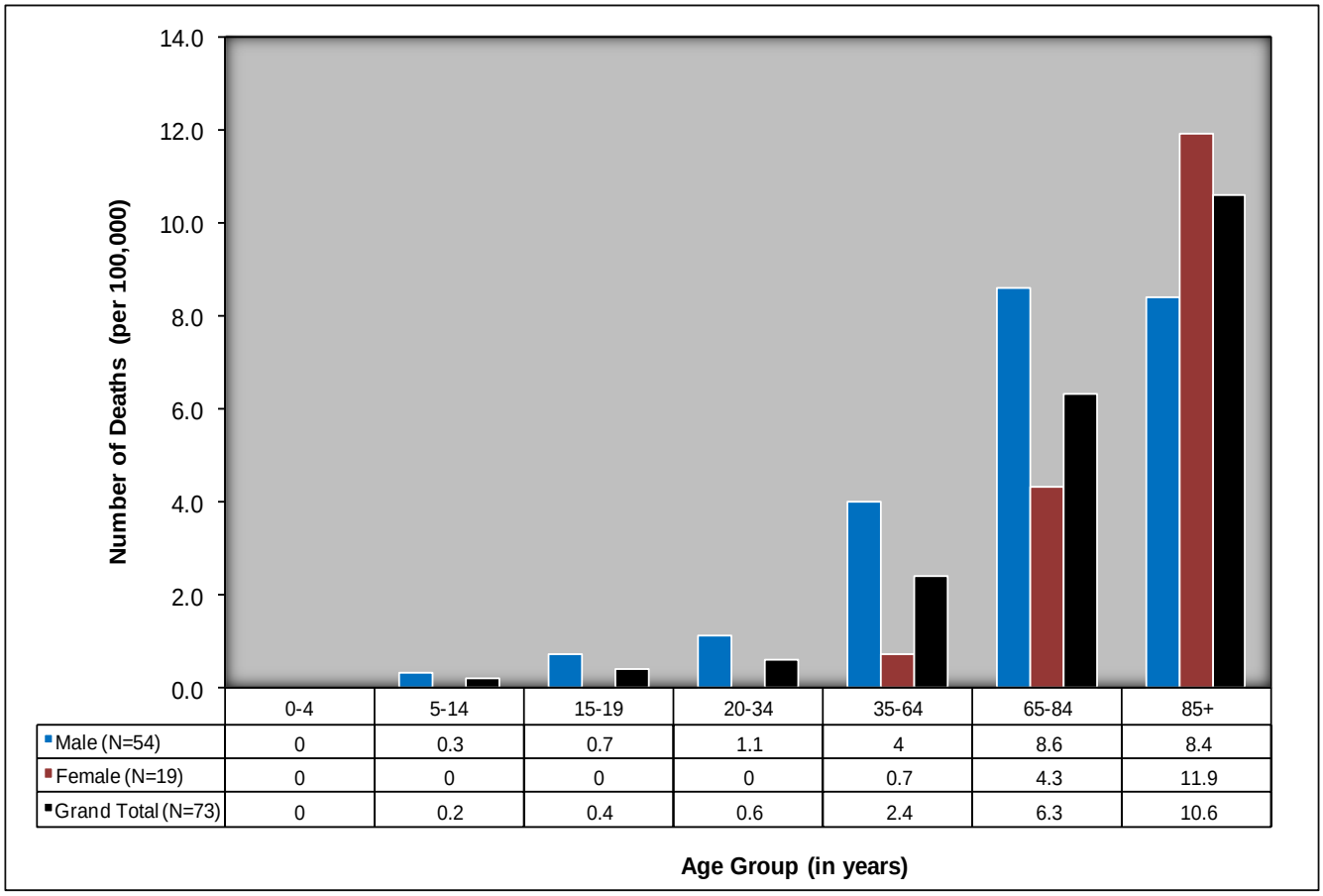
Graph 5. Percentage of Heat-associated Deaths by Age Group and Gender for Maricopa County, 2009



	<19	20-34	35-64	65-84	65-85	85+	Unknown
Male (N=55)	3.6%	9.1%	54.5%	25.5%	1.8%	3.6%	1.8%
Female (N=19)	0.0%	0.0%	26.3%	47.4%	0.0%	26.3%	0.0%
Grand Total (N=74)	2.7%	6.8%	47.3%	31.1%	1.4%	9.5%	1.4%

Graph 6. Overall, the rates for heat deaths in Maricopa County increases as age increases, but the pattern is different for males and females. The data shows that for women, the likelihood of heat-associated deaths begins in the age group of 35-64 and is greater for each subsequent age category. For men, the rates for heat-associated deaths begin earlier and generally outweigh those for females. However, for the 85+ age group, the rate for female deaths is noticeably higher. [See Appendix, Table B].

Graph 6. Heat-associated Death Rates* per 100,000 by Occurrence, Gender, and Age Group, Maricopa County, 2009

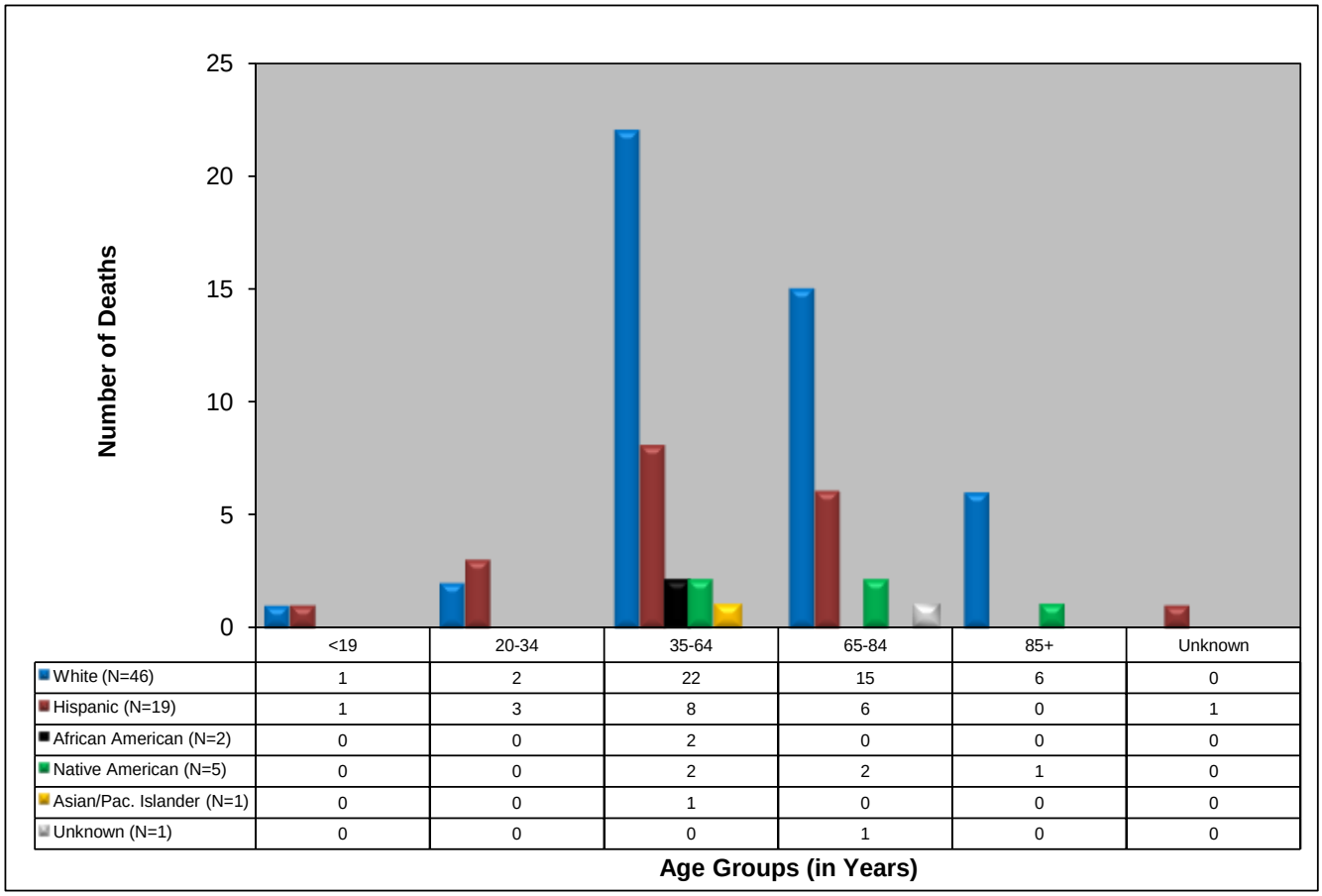


	0-4	5-14	15-19	20-34	35-64	65-84	85+
Male (N=54)	0	0.3	0.7	1.1	4	8.6	8.4
Female (N=19)	0	0	0	0	0.7	4.3	11.9
Grand Total (N=73)	0	0.2	0.4	0.6	2.4	6.3	10.6

* Based on Maricopa County census population estimates for 2009
**One male case excluded, age unknown

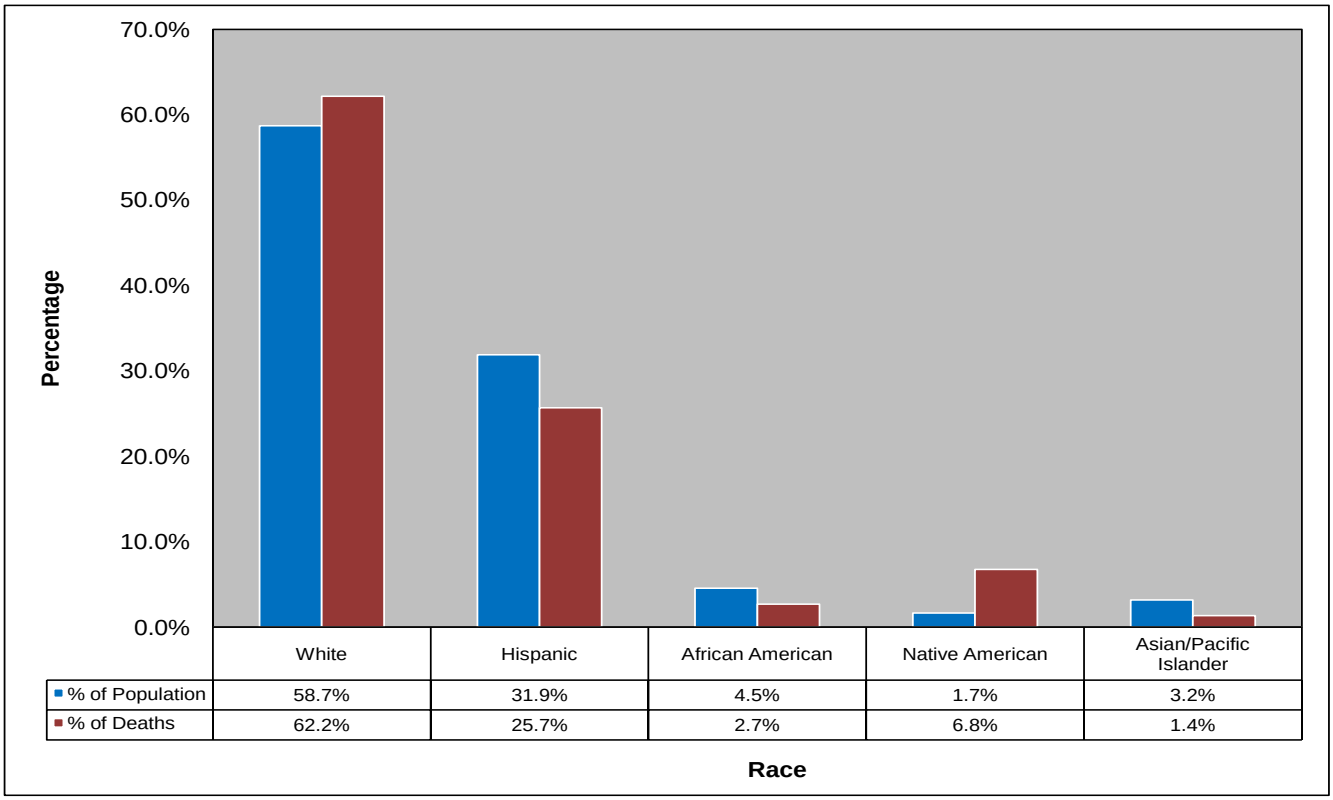
Graphs 7-9. As shown in Graph 7, more than half of the heat-associated deaths in Maricopa County occurred in Whites (46, 62.2%) with most of these deaths occurring in persons aged 35-64. Hispanics (19, 25.7%) were the next largest group for heat-associated deaths. The remaining nine cases were distributed between the following race/ethnicity groups: African Americans (2, 2.7%), Native Americans (5, 6.8%), Asian/Pacific Islander (1, 1.4%), and one case where race was unknown (1, 1.4%). Native Americans were overrepresented in heat-associated deaths as they make up approximately 2% of the population, but are almost 7% of the heat-associated deaths (Graph 8). Graph 9 shows that about two-thirds of heat associated deaths among Whites were among males and for each of the other race/ethnic groups, all or almost all heat-associated deaths were among males.

Graph 7. Heat-associated Deaths by Race and Age Group for Maricopa County, 2009



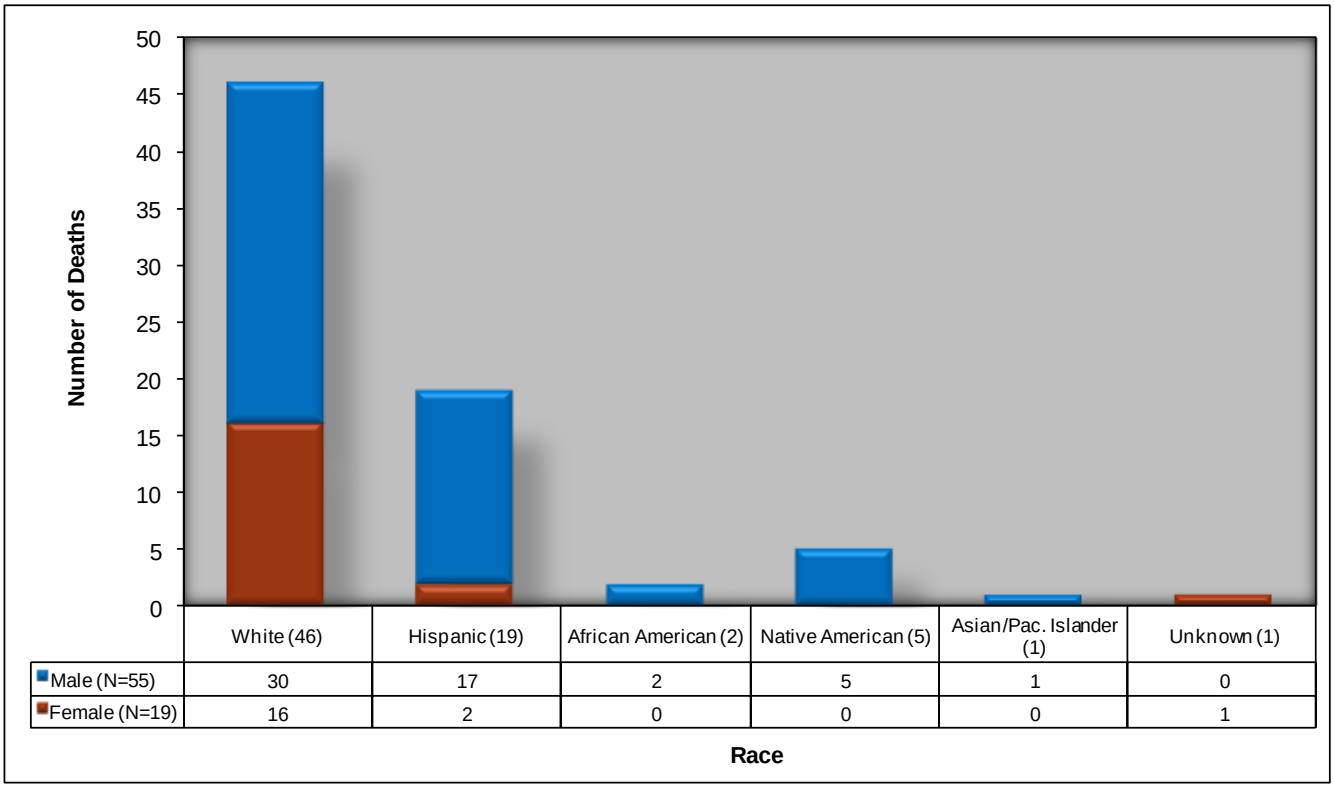
	<19	20-34	35-64	65-84	85+	Unknown
White (N=46)	1	2	22	15	6	0
Hispanic (N=19)	1	3	8	6	0	1
African American (N=2)	0	0	2	0	0	0
Native American (N=5)	0	0	2	2	1	0
Asian/Pac. Islander (N=1)	0	0	1	0	0	0
Unknown (N=1)	0	0	0	1	0	0

Graph 8. Percent of Heat-associated Deaths Vs. Percent of Total Population by Race Maricopa County, 2009



	White	Hispanic	African American	Native American	Asian/Pacific Islander
% of Population	58.7%	31.9%	4.5%	1.7%	3.2%
% of Deaths	62.2%	25.7%	2.7%	6.8%	1.4%

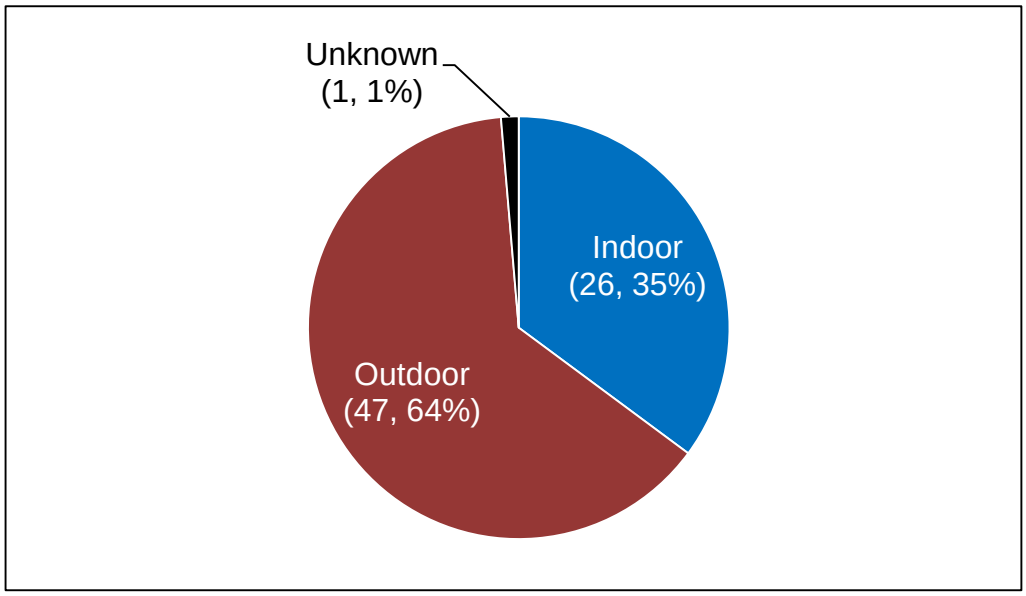
Graph 9. Heat-associated Deaths by Race and Gender for Maricopa County, 2009



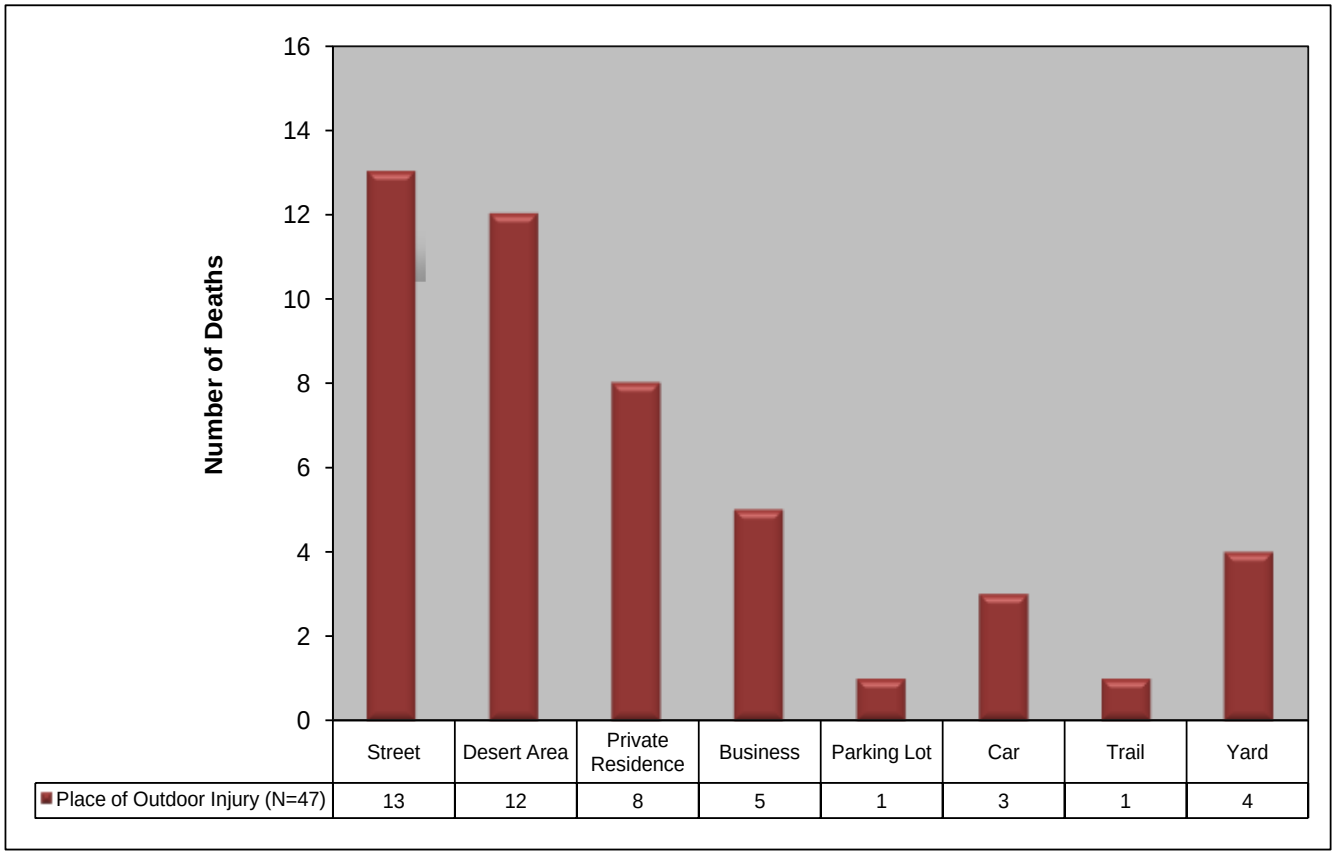
	White (46)	Hispanic (19)	African American (2)	Native American (5)	Asian/Pac. Islander (1)	Unknown (1)
Male (N=55)	30	17	2	5	1	0
Female (N=19)	16	2	0	0	0	1

Graphs 10-12. Graph 10 illustrates that 64% of heat deaths in 2009 occurred outdoors. These deaths most often occurred on the street or in a desert area (Graph 11). The remaining occurred indoors at a private residence (26, 35%). In some cases where the death occurred indoors, air conditioning was not in use (Graph 12). [See Appendix, Tables C-E]

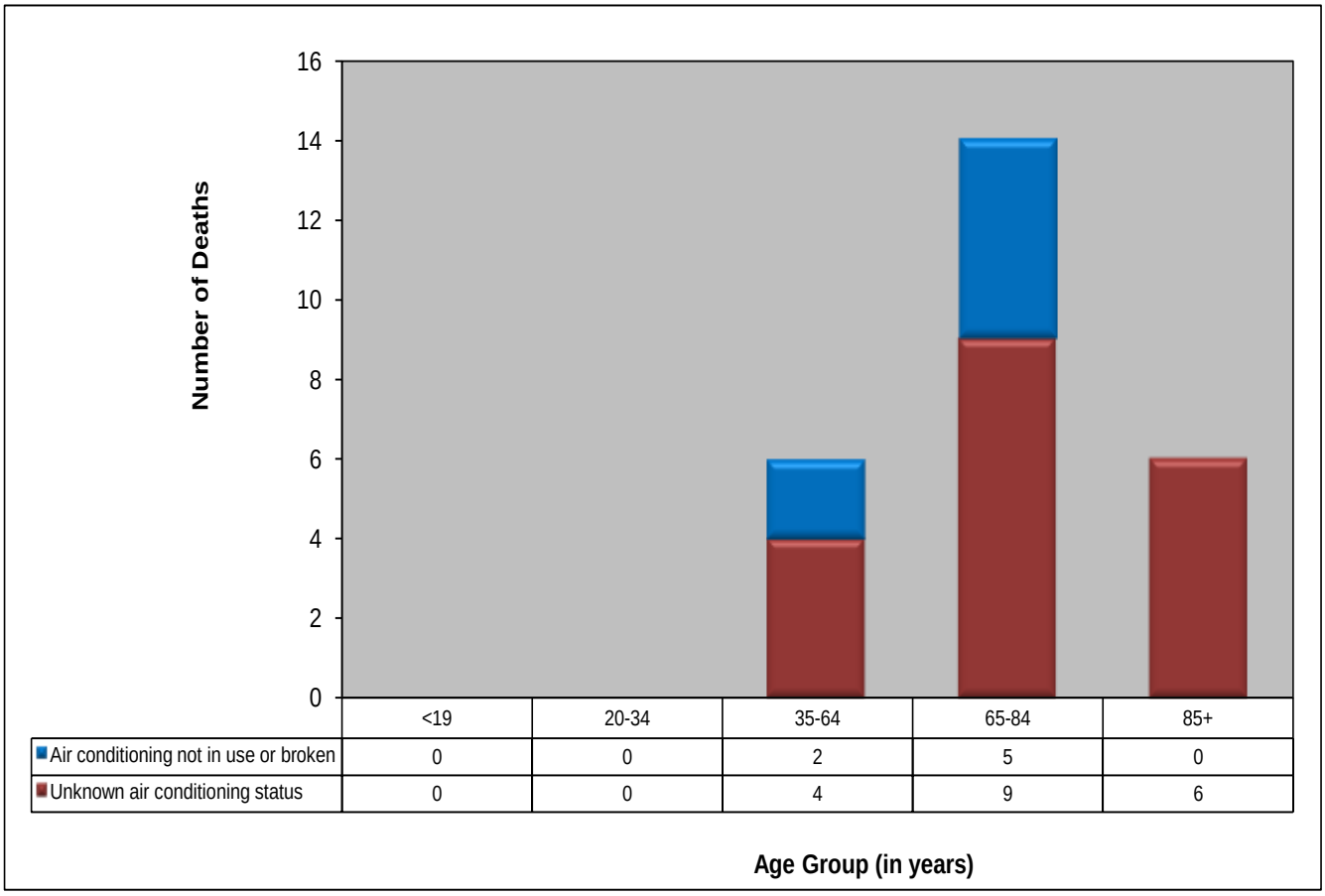
Graph 10. Heat-associated Deaths by Place of Occurrence, Maricopa County, 2009



Graph 11. Heat-associated Deaths by Place of Outdoor Death, Maricopa County, 2009



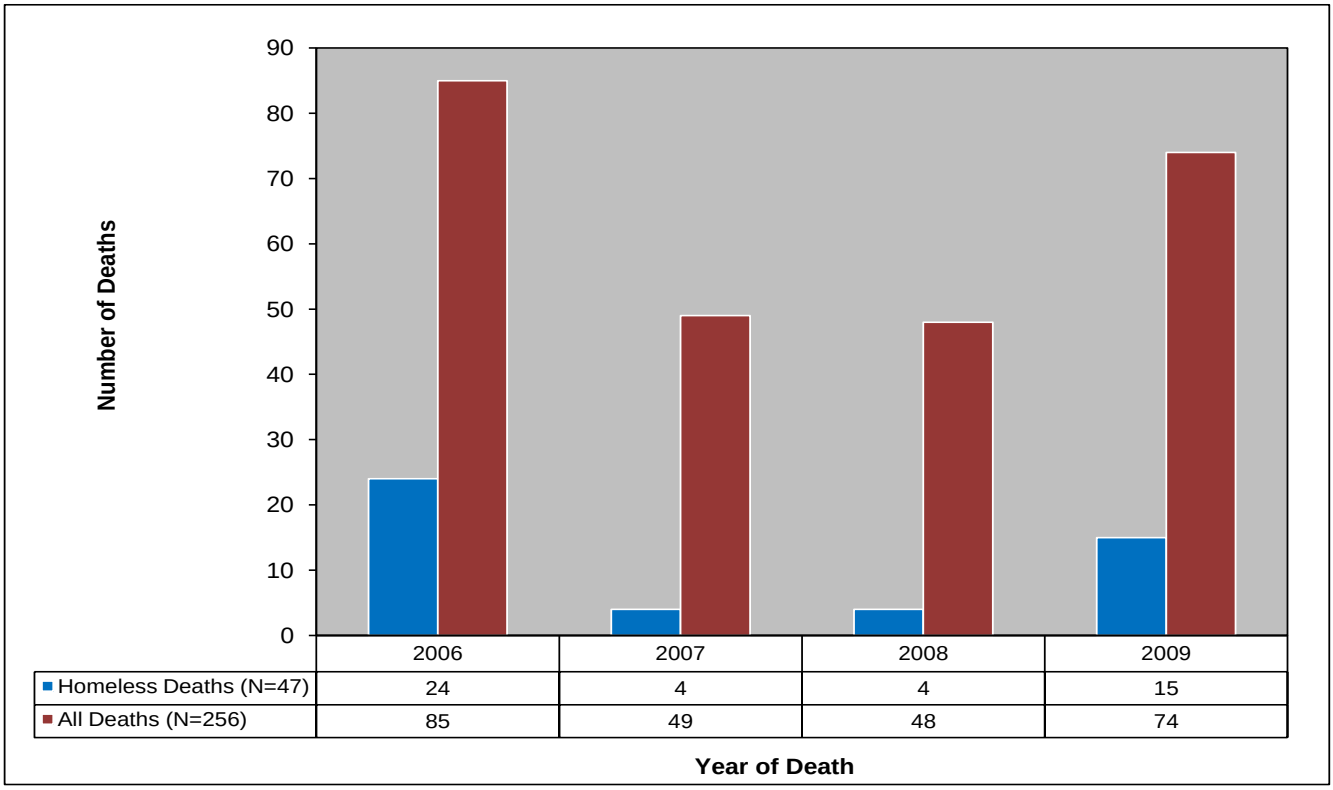
Graph 12. Heat-associated Deaths by Use of Air Conditioning and Age Group, (Indoor Only) Maricopa County, 2009



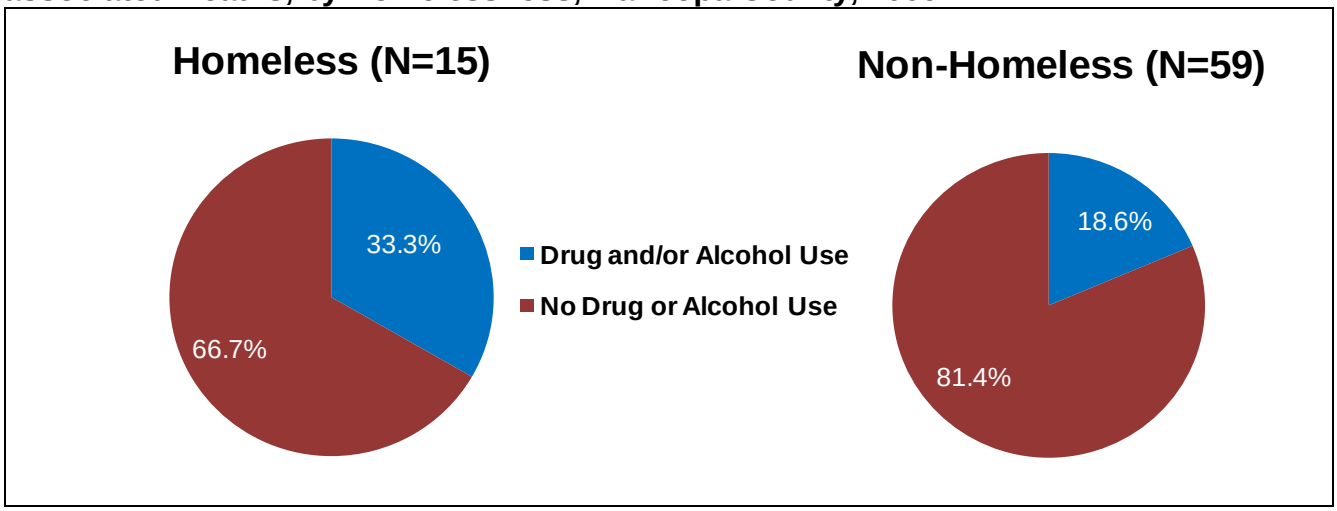
	<19	20-34	35-64	65-84	85+
Air conditioning not in use or broken	0	0	2	5	0
Unknown air conditioning status	0	0	4	9	6

Graphs 13-14. In 2006, 24 (28%) heat-associated deaths were homeless persons. In 2007, homeless heat deaths decreased to 4 (8%) and 4 (8%) in 2008. In 2009, there were 15 (20%) heat-associated deaths in homeless persons (Graph 13). Graph 14 shows that of the 15 homeless individuals who died in 2009, 33.3% of the homeless decedents were using drugs or alcohol upon their death compared to only 18.6% of non-homeless. This group is disproportionately at risk for heat-associated mortality, especially for the years 2006 and 2009 when heat-associated deaths were at their highest, although other factors must also be considered. [See Appendix, Table F]

Graph 13. Homeless Heat-associated Deaths, by Classification, Maricopa County, 2006-2009



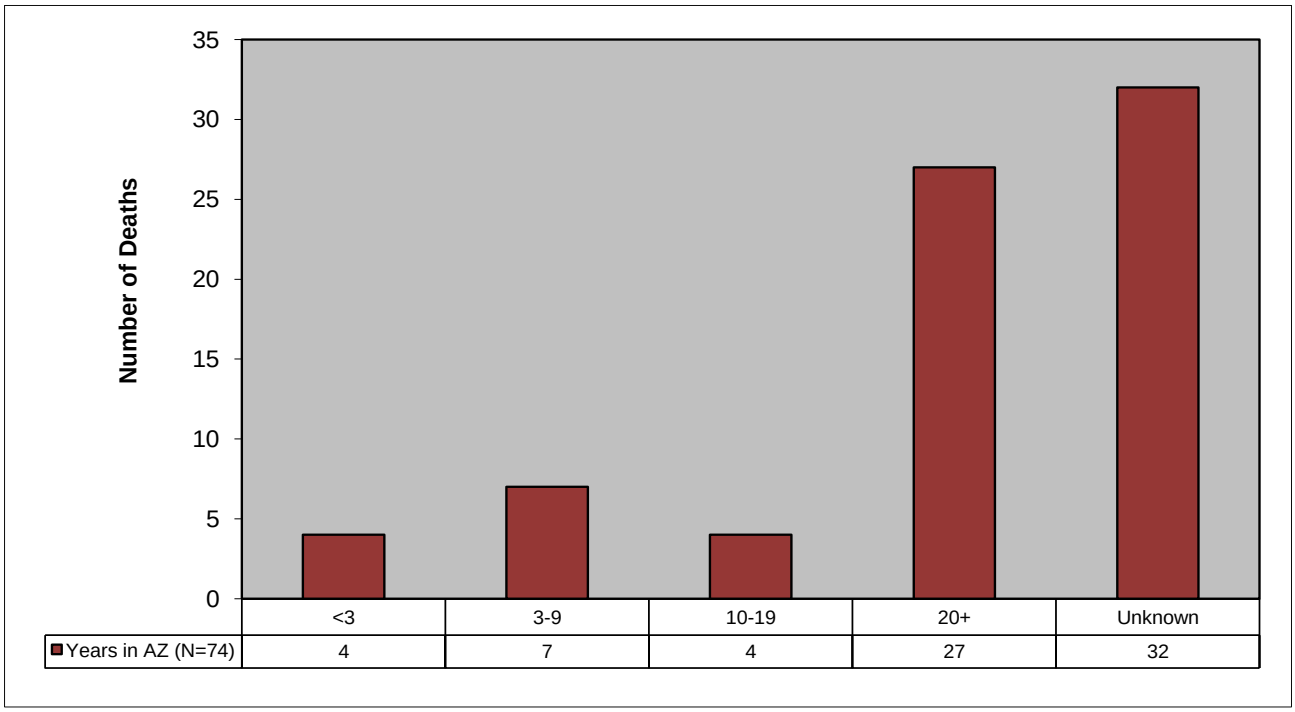
Graph 14. Drug and Alcohol Use, as Mentioned on the Death Certificate for Heat-associated Deaths, by Homelessness, Maricopa County, 2009



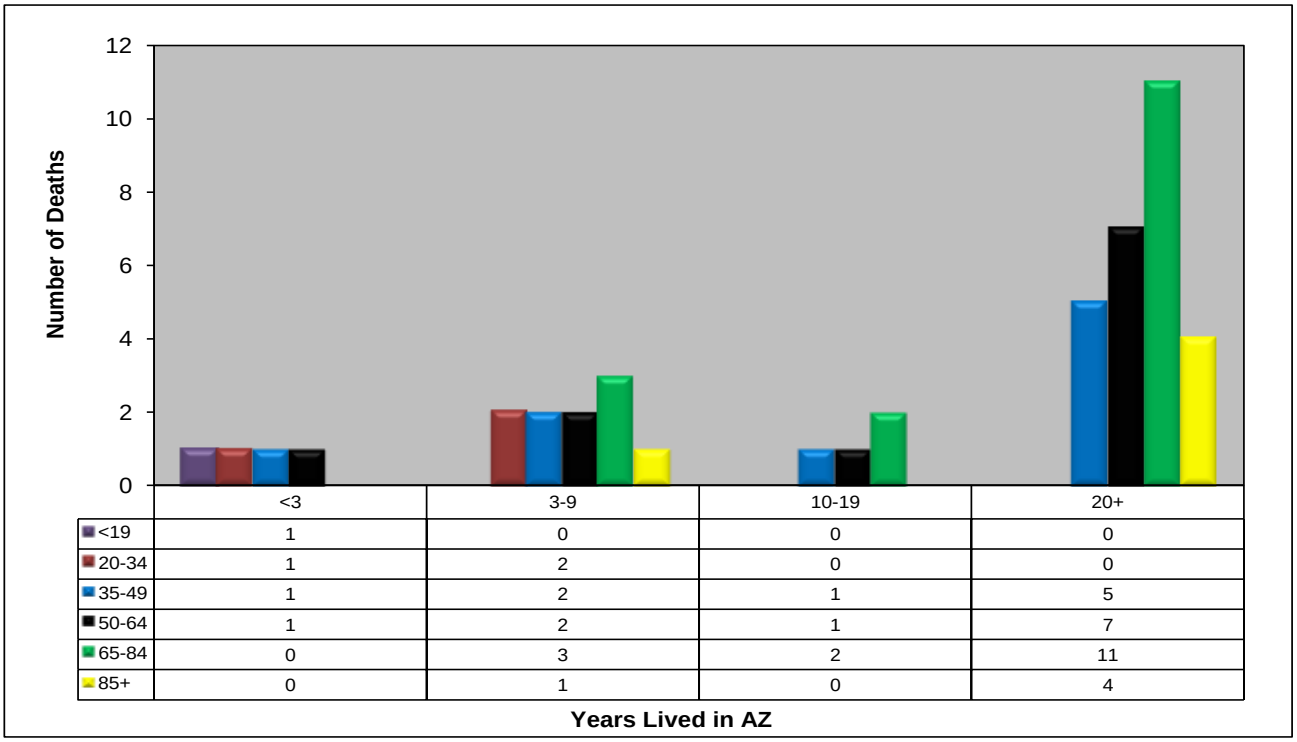
Maricopa County Heat-Associated Deaths, 2009

Graph 15-16. For cases where time spent in Arizona was known (42 decedents), 64% (27/42) resided in Arizona for 20 years or more and almost all (39/42, 90%) had lived in Arizona for at least 3 years.

Graph 15. Heat-associated Deaths by Years of Lifetime Spent in Arizona, Maricopa County, 2009



Graph 16. Heat-associated Deaths* Years of of Lifetime Spent in Arizona by Age Group, Maricopa County, 2009



*Excludes cases for which time spent in Arizona was unavailable at the time of analysis

Conclusion

The 2009 heat season was characterized by the following:

1. The number of heat-associated deaths increased in 2009 over the previous two years.
2. Most heat-associated deaths occurred among males.
3. Most heat-associated deaths occurred in individuals 35-64 years of age.
4. Heat-associated deaths among women tended to occur among those 65 and older while deaths among men tended to occur among those under 65.
5. While Whites had the highest incidence of heat-associated deaths, Native Americans were overrepresented.
6. One in five heat-associated deaths were among homeless individuals.
7. Most decedents (for whom residency length was known) were residents of Maricopa County or Arizona. They were not newcomers – less than 10% lived in Arizona for fewer than 3 years.

The findings from current MCDPH surveillance practices has created several avenues for community partners and MCDPH to respond to the effects of heat warnings more efficiently and effectively. Various organizations and jurisdictions have come together to create more cooling and hydrations stations. The number of heat deaths for 2009 has increased; however, efforts to curtail these deaths continue to be implemented with hopes that this preventable mortality will be better controlled in the future.

To learn more about services provided for cooling and hydration during the summer months, or how you can help, please visit:

http://www.maricopa.gov/publichealth/Programs/Heat/default.aspx

http://www.cir.org/

APPENDIX

Table A. Heat-associated Deaths by Gender and Age, Maricopa County, 2009

Age Group	2009 (N=74)					
	Male		Female		Total	
	#	%	#	%	#	%
<1	0	0	0	0	0	0
1-4	0	0	0	0	0	0
5-14	1	1.8	0	0	1	1.4
15-19	1	1.8	0	0	1	1.4
20-34	5	9.1	0	0	5	6.8
35-64	30	54.5	5	26.3	35	47.3
65-84	15	27.3	9	47.4	24	32.4
85+	2	3.6	5	26.3	7	9.5
Unknown	1	1.8	0	0	1	1.4
All Ages	55	100	19	100	74	100

Table B. Heat-associated Rates per 100,000 Population (and Counts) by Gender and Age, Maricopa County, 2009

Ages (in years)	Male	Female	Male/ Female
0-4	0 (0)	0 (0)	0 (0)
5-14	0.3 (1)	0 (0)	0.20 (1)
15-19	0.7 (1)	0 (0)	0.4 (1)
20-34	1.1 (5)	0 (0)	0.6 (5)
35-64	4.0 (30)	0.7 (5)	2.4 (35)
65-84	8.6 (15)	4.3 (9)	6.3 (24)
85+	8.4 (2)	11.9 (5)	10.6 (7)
Unknown	NA (1)	NA (0)	NA (1)
All Ages	**2.7 (55)**	**1.0 (19)**	**1.8 (74)**

Table C. Heat Caused/Related Deaths by Indoor or Outdoor Occurrence, Age, and Gender Maricopa County, 2009

Age group	Indoor			Outdoor			Unknown		
	Male	Female	**Total**	Male	Female	**Total**	Male	Female	**Total**
<1	0	0	0	0	0	0	0	0	0
1-4	0	0	0	0	0	0	0	0	0
5-14	0	0	0	1	0	1	0	0	0
15-19	0	0	0	1	0	1	0	0	0
20-34	0	0	0	5	0	5	0	0	0
35-64	5	1	6	24	4	28	1	0	1
65-84	7	7	14	8	2	10	0	0	0
85+	2	4	6	0	1	1	0	0	0
Unknown	0	0	0	1	0	1	0	0	0
Total	**14**	**12**	**26**	**40**	**7**	**47**	**1**	**0**	**1**

Table D. Heat-associated Deaths by Place Death Occurred and Age, Maricopa County, 2009

Age in Years	Private Residence			Business		Alley	Parking Lot	Car	Desert Area	Street	Trail	Yard	Unknown	Total
	In	Out	Unk	In	Out									
<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0	1	0	0	1
15-19	0	0	0	0	0	0	0	0	1	0	0	0	0	1
20-34	0	0	0	0	1	0	0	0	4	0	0	0	0	5
35-64	6	1	0	0	4	0	1	2	5	12	0	3	1	35
65-84	14	6	0	0	0	0	0	1	1	1	0	1	0	24
85+	6	1	0	0	0	0	0	0	0	0	0	0	0	7
Unknown	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Total	**26**	**8**	**0**	**0**	**5**	**0**	**1**	**3**	**12**	**13**	**1**	**4**	**1**	**74**

Table E. Heat-associated Deaths by Use of Air Conditioning and Age Group, (Indoor Only) Maricopa County, 2009

Age group	Air conditioning not in use or broken	Unknown if air conditioning in use or broken	Total
<1	0	0	0
1-4	0	0	0
5-14	0	0	0
15-19	0	0	0
20-34	0	0	0
35-64	2	4	6
65-84	5	9	14
85+	0	6	6
Unknown	0	0	0
Total	**7**	**19**	**26**

Table F. Drug and Alcohol Use, as Mentioned on the Death Certificate for Heat-associated Deaths, by Homelessness, Maricopa County, 2009

Transient	Drug and/or Alcohol Use	No Drug or Alcohol Use
Yes (15, 20.3%)	5(33.3%)	10(66.7%)
No (59, 79.7%)	11(18.6%)	48(81.4%)
Total (74,100%)	16(21.6%)	58(78.4%)