Heat-Associated Deaths in Maricopa County, AZ
Final Report for 2014

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Maricopa County Department of Public Health
http://www.maricopa.gov/publichealth/

Maricopa County Public Health
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Acknowledgements

The Maricopa County Department of Public Health (MCDPH), Office of Epidemiology would like to thank the following agencies for their contributions to this report:

- Maricopa County Office of the Medical Examiner (OME)
- Maricopa County Office of Vital Registration (OVR)
- Arizona Department of Health Services (ADHS), Office of Vital Registration
- National Weather Service (NWS)
- Maricopa Association of Governments (MAG)
- Local hospitals (infection preventionists, emergency departments, social worker staff)

Introduction

Mortality from environmental heat is a significant public health problem in Maricopa County, especially because it is largely preventable. Maricopa County has conducted heat surveillance since 2006. Each year, the enhanced heat surveillance season usually begins in May and ends in October. The main goals of heat surveillance are to identify the demographic characteristics of heat-associated deaths (e.g., age and gender) and the risk factors for mortality (e.g., homelessness). Sharing this information helps community stakeholders to design interventions in an effort to prevent heat-associated deaths among vulnerable populations.

The two main sources of data for heat surveillance are: preliminary reports of death (PRODs) from the Office of the Medical Examiner (OME) and death certificates from the MCDPH Office of Vital Registration.

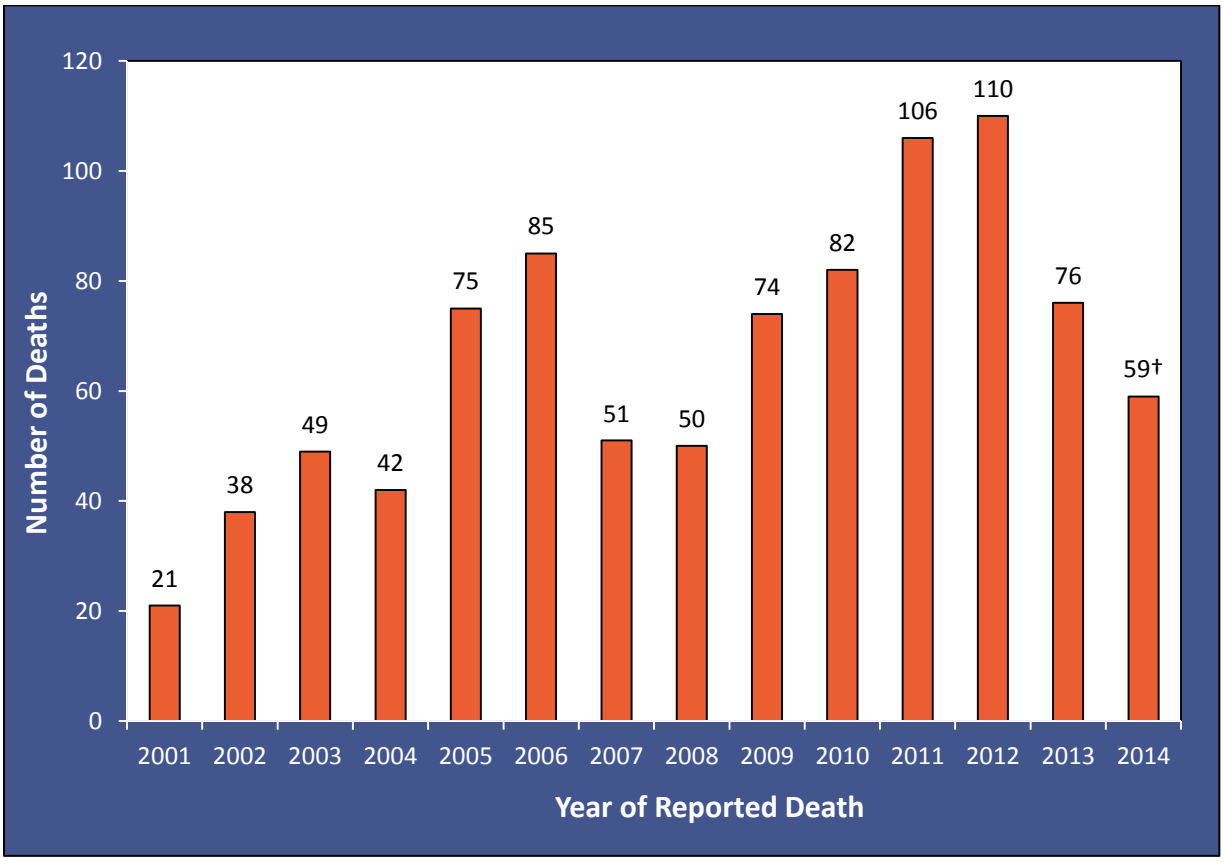
Heat-associated deaths are classified as heat-caused or heat related. Heat-caused deaths are those in which environmental heat was directly involved in the sequence of conditions causing deaths. Heat-related deaths are those in which environmental heat contributed to the deaths but was not in the sequence of conditions causing these deaths. For more information on how heat-associated deaths are classified, see the definitions in Appendix. For more information on MCDPH's surveillance system, see Background and Methodology.

Results

Heat-Associated Deaths by Year

- There were 59 heat-associated deaths reported in 2014.
- Three cases are still pending classification.
- See Appendix Table A for more information about the number of confirmed, ruled-out, and pending cases by year.

Graph 1. Confirmed Heat-Associated Deaths by Year, Maricopa County, 2001-2014*



Data Sources: Maricopa County, Office of Vital Registration and Office of Medical Examiner; Arizona Department of Health Services, Office of Vital Registration

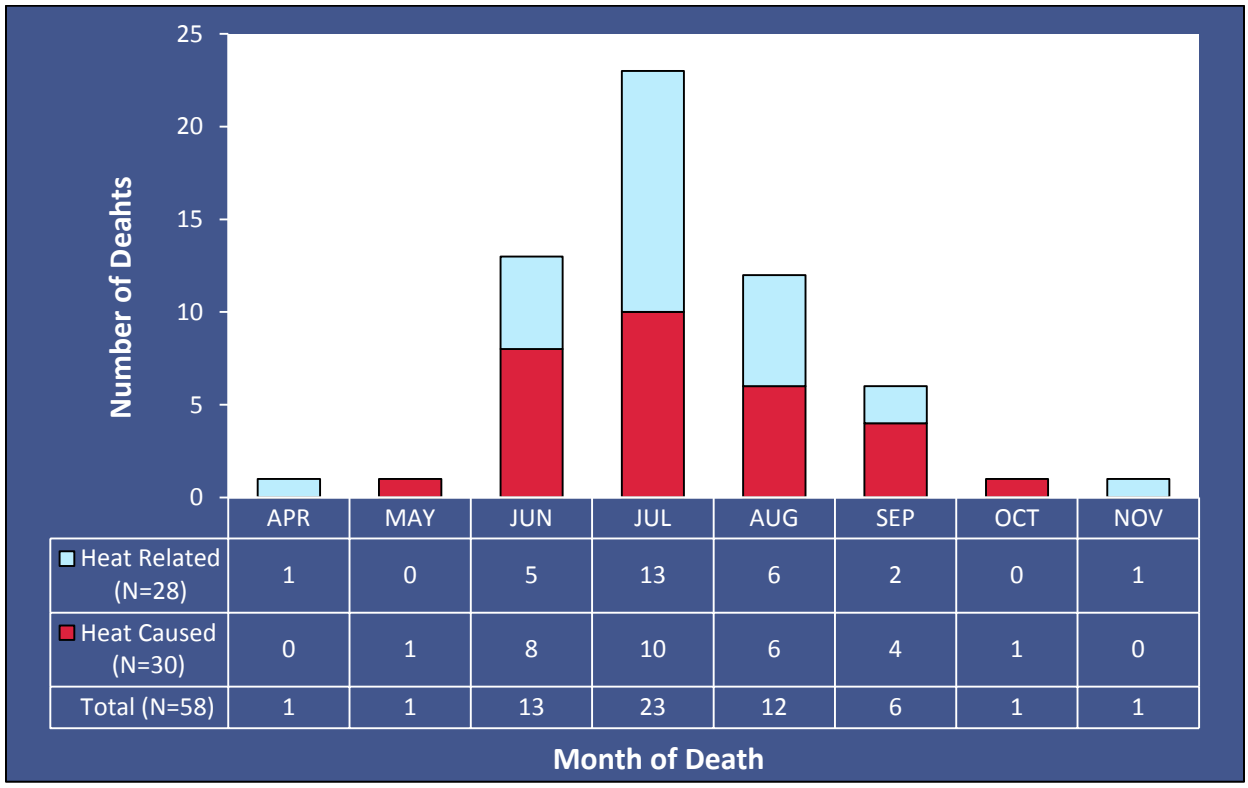
* These numbers are for heat-associated deaths reported to MCDPH as of 6/10/2015.

† One case had heat injury outside of Maricopa County, and therefore is not included in analysis; three cases are still pending a final cause of death

Heat-Associated Deaths by Month

- Most deaths occurred between June and August.
- Forty percent of all deaths occurred in the month of July (n=23).
- The majority of deaths were classified as heat-caused.

Graph 2. Heat-Associated Deaths by Month and Classification*, Maricopa County, 2014

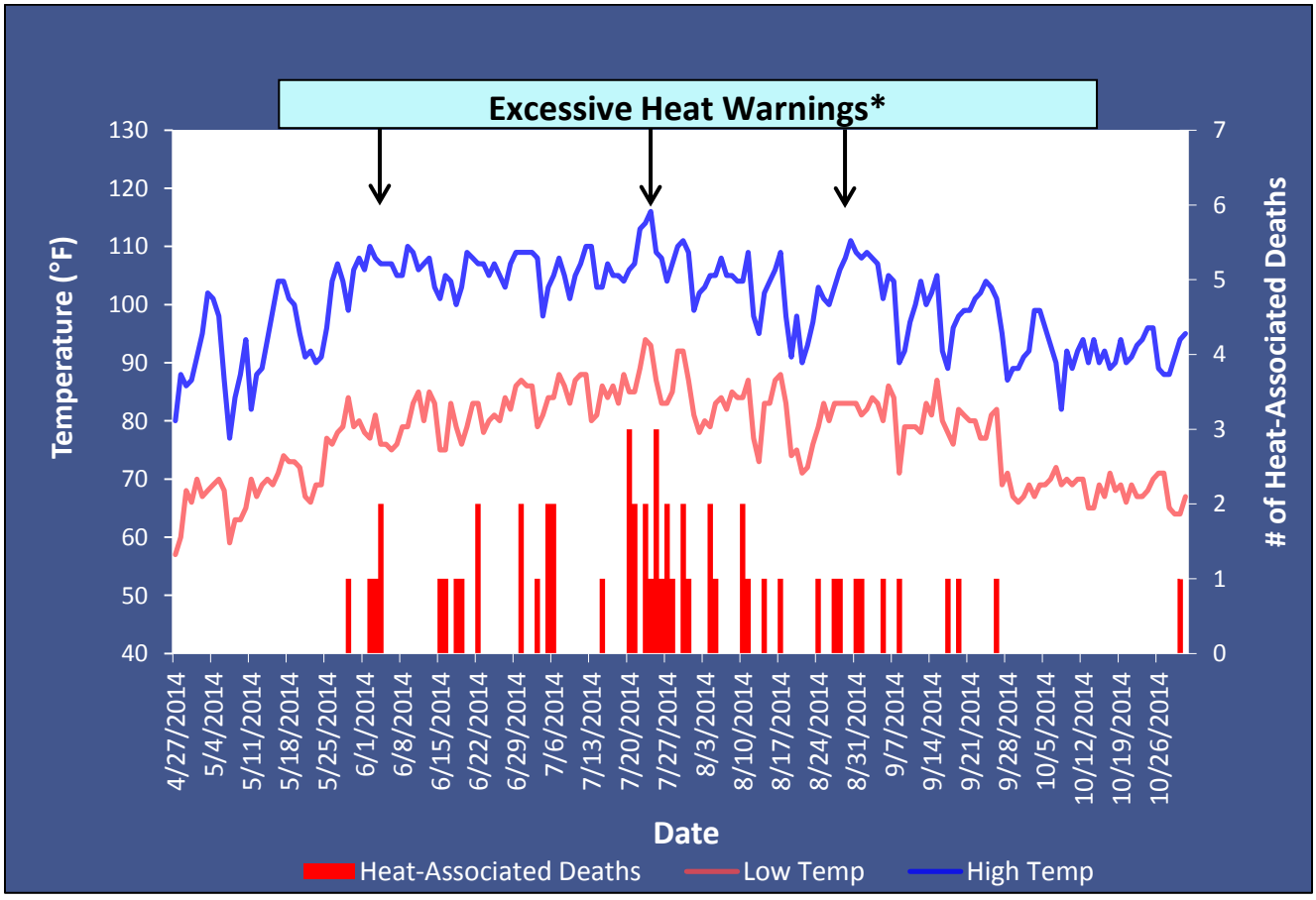


	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
Heat Related (N=28)	1	0	5	13	6	2	0	1
Heat Caused (N=30)	0	1	8	10	6	4	1	0
Total (N=58)	1	1	13	23	12	6	1	1

Heat-Associated Deaths and Temperatures

- The graph below shows the number of deaths that occurred each day, as well as the daily minimum and maximum temperatures.
- Excessive heat warnings are issued by the National Weather Service (NWS) for days with higher than normal temperatures.
- Three excessive heat warnings were issued in 2014.
- The highest daily maximum temperature this summer was 116°F and occurred on 7/24/2014.
- Eight heat-associated deaths occurred during the days when an excessive heat warning was issued.

Graph 3. Maricopa County Heat-Associated Deaths by Date of Death, Maximum and Minimum Temperatures and Excessive Heat Warnings [4/28/2014-11/1/2014 (N=58)]*

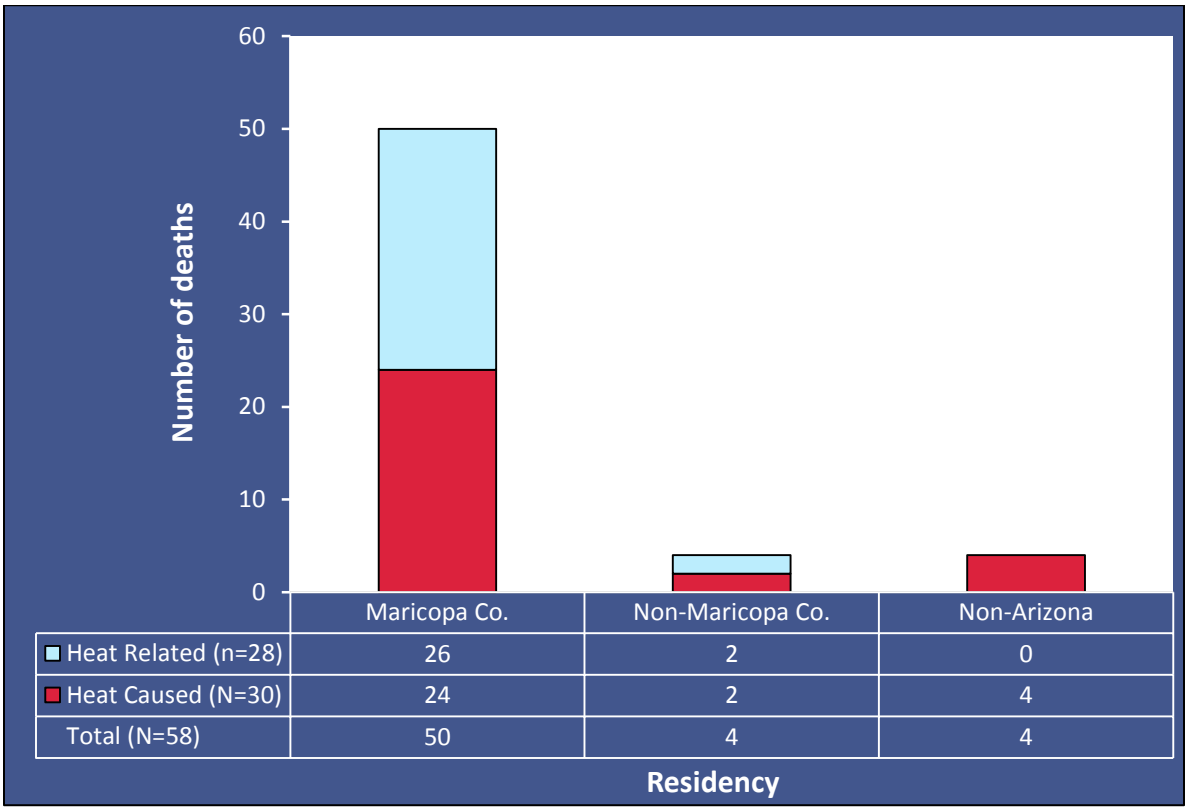


***Exact Dates of Excessive Heat Warnings**: 6/2/2014-6/4/2014 (3 days), 7/23/2014- 7/24/2014 (2 days), 8/28/2014 (1 day)

Heat-Associated Deaths by Residency

- Residency was identified for all of the heat-associated deaths in 2014.
- Most cases (86%) were Maricopa County residents.

Graph 4. Heat-Associated Deaths by Residency (n=58)* and Classification, Maricopa County, 2014



	Maricopa Co.	Non-Maricopa Co.	Non-Arizona
Heat Related (n=28)	26	2	0
Heat Caused (N=30)	24	2	4
Total (N=58)	50	4	4

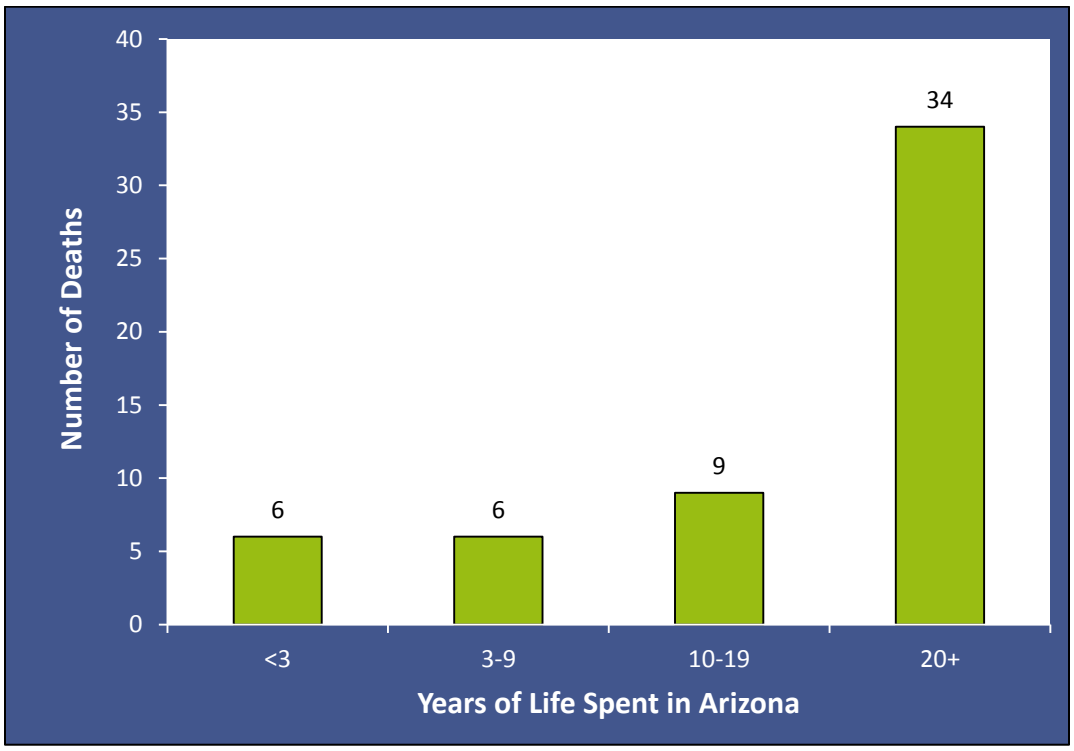
* Non-Maricopa County residents include four cases from unidentified AZ counties.

†Non-Arizona residents include three U.S. residents (California, Idaho, and Washington) and one non-U.S. resident (Brazil)

Heat-Associated Deaths by Time Spent in Arizona

• Of the 55 decedents for whom time spent in Arizona was known, 62% resided in Arizona for 20 years or more.

Graph 5. Heat-Associated Deaths by Years of Life Spent in Arizona (n=55)*, Maricopa County, 2014



* Excludes three cases for which time spent in Arizona was unknown at the time of analysis.

Demographic Characteristics of Heat-Associated Deaths

- The overwhelming majority of deaths were male (81%, n=47).
- No deaths occurred among individuals who were 19 years old or younger.
- Most deaths occurred among individuals who were 50-64 years old.
- Most of the decedents were White (67%, n=39).

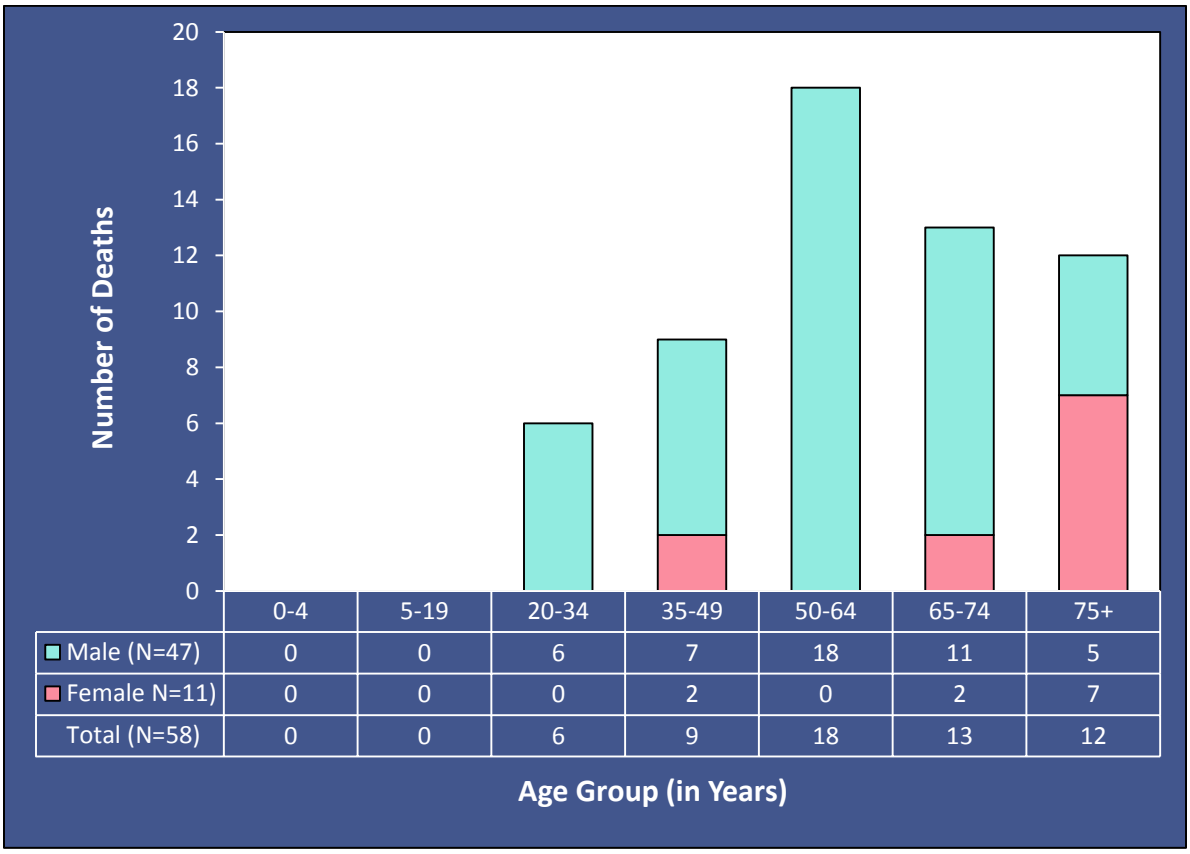
Table 1. Heat-Associated Deaths by Gender, Age, and Race/Ethnicity; Maricopa County, 2014

	TOTAL	%
GENDER		
Male	47	81%
Female	11	19%
Total	**58**	**100%**
AGE GROUP		
0-4 years old	0	0%
5-19 years old	0	0%
20-34 years old	6	10%
35-49 years old	9	16%
50-64 years old	18	31%
65-74 years old	13	22%
75+ years old	12	21%
Total	**58**	**100%**
RACE/ETHNICITY		
White	39	67%
Hispanic	7	12%
Black	5	9%
Native American	5	9%
Asian/Pacific Islander	1	2%
Other	1	2%
Total	**58**	**100%**

Heat-Associated Deaths by Age and Gender

- For males, the highest proportion of deaths occurred in the 50-64 age group (38%, n=18).
- For females, the highest proportions of deaths occurred in the 75+ age group (64%, n=7).
- In general, there were far fewer female deaths than male deaths.
- Females also tended to be older than males.

Graph 6. Heat-Associated Deaths by Age Group and Gender, Maricopa County, 2014



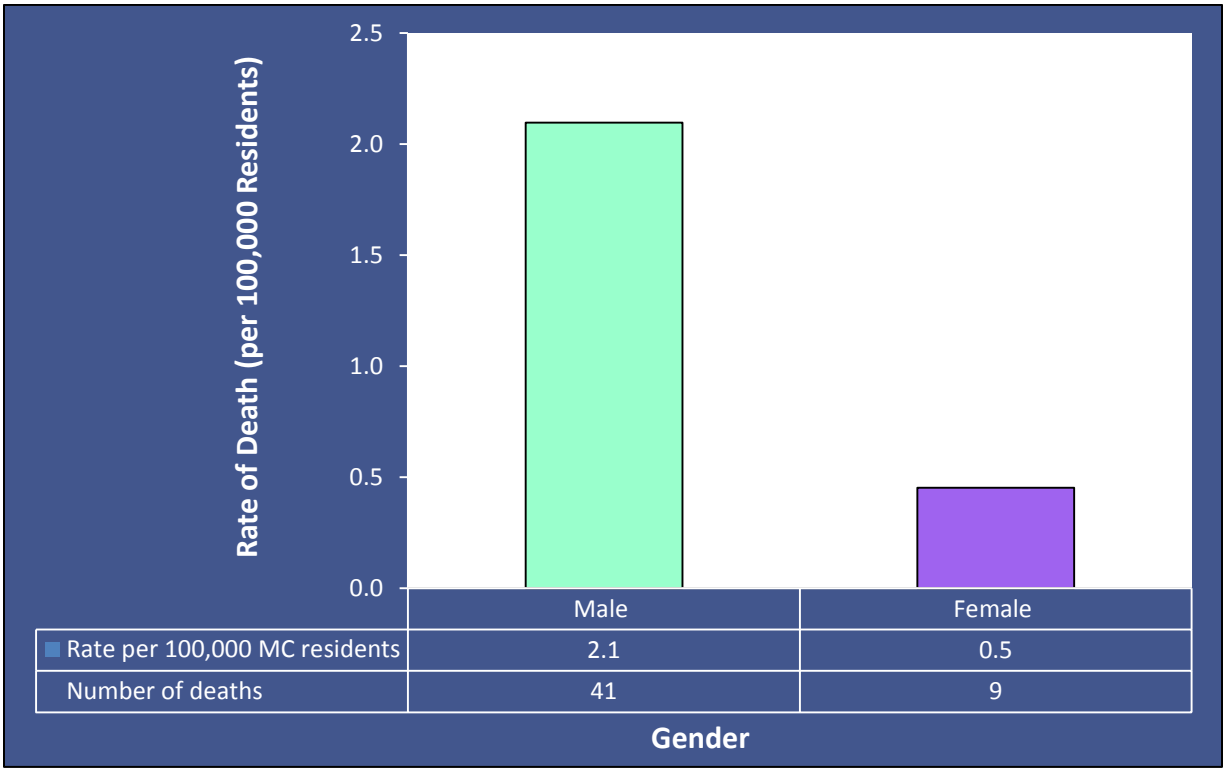
	0-4	5-19	20-34	35-49	50-64	65-74	75+
Male (N=47)	0	0	6	7	18	11	5
Female N=11)	0	0	0	2	0	2	7
Total (N=58)	0	0	6	9	18	13	12

Heat-Associated Death Rates

Death rate by Gender

- The graph below and all other graphs involving death rates only include Maricopa County residents.
- The death rate for males was 4.2 times greater than the rate for females (2.1 and 0.5 deaths per 100,000 residents, respectively).
- See Appendix Table C and Table E for more information on gender.

Graph 7. Heat-Associated Crude Death Rate per 100,000 Maricopa County Residents* by Gender (n=50), Maricopa County, 2014

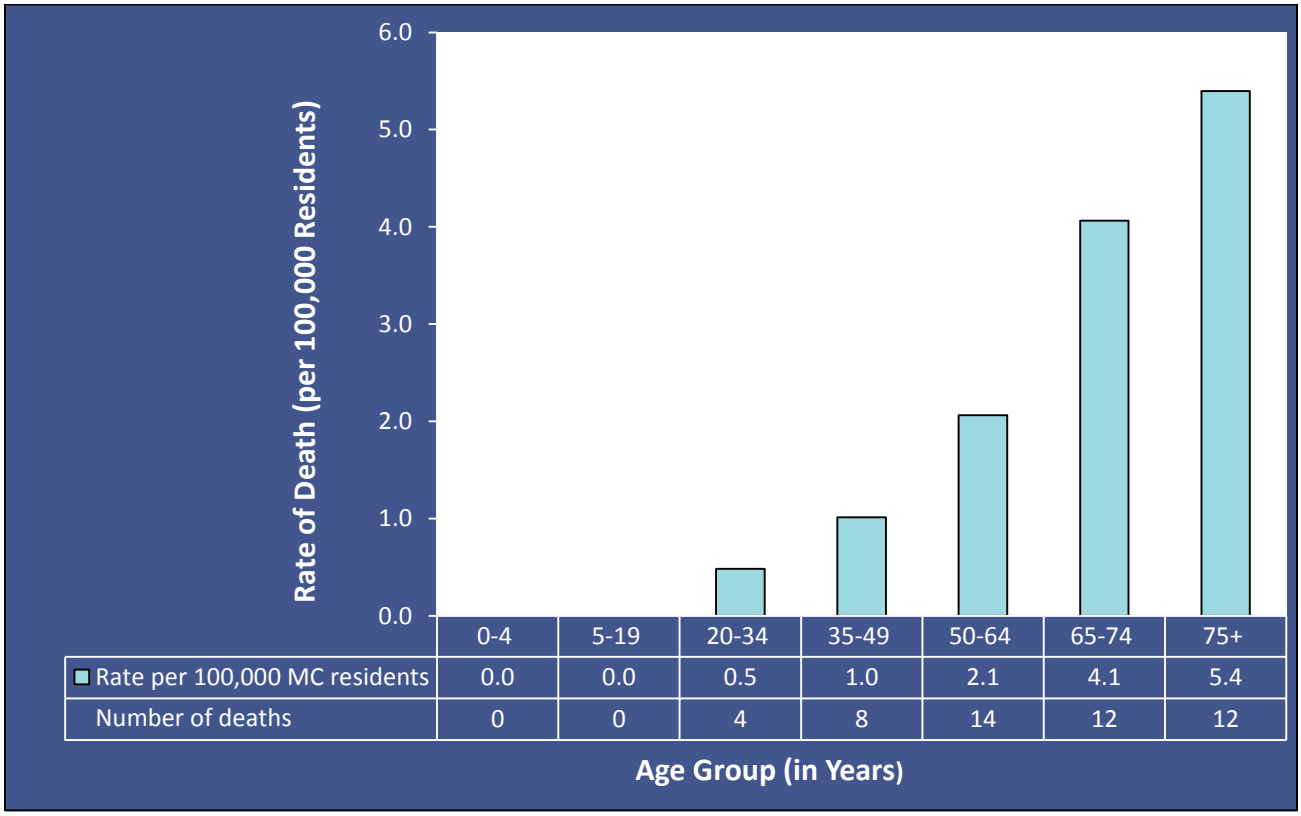


* Based on 2013 Census population estimates for Maricopa County. Excludes eight cases that were not Maricopa County residents

Death Rate by Age

- The heat-associated crude death rate increases with age.
- The 75+ age group has the highest rate of heat-associated death at 5.4 per 100,000 Maricopa County Residents.
- See Appendix Table C and Table D for more information on age.

Graph 8. Heat-Associated Crude Death Rate per 100,000 Maricopa County Residents* by Age Group (n=50), Maricopa County, 2014



	0-4	5-19	20-34	35-49	50-64	65-74	75+
Rate per 100,000 MC residents	0.0	0.0	0.5	1.0	2.1	4.1	5.4
Number of deaths	0	0	4	8	14	12	12

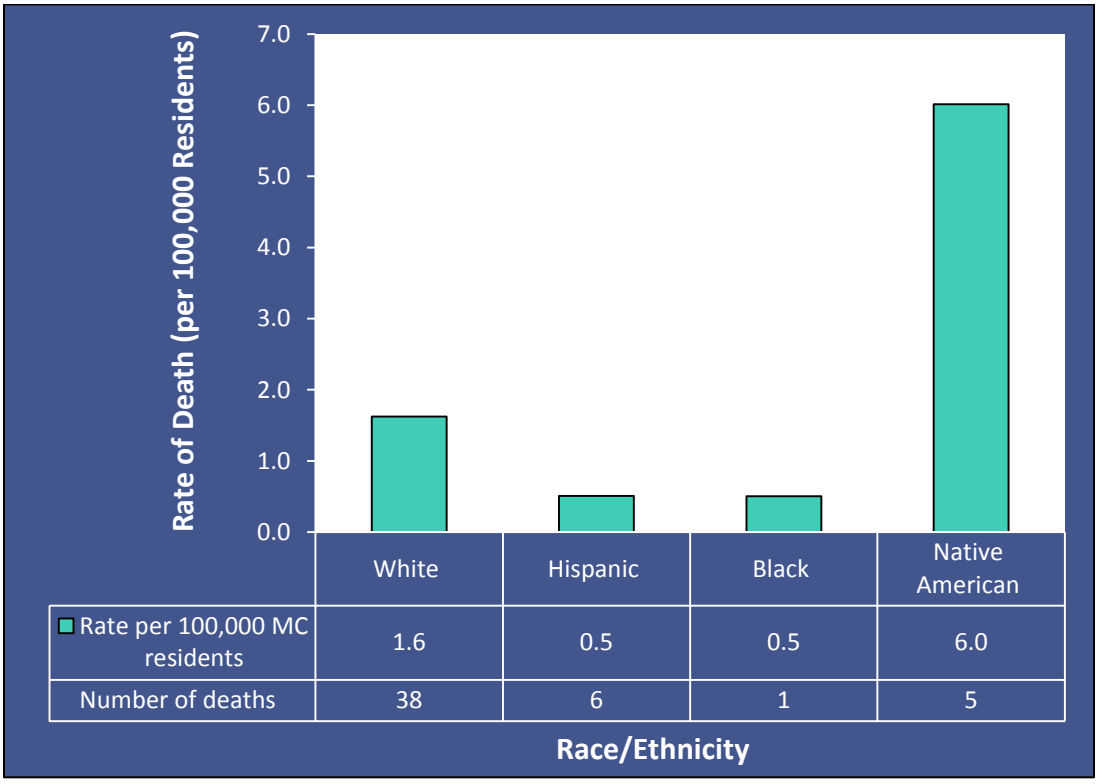
* Based on 2013 Census population estimates for Maricopa County. Excludes eight cases that were not Maricopa County residents

Death Rate by Race/Ethnicity

- Native Americans had the highest rate of heat-associated death at 6.0 per 100,000 Maricopa County residents.

- See Appendix Table D and Table E for more information on race/ethnicity.

Graph 9. Heat-Associated Crude Death Rate per 100,000 Maricopa County Residents* by Race/Ethnicity (n=50), Maricopa County, 2014

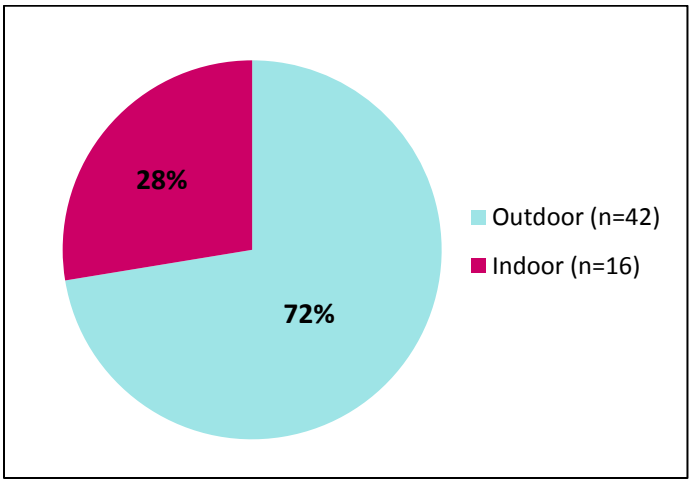


* Based on 2013 Census population estimates for Maricopa County. Excludes eight cases that were not Maricopa County residents

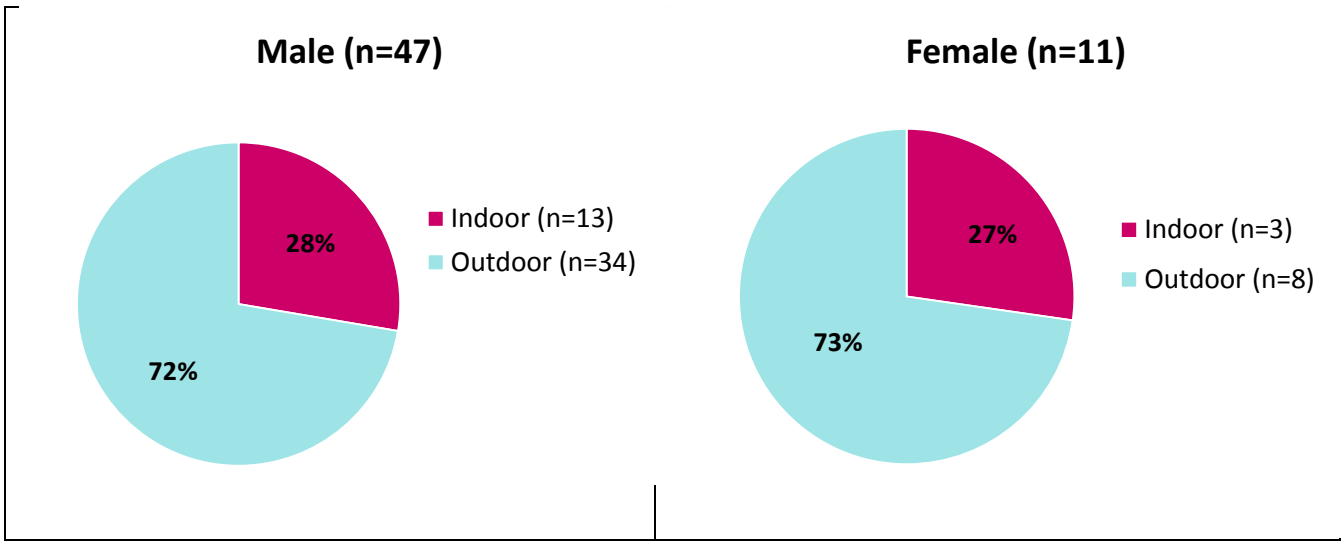
Heat-Associated Deaths by Place of Injury

- Most heat injuries occurred outdoors (72%, n=42).
- The proportion of injuries occurring outdoors was the same for both males and females.

Graph 10. Heat-Associated Deaths by Place of Injury (n=58)



Graph 11. Heat-Associated Deaths by Place of Injury and Gender



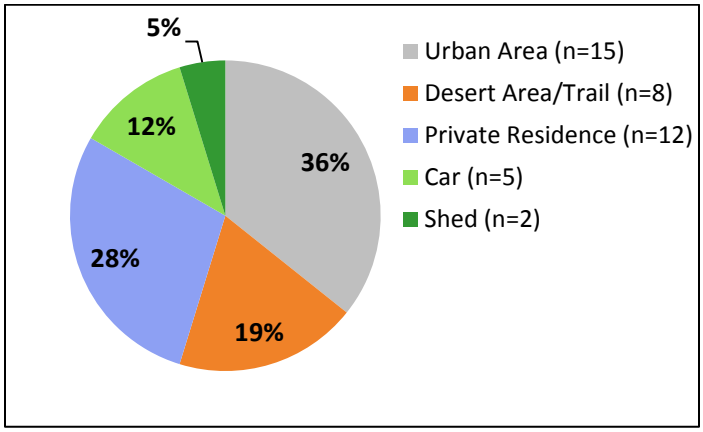
•Most outdoor deaths were injured in an urban area (36%, n=15).

• Five cases were injured in a car. Of those, four were males and one was female. One was between 20-34 years old, one was 35-49 years old, two were 50-64 years old, and one was 65-74 years old.

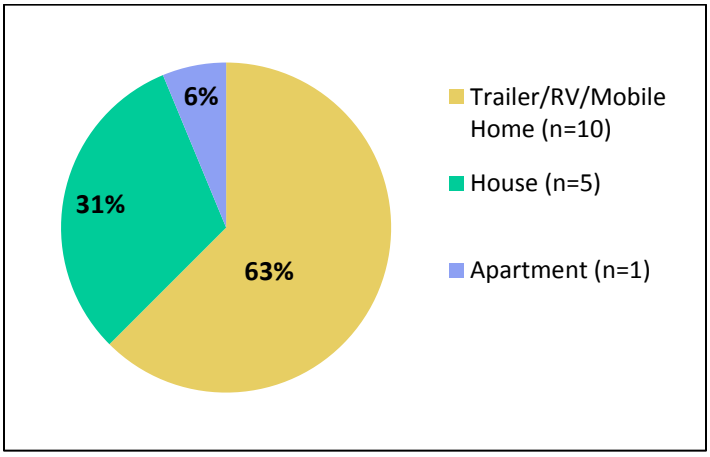
• Most indoor deaths were injured in a trailer, RV, or mobile home (63%, n=10).

• See Appendix Table F and Table G for more information on place of injury.

Graph 12. Outdoor Heat-Associated Deaths by Place of Injury (n=42)



Graph 13. Indoor Heat-Associated Deaths by Place of Injury* (n=16)



***Definitions:**

Trailer: an unpowered vehicle that is towed by another vehicle

Recreational vehicle (RV): a motor vehicle equipped with a living space and amenities found in a home.

Mobile home: a large house trailer that is parked in one particular place and used as a permanent living accommodation.

Air Conditioning Use for Indoor Deaths

• Eighty-seven percent of all indoor deaths (14 out of 16) were injured in an indoor environment that was not cooled by air conditioning (AC) (graph 14).

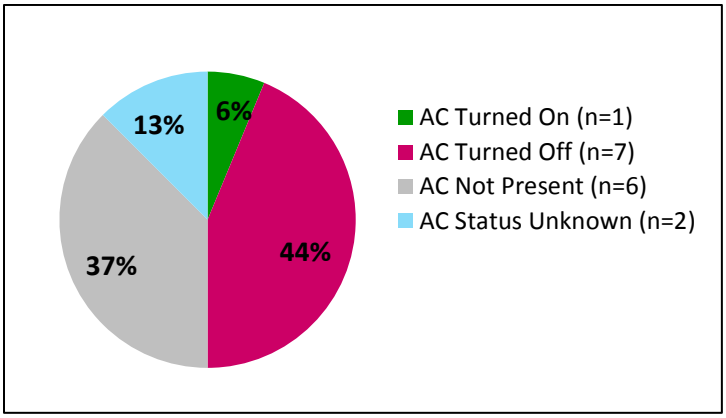
• Forty-four percent of indoor deaths had the AC unit turned off and 37% did not have an air conditioner physically present (graph 14).

• One indoor death (13%) did have the AC turned on; however it was blowing hot air (graph 14).

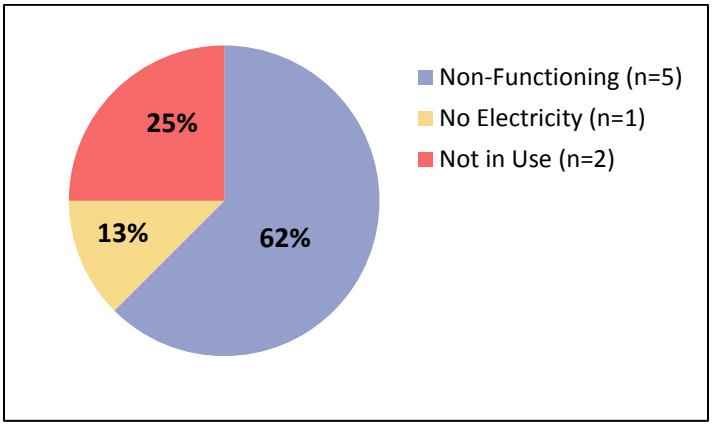
• For the 8 indoor deaths that had an air conditioner present, the most common reason for not having properly running AC was that it was non-functioning (graph 15).

• See Appendix Table H for more information on AC status.

Graph 14. Heat-Associated Deaths by Use of Air Conditioning for Indoor Deaths (n=16)



Graph 15. Reasons for not having properly running AC (n=8)

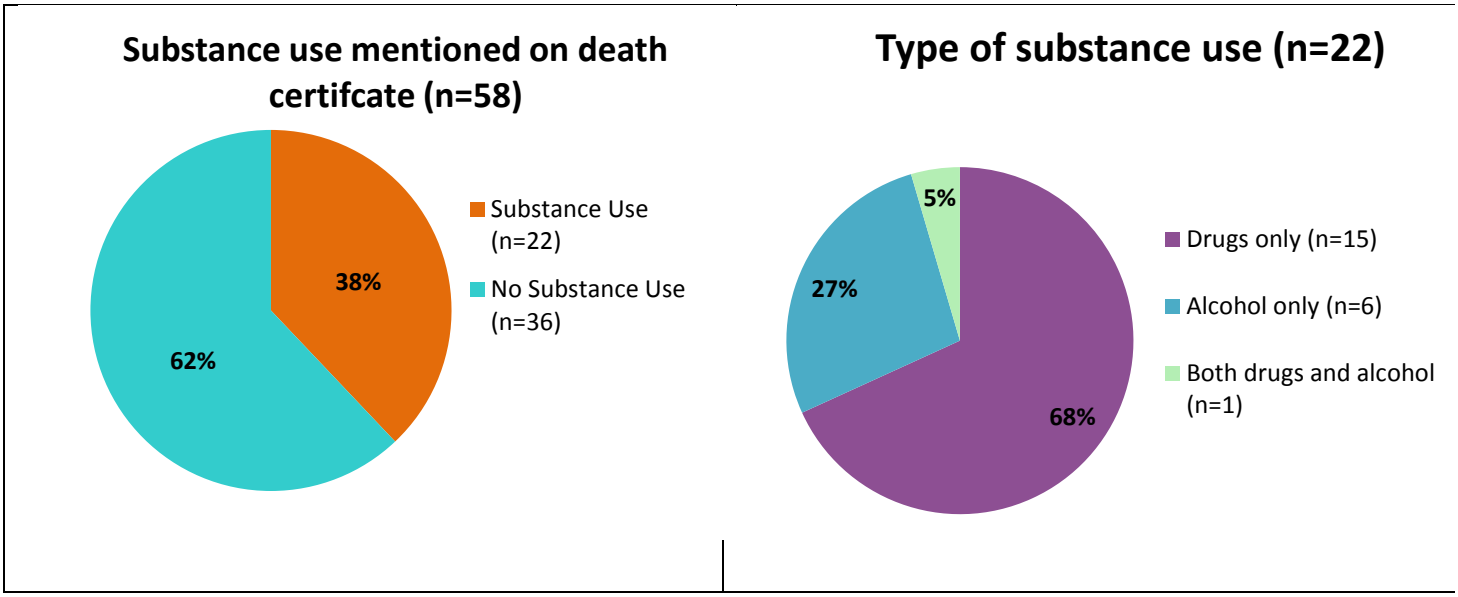


Substance Use among Heat-Associated Deaths

• Thirty-eight percent of heat-associated deaths had substance use mentioned on their death certificates.

• Drugs (both illicit and legal) were the most common form of substance use. Twenty-eight percent (n=16) of all heat-associated deaths had drug use mentioned on their death certificate.

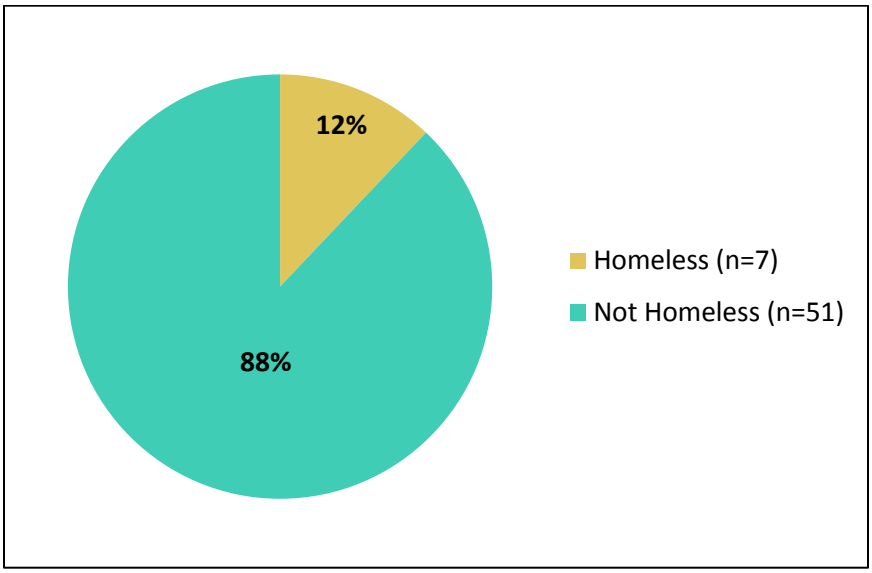
Graph 16. Substance Use, as Mentioned on the Death Certificate for Heat-Associated Deaths, Maricopa County, 2014



Homelessness among Heat-Associated Deaths

- Twelve percent of all heat-associated deaths in 2014 were homeless.
- The majority of the homeless deaths were male and between 50 and 64 years old (85.7%, n=6).
- All of the homeless deaths occurred outside.
- For more information on how homeless status is determined, see the definition of homelessness in the Appendix.

Graph 17. Living Situation of Heat-Associated Deaths, Maricopa County, 2014



Conclusions

•There were 22% fewer heat-associated deaths in 2014 compared to 2013.

•Three excessive heat warnings were issued in the summer of 2014, and ranged in duration from 1 to 3 days.

•Most deaths occurred in the month of July.

•There were slightly more heat-caused deaths than heat-related deaths.

•The majority of cases were residents of Maricopa County. Furthermore, most cases had lived in Arizona for 20 years or more.

•Overall, there were much fewer deaths among females than among males; female cases were also older than the male cases.

•Among Maricopa County residents, the rate of heat-associated deaths was the highest for males, those 75 years old and older, and Native Americans.

•The majority of cases were injured outdoors. The most common place of injury for the outdoor deaths was an urban area. The most common place of injury for indoor deaths was a trailer/RV/mobile home.

•Most cases that were injured indoors in an environment that was not cooled by air conditioning (87.5%, n=14). Some cases did not have an air conditioner at all. For those that had access to AC, the air conditioner was non-functioning, or not in use, or the house did not have electricity.

• Drugs or alcohol were mentioned in the death certificate for 38% of the cases.

•Twelve percent of heat-associated deaths occurred among homeless individuals.

Future Plans

- Expand heat morbidity surveillance by analyzing hospital discharge data, data from BioSense (a CDC syndromic surveillance system) , and data from the Arizona Prehospital Information and EMS Registry System (AZ-PIERS).
- Provide community stakeholders with information related to heat mortality and morbidity that can be used for prevention efforts .
- Incorporate Geographic Information System (GIS) maps in future heat reports .
- Analyze the relationship between environmental temperatures and heat-associated mortality and morbidity.

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

Background

In July 2005, Maricopa County (MC) experienced exceptionally high temperatures that contributed to 45 deaths, of which 35 occurred over nine consecutive days. Temperatures reached 116° F and three excessive heat warnings were issued during this month. After this event, the Maricopa County Department of Public Health (MCDPH) created a novel and effective approach for surveillance of heat-associated deaths in 2006 and has continued to use this system annually.

Methodology

Surveillance data is obtained from the following sources:

1. The Maricopa County Office of the Medical Examiner (OME) forwards suspected heat-related deaths to MCDPH and provides data including demographics, preliminary information regarding how the death occurred, and the circumstances of death. In the past, this information came solely as a weekly line list with limited information for each case. However, in February of 2012, MCDPH started receiving all preliminary reports of death (PRODs) from the OME. These reports provide expanded information on a daily basis and have changed the screening methods used by MCDPH staff to ensure that all potential heat-related deaths are documented.

2. The MCDPH Office of Vital Registration registers all Maricopa County death certificates in the Arizona Department of Health Services vital records database. The MCDPH Office of Epidemiology searches this database looking for causes of death associated with environmental heat. A Statistical Analysis Software (SAS) program looks for the key phrases and International Classification of Disease-10 (ICD-10) codes listed below.

Key Phrases
HEAT EXPOSURE
ENVIRON
EXHAUSTION
SUN
HEAT STRESS
HEAT STROKE
HYPERTHERMIA

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

3. Hospital and media reports can sometimes initiate a heat death investigation, for example, if a child is reportedly left in a hot car.

Once data are 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 deaths where environmental heat terms were indicated in ***Part I***[1] of the death certificate causes of death (diseases or conditions in the direct sequence causing death), for cause of death variables (*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 where environmental heat terms were mentioned in ***Part II***[2] 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 death variables (*cod_a, cod_b, cod_c, or cod_d*). County of death: Maricopa.

For the purposes of this report, heat-caused and heat-related deaths are combined and referred to as "heat-associated deaths." Please note that most jurisdictions report only heat-caused deaths. This should be considered when comparing Maricopa County data with data from other locations.

Death certificate data, in combination with the OME notes, are used to produce the information that is contained in this report. Total case count, demographics, residency, drug/alcohol use, and years lived in Arizona are directly retrieved from death certificate data. Place of death location, indoor/outdoor occurrence, air conditioning use, and homelessness are retrieved based on explicit notations made in the death certificate and/or OME notes.

Homelessness is defined as having an address on the death certificate that matches a homeless shelter, government agency, business, or an intersection. Cases are also classified as homeless if there is an indication on the death certificate. If the address is listed as unknown on the death certificate then an examination of the medical examiner's notes is made to determine if there is a reference to an address - if none, then the person is classified as homeless. If the address is listed as out of jurisdiction then time spent in Arizona, as provided by the death certificate, is taken into consideration.

Once classification is completed, the data are summarized for the production and dissemination of reports. Reports are generated weekly during the season and posted to the MCDPH website which can be found at: http://www.maricopa.gov/publichealth/Services/EPI/Reports/heat.aspx

[1] **Part I of the death certificate:** cod a – is the immediate cause (final disease or condition resulting in death) cod b, cod c, cod d – are sequentially listed conditions leading to the cause listed on cod a.

[2] **Part II of the death certificate:** Other significant conditions contributing to death but not resulting in the underlying cause given in Part I.

Appendix Tables

Table A. Heat-Associated Deaths Reported by Investigation Status, Maricopa County, 2006-2014

Year	Total Reported n	Confirmed n (%)	Ruled-Out n(%)	Pending n(%)
2006	104	85 (82%)	19 (18%)	0 (0%)
2007	131	51 (39%)	80 (61%)	0 (0%)
2008	97	50 (52%)	47 (48%)	0 (0%)
2009	114	74 (65%)	40 (35%)	0 (0%)
2010	142	82 (58%)	60 (42%)	0 (0%)
2011	144	106 (74%)	38 (26%)	0 (0%)
2012	173	110 (64%)	63 (36%)	0 (0%)
2013	145	76 (52%)	69 (48%)	0 (0%)
2014	115	59† (51%)	53 (46%)	3* (3%)
Total	**1,165**	**693 (59%)**	**469 (40%)**	**3 (1%)**

Data Sources: Maricopa County, Office of Vital Registration and Office of Medical Examiner; Arizona Department of Health Services, Office of Vital Registration

The numbers reported here are for heat-associated deaths reported to MCDPH as of 6/10/2015.

* Three cases are still pending a final cause of death classification for 2014

† One case had heat injury outside of Maricopa County, and therefore not included in analysis.

Table B. Heat-Associated Deaths by Gender and Age Group, Maricopa County, 2014

Age Group	Deaths by Gender					
	Male n (%)		Female n (%)		Total n (%)	
0-4	0	0%	0	0%	0	0%
5-19	0	0%	0	0%	0	0%
20-34	6	13%	0	0%	6	10%
35-49	7	15%	2	18%	9	16%
50-64	18	38%	0	0%	18	31%
65-74	11	23%	2	18%	13	22%
75+	5	11%	7	64%	12	21%
All Ages	**47**	81%	**11**	19%	**58**	100%

Table C. Heat-Associated Deaths Rates per 100,000 Residents* by Gender and Age Group, Maricopa County, 2014

Age Group	Gender Rate per 100,000 (n)		
	Male	Female	Total
0-4	0.0 (0)	0.0 (0)	0.0 (0)
5-19	0.0 (0)	0.0 (0)	0.0 (0)
20-34	0.9 (4)	0.0 (0)	0.5 (4)
35-49	1.8 (7)	0.3 (1)	1.0 (8)
50-64	4.3 (14)	0.0 (0)	2.1 (14)
65-74	8.0 (11)	0.6 (1)	4.1 (12)
75+	5.3 (5)	5.4 (7)	5.4 (12)
All Ages	**2.1 (41)**	**0.5 (9)**	**1.3 (50)**

* Based on 2013 Census population estimates for Maricopa County. Excludes eight cases that were not Maricopa County residents

Table D. Heat-Associated Deaths Rates per 100,000 Residents* by Age Group and Race/Ethnicity, Maricopa County, 2014

Race/Ethnicity	Age Group Rate per 100,000 (n)							
	0-4	5-19	20-34	35-49	50-64	65-74	75+	Total
White	0.0 (0)	0.0 (0)	0.7 (3)	0.9 (4)	1.8 (9)	4.5 (11)	5.7 (11)	1.6 (38)
Hispanic	0.0 (0)	0.0 (0)	0.3 (1)	0.8 (2)	0.8 (1)	3.0 (1)	5.3 (1)	0.5 (6)
Black	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	3.3 (1)	0.0 (0)	0.0 (0)	0.5 (1)
Asian/Pac. Islander	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Native American	0.0 (0)	0.0 (0)	0.0 (0)	12.3 (2)	29.9 (3)	0.0 (0)	0.0 (0)	6.0 (5)
All Race/Ethnicities	**0.0 (0)**	**0.0 (0)**	**0.5 (4)**	**1.0 (8)**	**2.1 (14)**	**4.1 (12)**	**5.4 (12)**	**1.3 (50*)**

* Based on 2013 Census population estimates for Maricopa County. Excludes eight cases that were not Maricopa County residents

Table E. Heat-Associated Deaths Rates per 100,000 Residents* by Gender and Age Group, Maricopa County, 2014

Race/Ethnicity	Gender Rate per 100,000 (n)		
	Male	Female	Total
White	2.7 (31)	0.6 (7)	1.6 (38)
Hispanic	0.8 (5)	0.2 (1)	0.5 (6)
Black	1.0 (1)	0.0 (0)	0.5 (1)
Asian/Pac. Islander	0.0 (0)	0.0 (0)	0.0 (0)
Native American	10.1 (4)	2.3 (1)	6.0 (5)
All Races	**2.1 (41)**	**0.5 (9)**	**1.3 (50)**

* Based on 2013 Census population estimates for Maricopa County. Excludes eight cases that were not Maricopa County residents

Table F. Heat-Associated Deaths by Place Injury Occurred and Age Group, Maricopa County, 2014

Age Group	Indoor (n=16)	Outdoor (n=42)							
	Private Residence	Private Residence	Desert Area/ Trail	Car	Urban Area				Total
					Business	Street/ Alley	Field/ Park	Shed	
0-4	0	0	0	0	0	0	0	0	0
5-19	0	0	0	0	0	0	0	0	0
20-34	0	0	3	1	1	0	1	0	6
35-49	1	1	1	1	0	4	0	1	9
50-64	4	3	0	2	2	5	1	1	18
65-74	6	2	3	1	0	0	1	0	13
75+	5	6	1	0	0	0	0	0	12
Total	**16**	**12**	**8**	**5**	**3**	**9**	**3**	**2**	**58**

Table G. Heat-Associated Deaths by Indoor or Outdoor Occurrence, Age Group, and Gender, Maricopa County, 2014

Age Group	Indoor			Outdoor		
	Male	Female	Total	Male	Female	Total
0-4	0	0	0	0	0	0
5-19	0	0	0	0	0	0
20-34	0	0	0	6	0	6
35-49	1	0	1	6	2	8
50-64	4	0	4	14	0	14
65-74	6	0	6	5	2	7
75+	2	3	5	3	4	7
Total	**13**	**3**	**16**	**34**	**8**	**42**

Table H. Heat-Associated Deaths by Use of Air Conditioning (AC) and Age Group, (Indoor Only) Maricopa County, 2014

Age Group	AC On	AC Off	AC Not Present	AC Status Unknown	Total
0-4	0	0	0	0	0
5-19	0	0	0	0	0
20-34	0	0	0	0	0
35-49	0	0	1	0	1
50-64	0	1	2	1	4
65-74	1	3	2	0	6
75+	0	3	1	1	5
Total	**1**	**7**	**6**	**2**	**16**

Table I. Heat-Associated Deaths by Smoking/Tobacco Use, Maricopa County, 2014

Smoking/Tobacco Use	n (%)
Yes	1 (2%)
No	13 (22%)
Past	1 (2%)
Unknown	43 (74%)
Total	**58 (100%)**

Table J. Heat-Associated Deaths by Education Category, Maricopa County, 2014

Education Category	n (%)
8th grade or less	7 (12%)
9th through 12th grade; no diploma	8 (14%)
High school graduate or GED completed	19 (33%)
Some college credit, but no degree	14 (24%)
Associate degree (e.g.AA,AS)	3 (5%)
Bachelor's degree (e.g.BA,BS)	3 (5%)
Master's degree (e.g.MA,MS,MEng,MEd,MSW,MBA)	2 (3%)
Doctorate (e.g.PhD,EdD) or Professional degree (e.g.MD,DDS,DVM,LLB,JD)	0 (0%)
Unknown	2 (3%)
Total	**58 (100%)**