

Heat-Associated Deaths in Maricopa County, AZ Final Report for 2017



Photograph by Dan Sorensen:
<http://www.dansorensenphotography.com/>

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- 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)
- City of Phoenix Heat Relief Network

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.

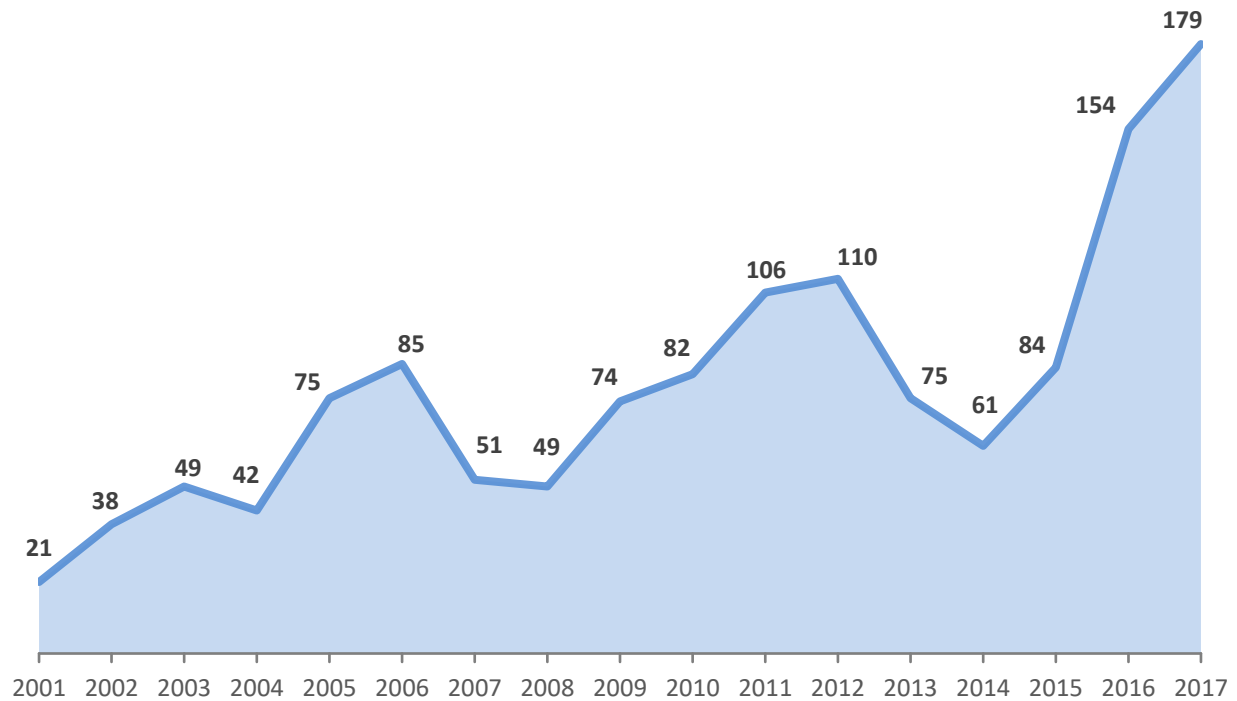
The two main sources of data for heat surveillance are: preliminary reports of death (PRODs) from the Office of the Medical Examiner (OME) and death certificates from the MCDPH Office of Vital Registration.

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

Graph 1. There were 179 heat-associated deaths reported in 2017. This was a sixteen percent increase from the previous year.

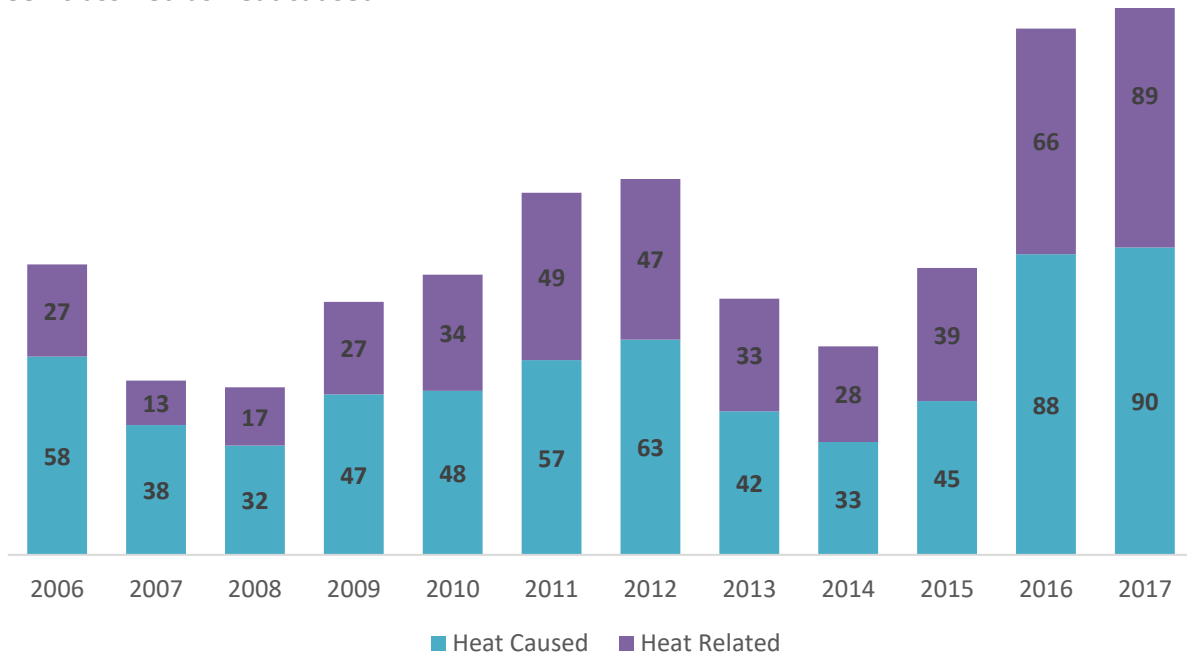


Data Sources: Maricopa County, Office of Vital Registration and Office of Medical Examiner; Arizona Department of Health Services, Office of Vital Registration

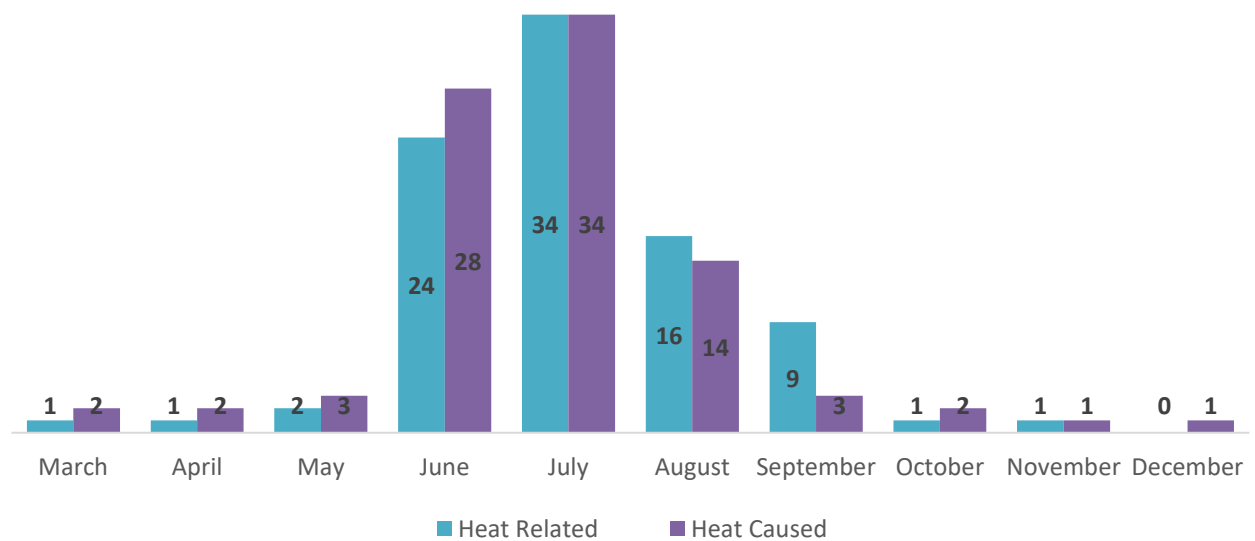
- See [Methodology](#) in the Appendix for more information about the number of confirmed, ruled-out, and pending cases by year.

Heat-Associated Deaths by Month

Graph 2. Fifty-eight percent of heat-associated deaths since 2006 have been classified as heat caused.



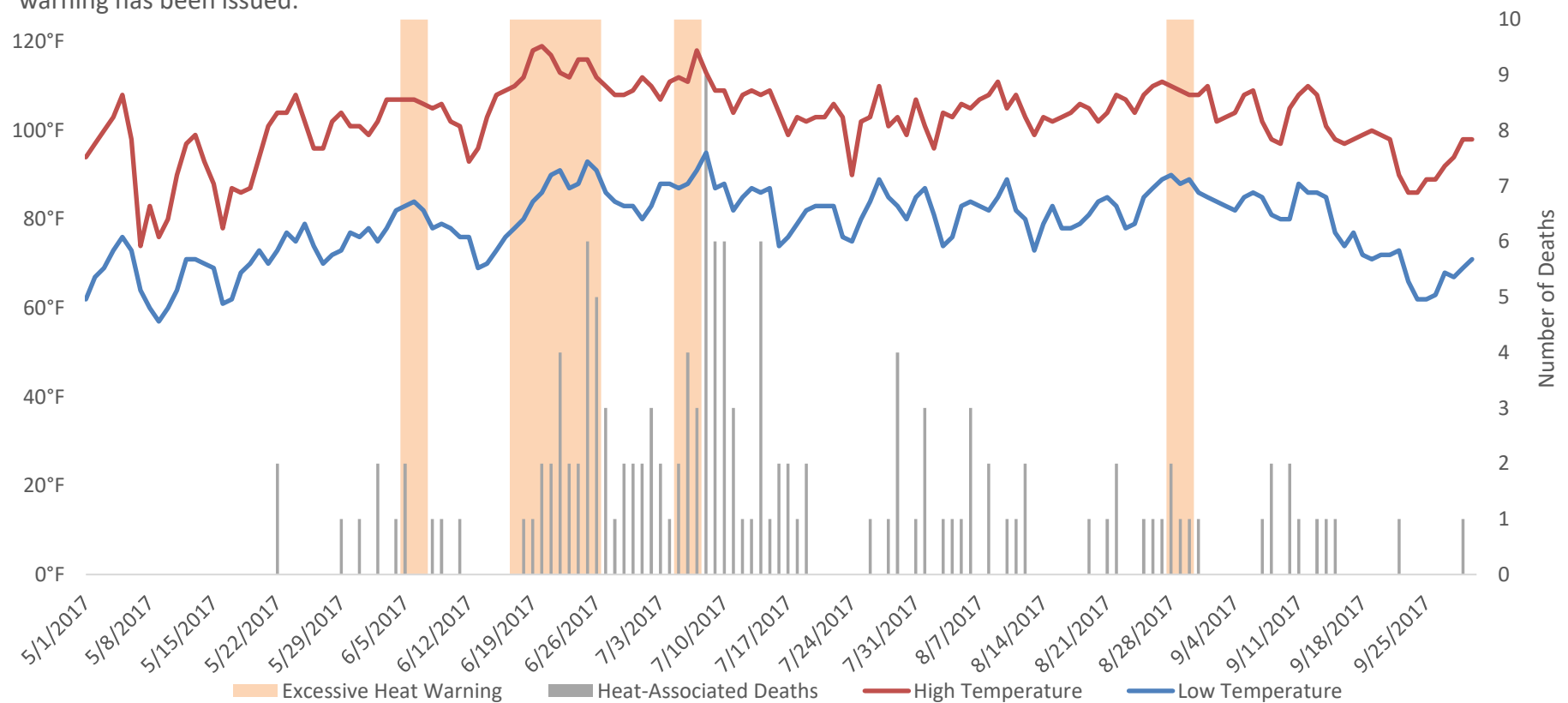
Graph 3. Eighty-four percent of all heat-associated deaths occurred in the months of June, July, and August (N=150).



Heat-Associated Deaths and Temperatures

- The National Weather Service issued four excessive heat warnings in 2017 for a total of nineteen days.
- The highest daily maximum temperature in 2017 was 119°F and occurred on June 20th.

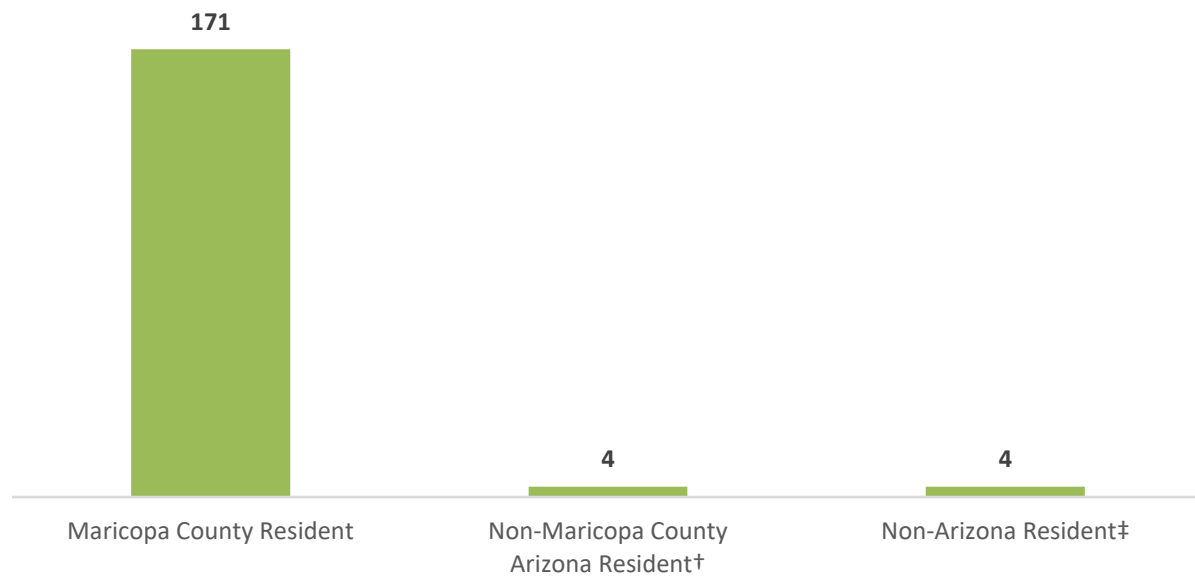
Graph 4. Twenty-two percent (N=40) of heat-associated deaths occurred on days for which an excessive heat warning has been issued.



*Eleven deaths which occurred outside of the MCDPH enhanced heat surveillance season (May 1 – September 30) excluded from graph.

Heat-Associated Deaths by Residency

Graph 5. Maricopa County residents accounted for ninety-six percent of all heat-associated deaths reported in 2017.

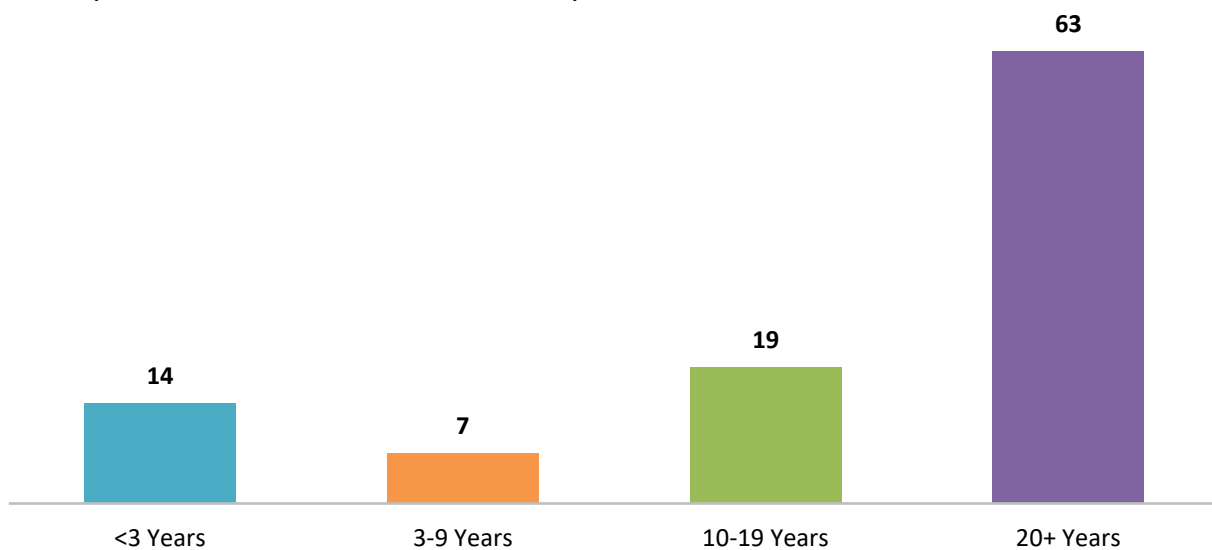


† Non-Maricopa County Arizona resident cases include residents from Apache, Cochise, Pinal, and Yuma Counties.

‡ Non-Arizona resident cases include three U.S. residents (from California, Oklahoma, and Wisconsin) and one non-U.S. residents (from Mexico).

Heat-Associated Deaths by Time Residing in Arizona*

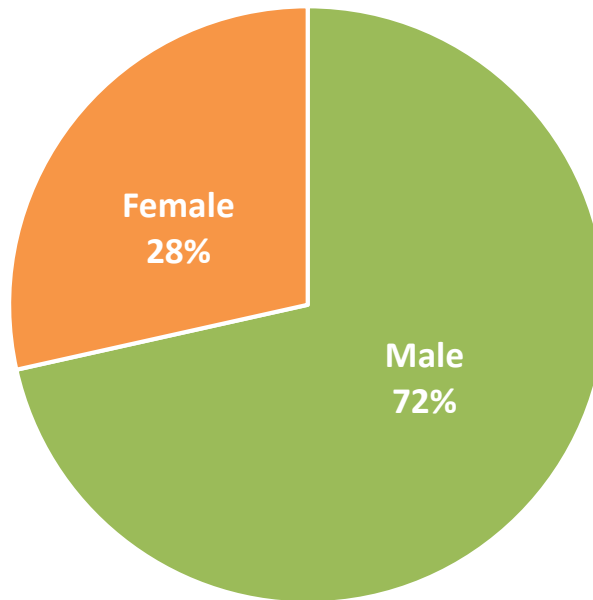
Graph 6. Sixty-one percent of heat-associated deaths with known residency history had lived in Arizona for 20 or more years at the time of death.



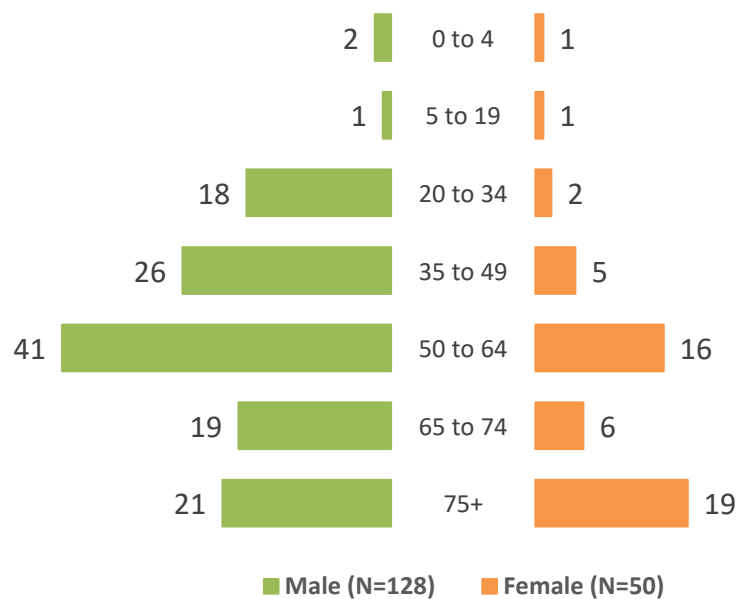
*Seventy-six cases for which time spent in Arizona was unknown were excluded from analysis.

Demographic Characteristics of Heat-Associated Deaths

Graph 7. The majority of heat-associated deaths occurred among males.

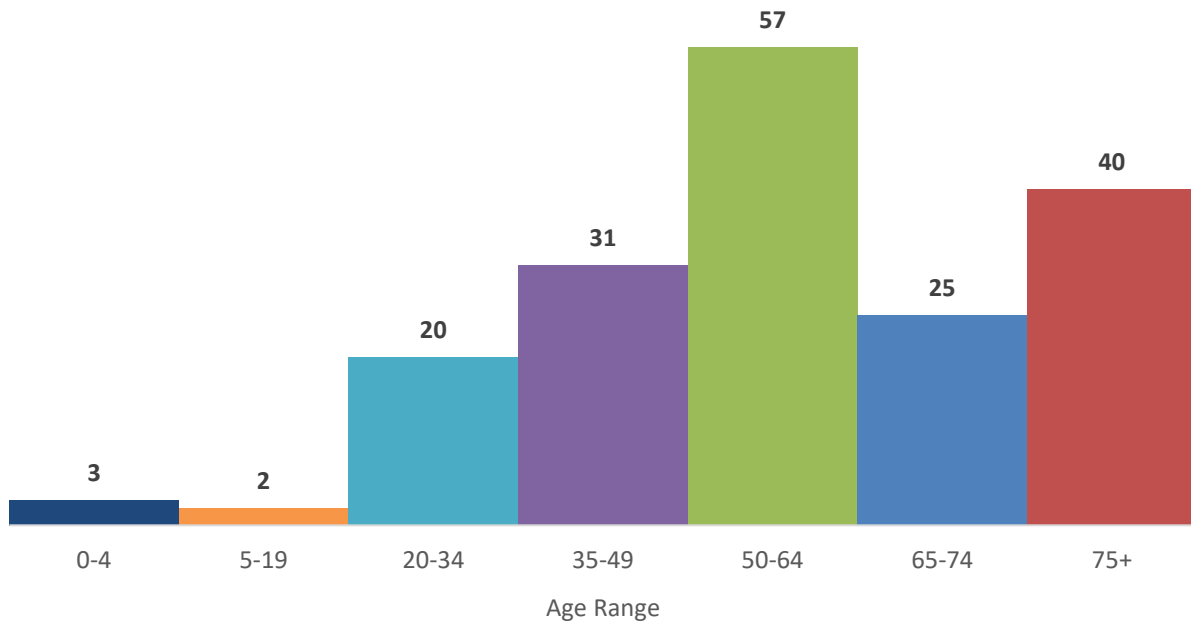


Graph 8. The largest proportion of deaths in males was in the 50-64 age group, while the proportion of deaths in females was highest in the 75+ age group.*



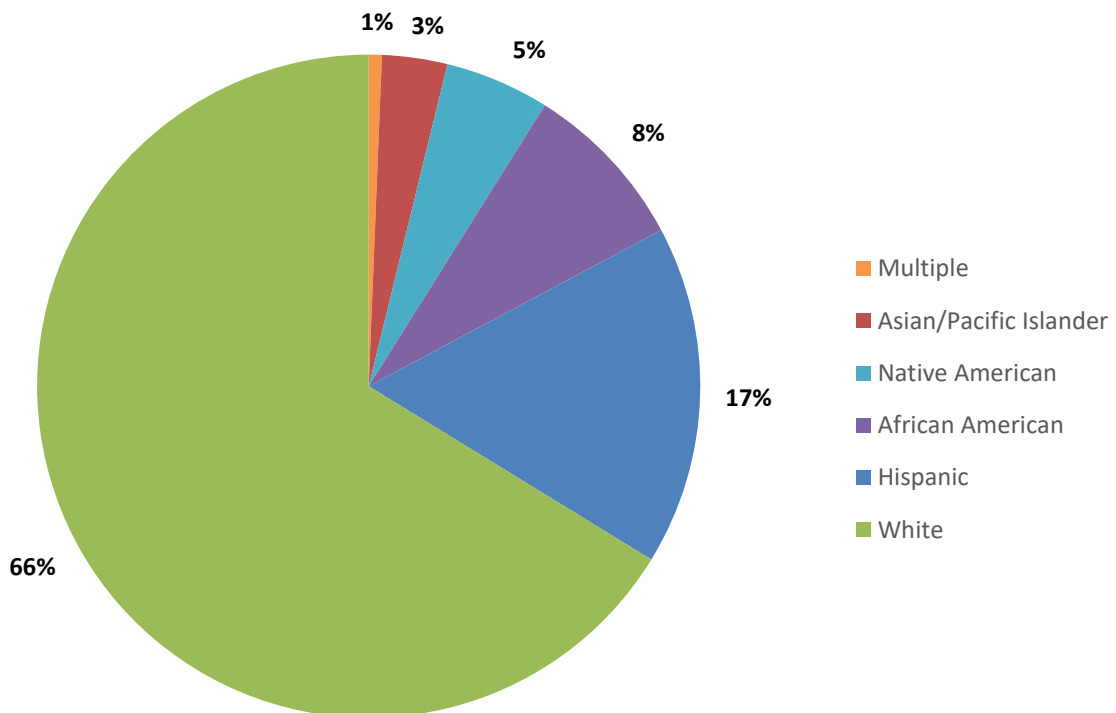
*One case of unknown age excluded from analysis.

Graph 9. Sixty-nine percent (N=122) of heat-associated deaths were among those 50 and older.*



*One case of unknown age excluded from analysis.

Graph 10. Sixty-six percent (N=104) of heat-associated deaths for which race and ethnicity are known occurred among whites.



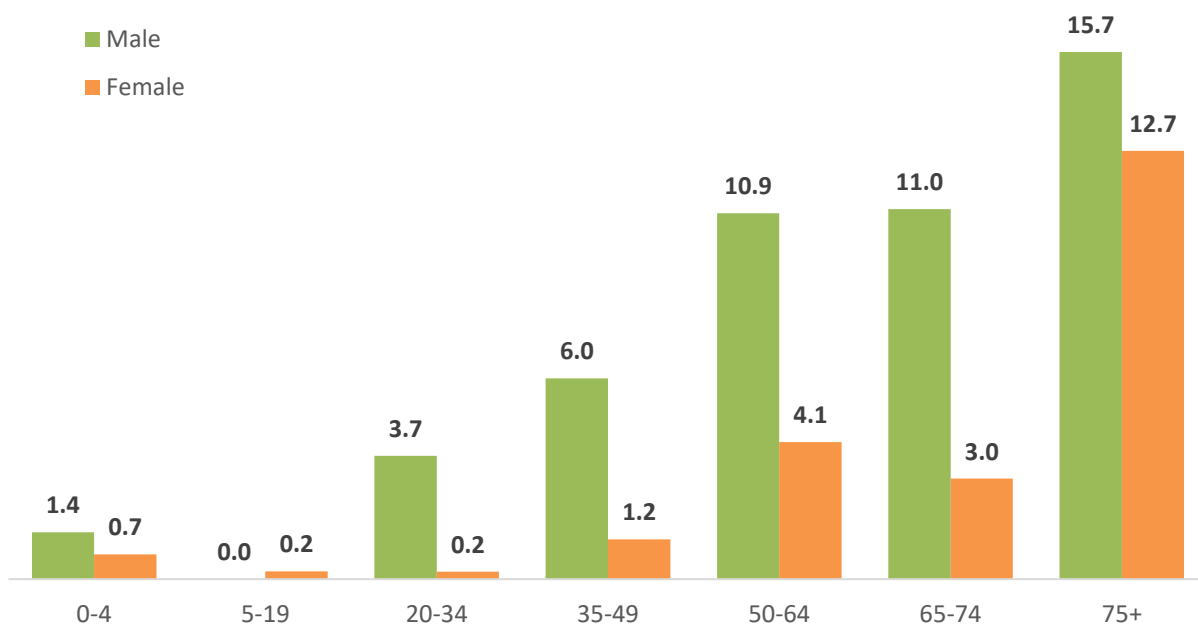
Heat-Associated Death Rates*

*Death rate graphs below include rates per 100,000 residents. Non-Maricopa County residents were excluded. Rates calculated using census population estimates for 2017.

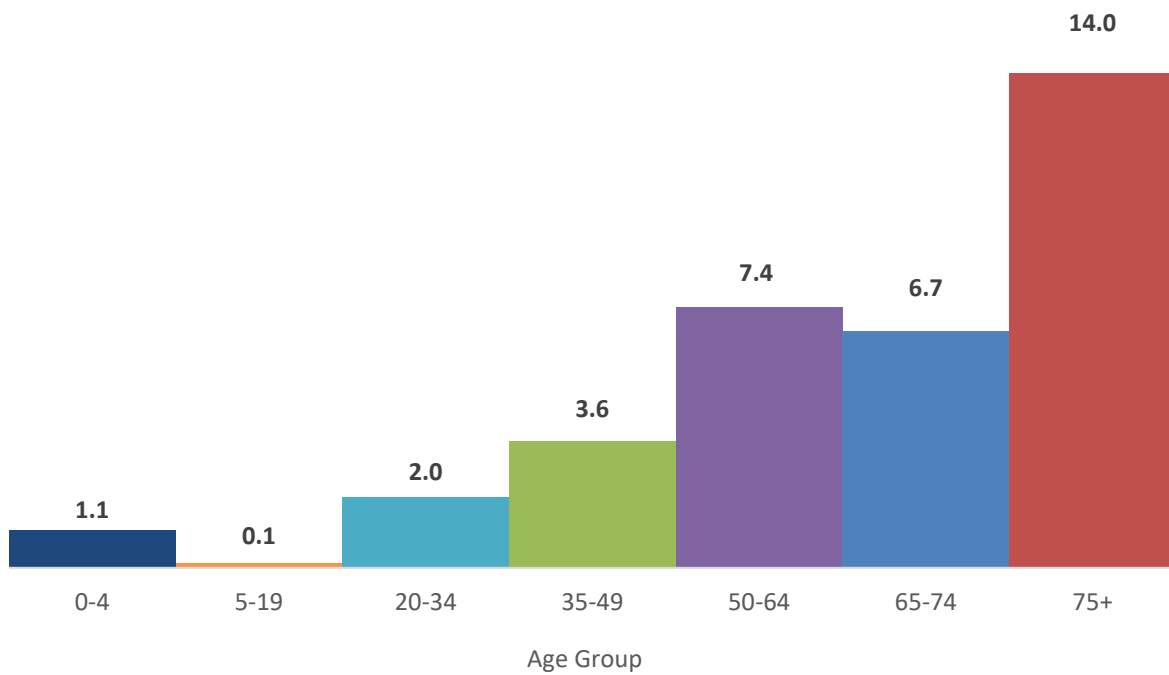
Graph 11. The heat-associated death rate for males was more than two times greater than the death rate for females.



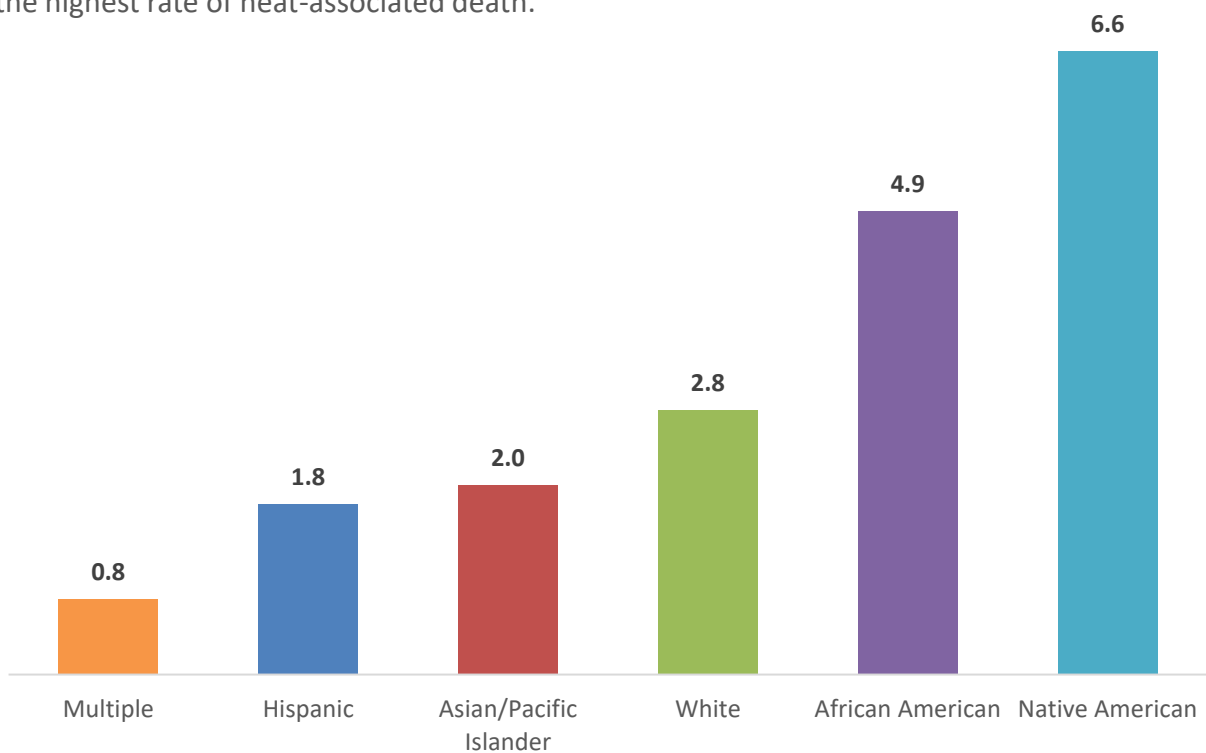
Graph 12. For both male and female residents, the heat-associated death rate was highest in the 75+ age group.



Graph 13. The heat-associated death rate increases with age.

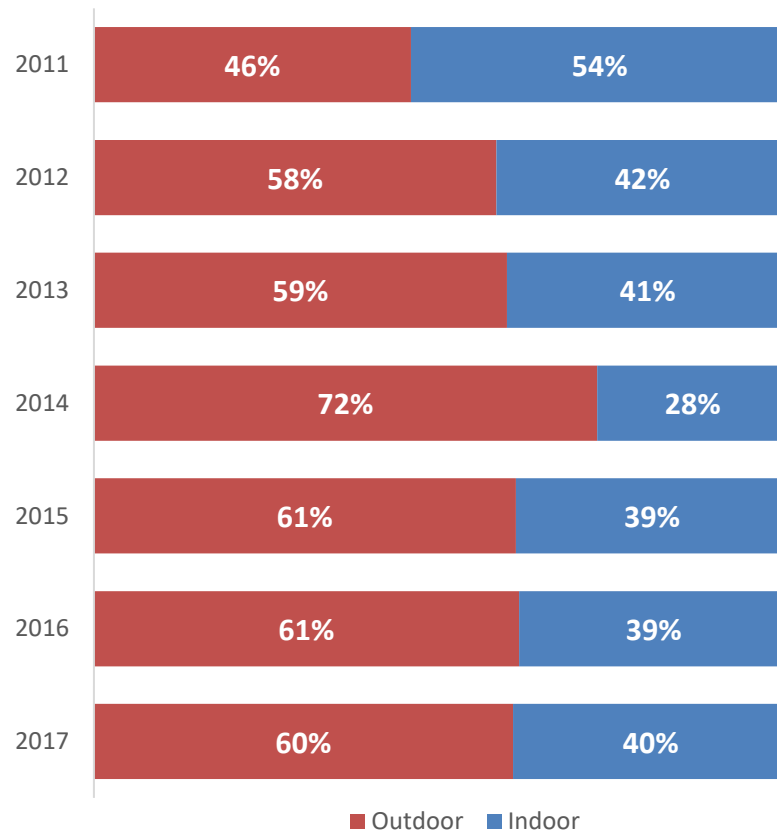


Graph 14. Among cases of known race and ethnicity, Native Americans had the highest rate of heat-associated death.

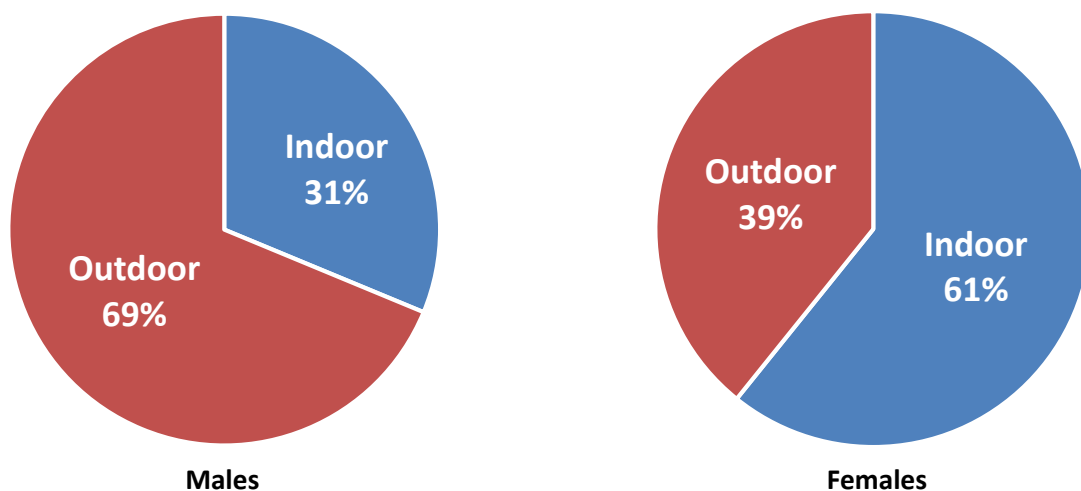


Heat-Associated Deaths by Place of Injury

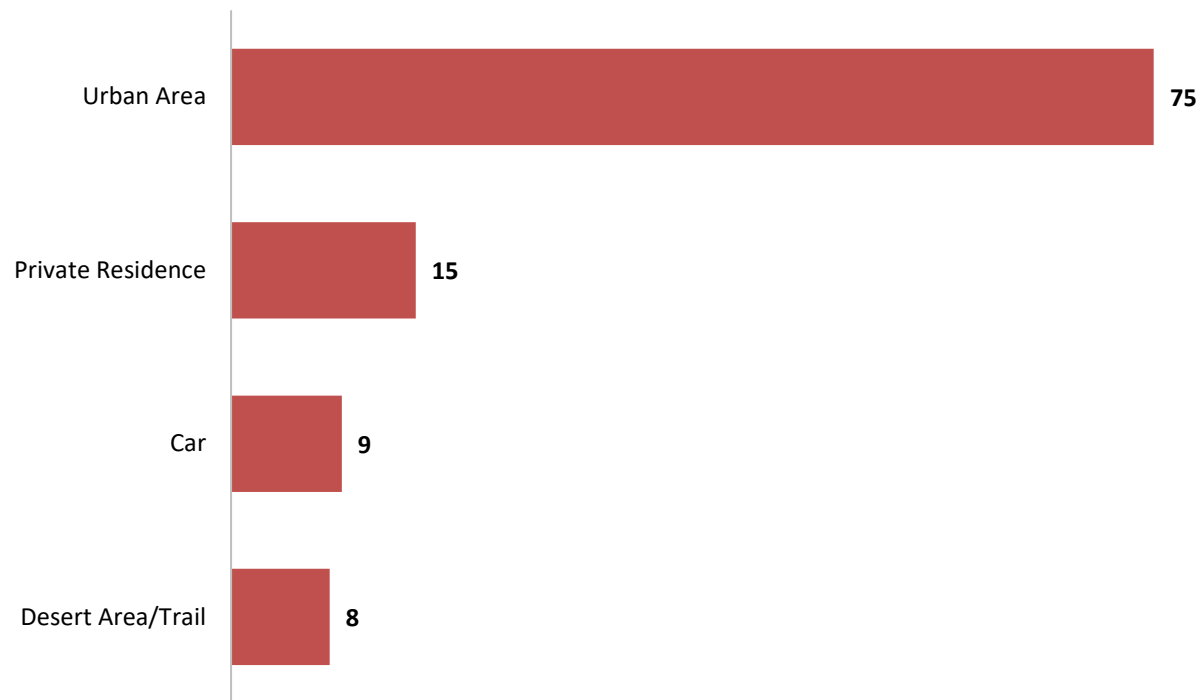
Graph 15. The proportion of heat-associated deaths occurring outdoors was similar to previous years.



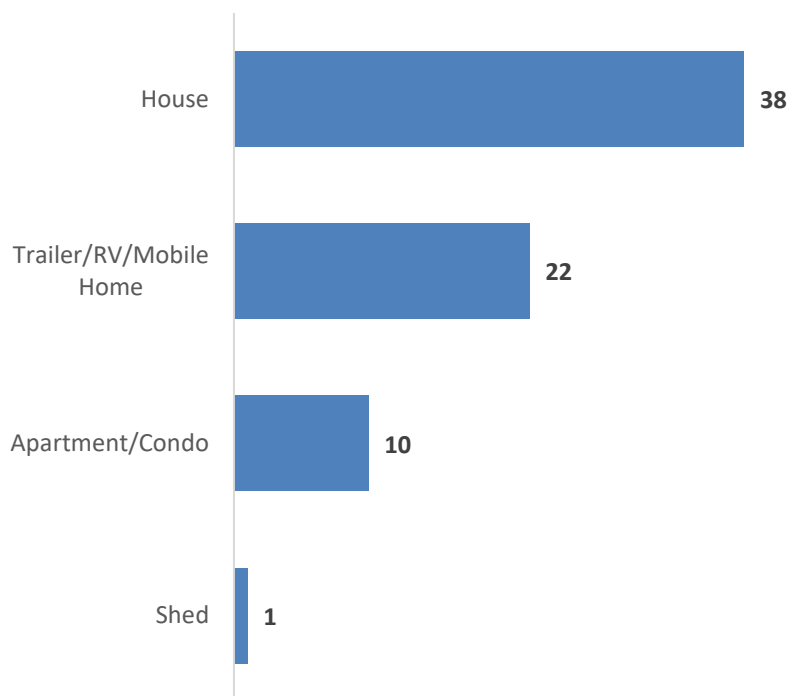
Graph 16. While the majority of male heat-associated deaths occurred outdoors (N=88), the majority of female deaths occurred indoors (N=31).



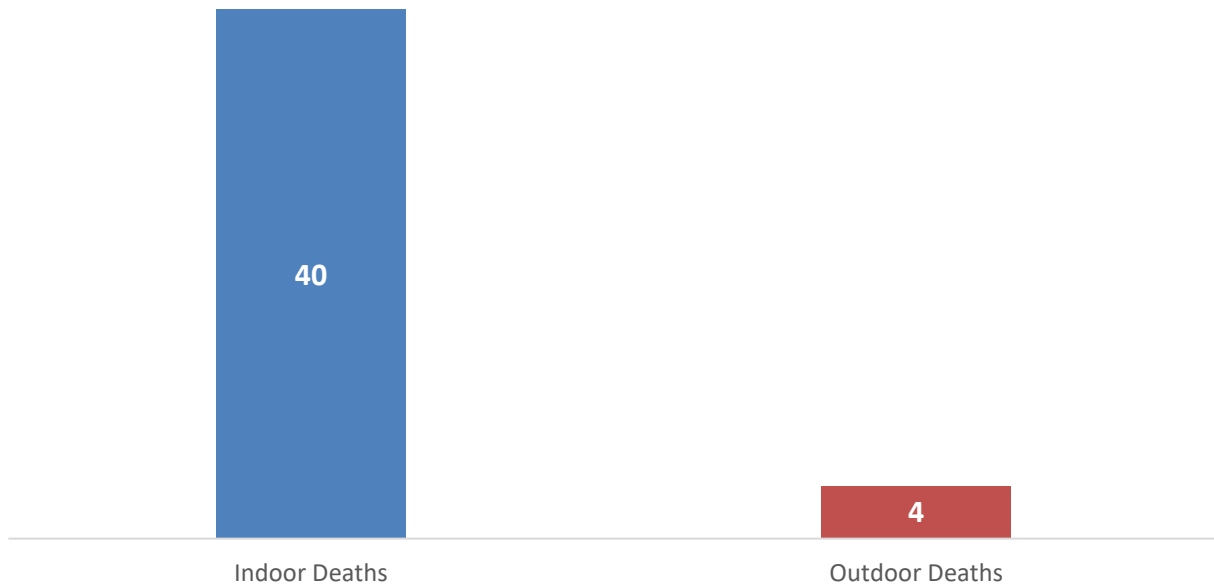
Graph 17. Seventy percent of outdoor deaths occurred in an urban area.



Graph 18. Sixty-eight percent of indoor deaths occurred in a house or apartment.



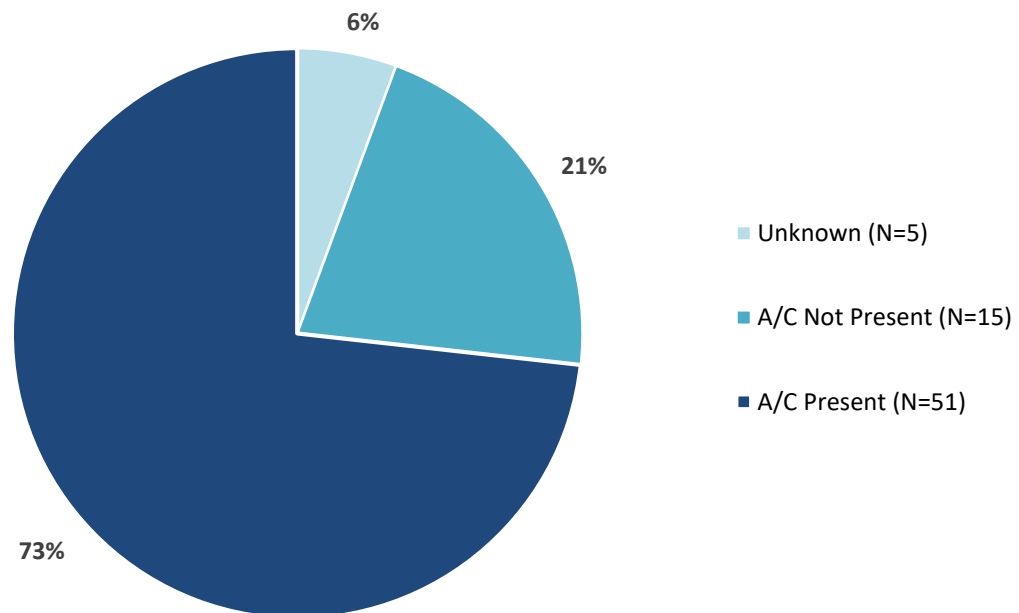
Graph 19. Fifty-six percent of indoor deaths were discovered during a welfare check, compared to just four percent of outdoor deaths.



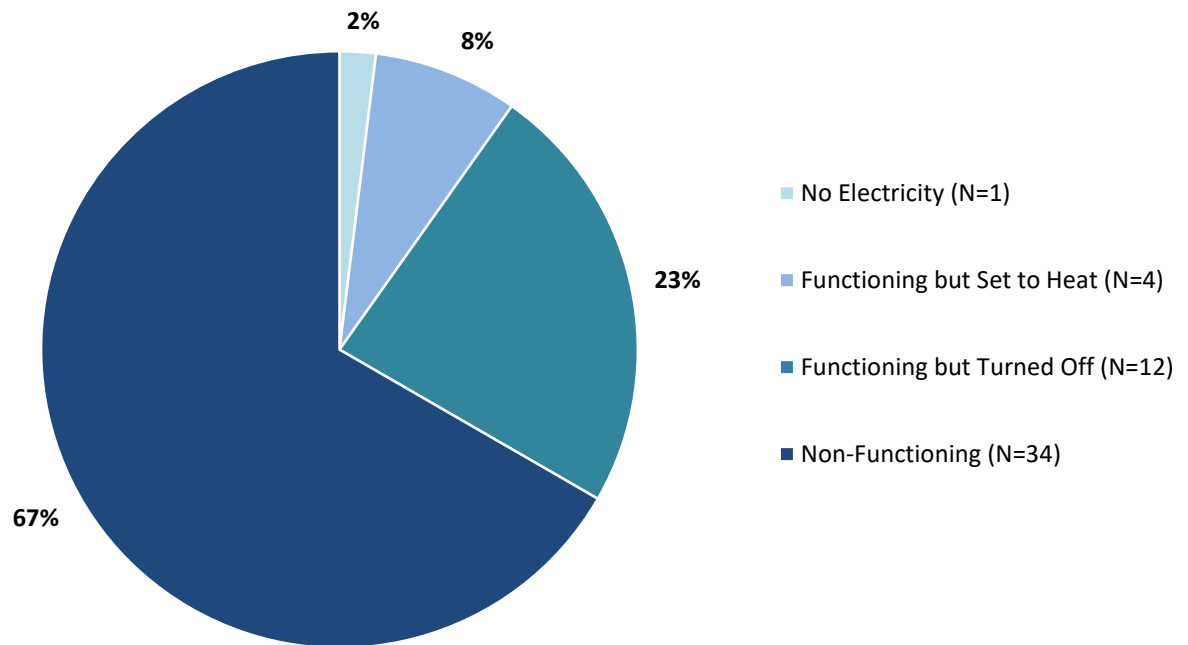
Air Conditioning Use for Indoor Deaths*

*Evaporative coolers were not considered as A/C units as their ability to cool becomes inadequate in extreme Maricopa County temperatures.

Graph 20. Seventy-three percent indoors deaths had an air conditioning unit present at the place of injury.

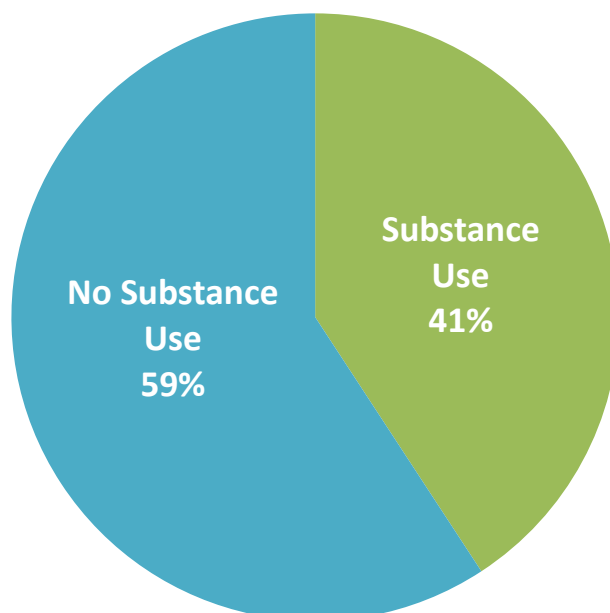


Graph 21. Among indoor deaths where an A/C unit was present, a non-functioning A/C unit was the most common known reason for not having a cooled environment at the time of death.

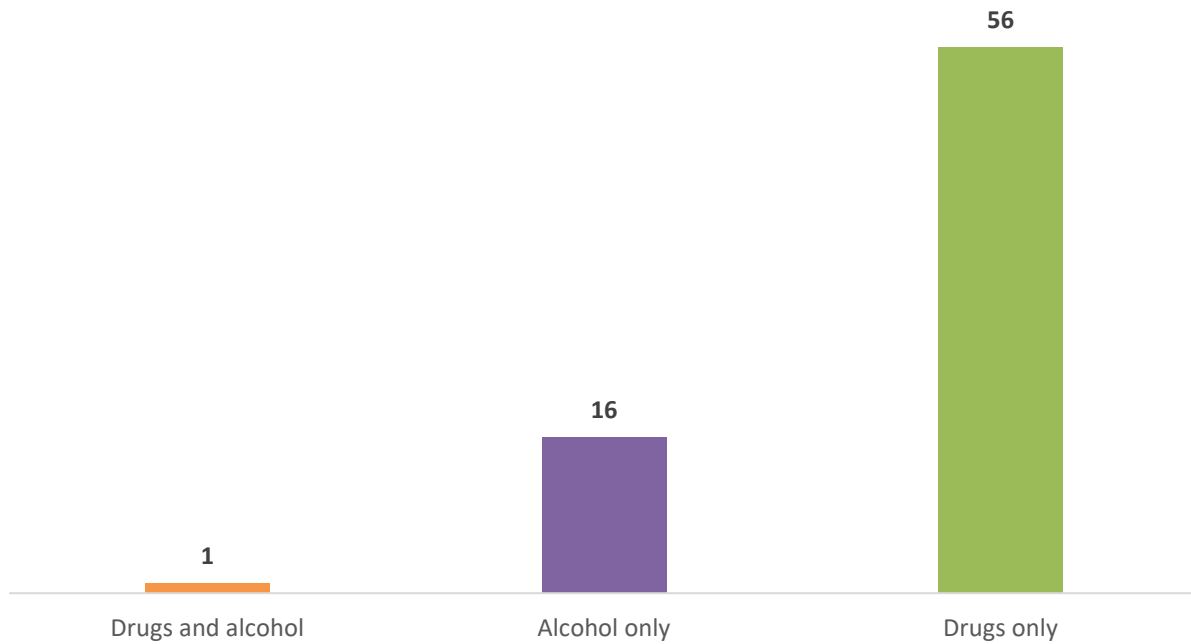


Substance Use among Heat-Associated Deaths

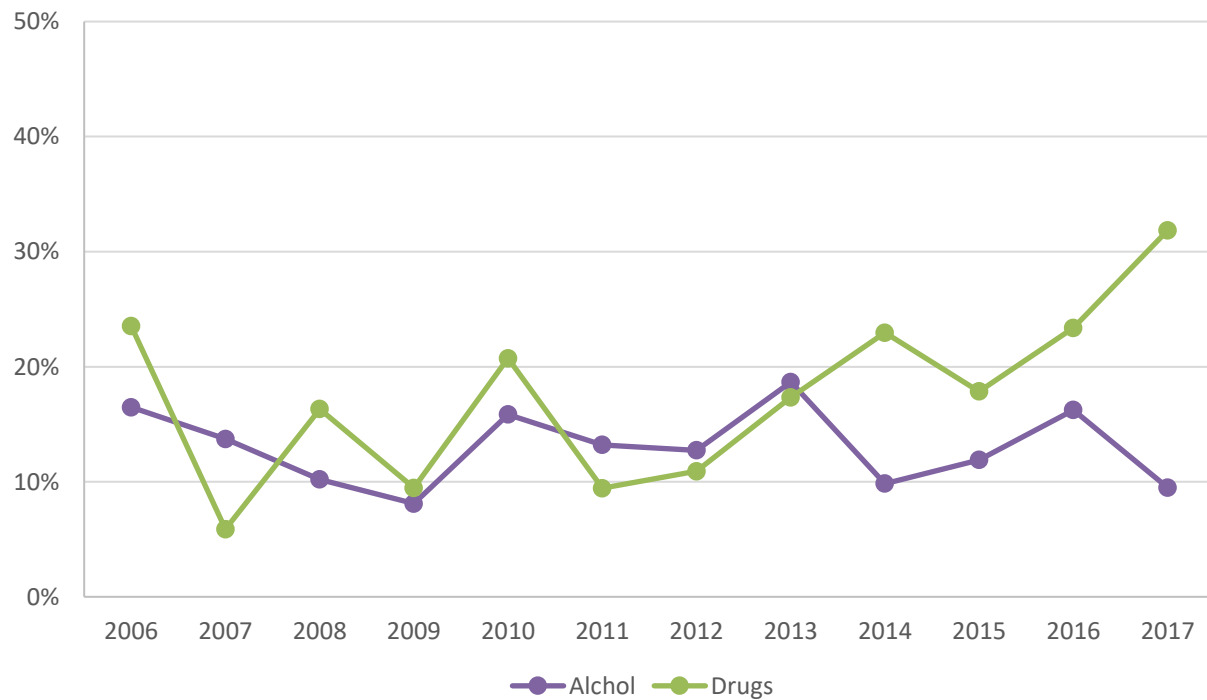
Graph 22. Forty-one percent of cases (N=73) involved substance use as a cause of death or a contributing factor.



Graph 23. In thirty-two percent of cases (N=57), drug use was listed as either a cause of death or a contributing factor.



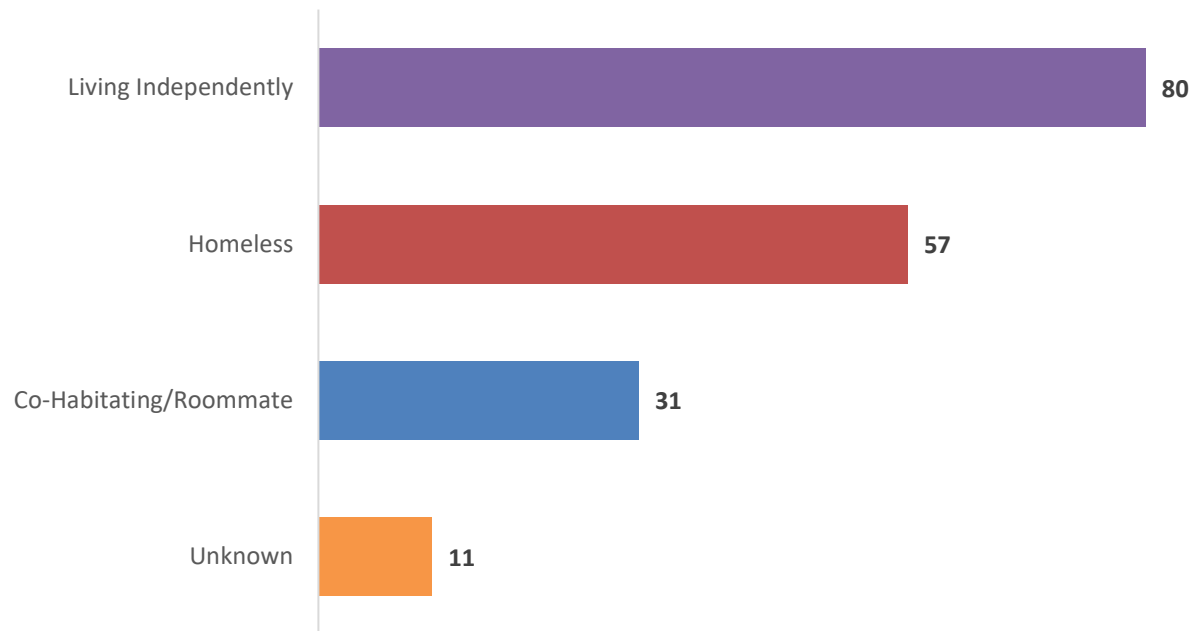
Graph 24. The proportion of heat-associated deaths involving drug use increased thirty-six percent over the previous year.*



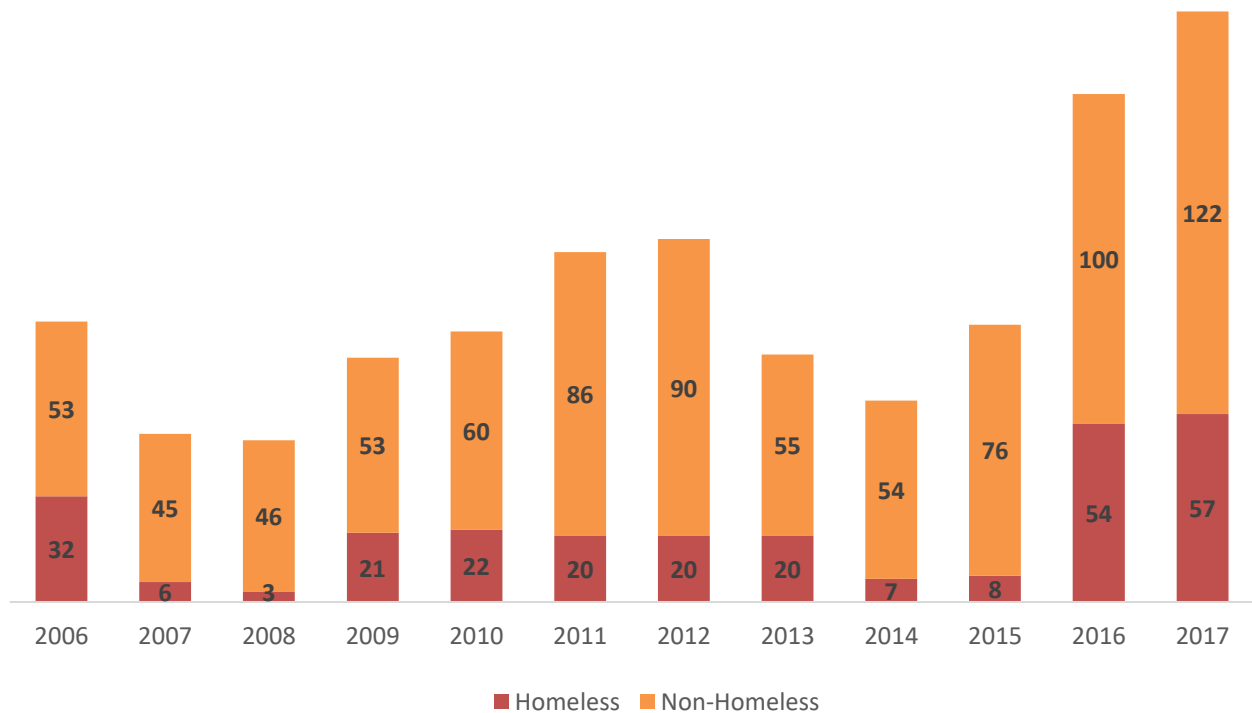
*Cases involving both drug and alcohol use are represented uniquely on each line.

Living Situation among Heat-Associated Deaths

Graph 25. Thirty-two percent of cases were homeless at time of death.



Graph 26. More heat-associated deaths occurred among homeless individuals than any previous year on record.



Conclusions

- There were 16% more heat-associated deaths in 2017 compared to 2016.
- Four excessive heat warnings were issued in 2017, and ranged in duration from 3 to 10 days. On those days, 22% of the heat associated deaths occurred.
- Most of the deaths occurred in the months of June, July, and August.
- There were 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
- Among Maricopa County residents, the rate of heat-associated deaths was the highest for males, Native Americans, and those 75 years of age or older.
- 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 at a private residence.
- While 73% of indoor deaths had an A/C unit present at the time of death, in all cases the environment was not being adequately cooled. Reasons for lack of cooling in the presence of an A/C unit include a malfunctioning unit, a lack of electricity, the unit being turned off due to cost, forgetfulness, or other reasons, and the unit being set to a high temperature. A total of 21% of indoor cases did not have an A/C unit present.
- Drugs or alcohol were mentioned on the death certificate in 41% of cases.
- Homeless individuals accounted for 32% of heat-associated deaths.
- The average years of life lost for those with heat-related deaths was 16.9 years with a median age at death of 59 years.

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. For the purposes of this report, reasons for not having a cooled environment at the time of death in indoor cases where an A/C unit was present were grouped into three categories: non-functioning, functioning but turned off, and no electricity. “Non-functioning” is defined as an A/C unit that was not operating properly, was broken, or could not be turned on despite the presence of electricity. Cases categorized as having a “functioning but turned off” A/C unit indicate that the unit worked properly but was the A/C was turned off for some reason at the time of the OME scene inspection. In cases where the unit could not be turned on due to a lack of electricity, regardless of whether it was functioning or non-functioning, were counted in the “no electricity” category.

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.

Tables

Table A. Heat-Associated Deaths Reported by Investigation Status, Maricopa County, 2006-2017

YEAR	TOTAL CASES REPORTED	CONFIRMED CASES (%)	RULED-OUT CASES (%)	PENDING CASES (%)
2006	104	85 (82%)	19 (18%)	0 (0%)
2007	131	51 (39%)	80 (61%)	0 (0%)
2008	97	49 (51%)	48 (49%)	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	75 (52%)	70 (48%)	0 (0%)
2014	115	61 (53%)	54 (47%)	0 (0%)
2015	144	84 (58%)	59 (42%)	0 (0%)
2016	240	154 (64%)	86 (36%)	0 (0%)
2017	264	179 (68%)	85 (32%)	0 (0%)
TOTAL	1,549	931 (60%)	617 (40%)	0 (0%)

Table B. Heat-Associated Deaths by Gender and Age Group, Maricopa County, 2017

AGE GROUP	MALE CASES (%)	FEMALE CASES (%)	TOTAL CASES (%)
0-4	2 (1%)	1 (<1%)	3 (2%)
5-19	1 (<1%)	1 (<1%)	2 (1%)
20-34	18 (10%)	2 (1%)	20 (11%)
35-49	26 (15%)	5 (3%)	31 (17%)
50-64	41 (23%)	16 (9%)	57 (32%)
65-74	19 (11%)	6 (3%)	25 (14%)
75+	21 (12%)	19 (11%)	40 (22%)
Unknown	0 (0%)	1 (<1%)	1 (<1%)
TOTAL	128 (72%)	51 (28%)	179 (100%)

Table C. Heat-Associated Deaths Rates per 100,000 Residents* by Gender and Age Group, Maricopa County, 2017

AGE GROUP	MALE RATE (N)	FEMALE RATE (N)	TOTAL RATE (N)
0-4	1.4 (2)	0.7 (1)	1.1 (3)
5-19	0.0 (0)	0.2 (1)	0.1 (1)
20-34	3.7 (17)	0.2 (1)	2.0 (18)
35-49	6.0 (25)	1.2 (5)	3.6 (30)
50-64	10.9 (40)	4.1 (16)	7.4 (56)
65-74	11.0 (19)	3.0 (6)	6.7 (25)
75+	15.7 (18)	12.7 (19)	14.0 (37)
TOTAL	5.7 (121)	2.3 (50)	4.0 (171)

*Based on 2017 census population estimates for Maricopa County. Eight cases that were not Maricopa County residents excluded. Total includes one case of unknown age.

Table D. Heat-Associated Deaths Rates per 100,000 Residents* by Age Group and Race/Ethnicity, Maricopa County, 2017

RACE/ETHNICITY	AGE GROUP RATE (N)							TOTAL
	0-4	5-19	20-34	35-49	50-64	65-74	75+	
WHITE	0.9 (2)	0.0 (0)	1.2 (9)	2.2 (15)	4.7 (31)	5.0 (17)	10.5 (26)	2.8 (100)
HISPANIC	0.0 (0)	0.3 (1)	1.5 (5)	1.1 (3)	4.4 (7)	6.5 (3)	20.1 (5)	1.8 (24)
BLACK	4.9 (1)	0.0 (0)	3.0 (2)	7.5 (4)	9.9 (4)	7.2 (1)	14.0 (1)	4.9 (13)
ASIAN/PACIFIC ISLANDER	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	6.3 (2)	7.9 (1)	13.9 (1)	2.0 (4)
NATIVE AMERICAN	0.0 (0)	0.0 (0)	3.0 (1)	8.4 (2)	13.3 (2)	0.0 (0)	165.8 (3)	6.6 (8)
MULTIPLE	0.0 (0)	0.0 (0)	3.3 (1)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.8 (1)
TOTAL	1.1 (3)	0.1 (1)	2.0 (18)	3.6 (30)	7.4 (56)	6.7 (25)	14.0 (37)	4.0 (171)

*Based on 2017 census population estimates for Maricopa County. Eight cases that were not Maricopa County residents excluded. Total includes twenty-one cases with unknown race/ethnicity and one case of unknown age.

Table E. Heat-Associated Deaths Rates per 100,000 Residents* by Gender and Race/Ethnicity, Maricopa County, 2017

RACE/ETHNICITY	MALE RATE (N)	FEMALE RATE (N)	TOTAL RATE (N)
White	3.6 (64)	2.0 (36)	2.8 (100)
Hispanic	2.8 (19)	0.7 (5)	1.8 (24)
Black	8.3 (11)	1.5 (2)	4.9 (13)
Asian/Pacific Islander	3.1 (3)	1.0 (1)	2.0 (4)
Native American	8.5 (5)	4.8 (3)	6.6 (8)
Multiple	1.6 (1)	0.0 (0)	0.8 (1)
TOTAL	5.7 (121)	2.3 (50)	4.0 (171)

*Based on 2017 census population estimates for Maricopa County. Eight cases that were not Maricopa County residents excluded. Total includes twenty-two cases with unknown race/ethnicity and one case of unknown age.

Table F. Indoor Heat-Associated Deaths by Place of Injury and Age Group, Maricopa County, 2017

AGE GROUP	HOUSE	APARTMENT	TRAILER/RV/ MOBILE HOME	SHED	TOTAL
0-4	0	0	1	0	1
5-19	0	0	0	0	0
20-34	2	0	0	0	2
35-49	2	0	1	0	3
50-64	9	5	3	1	18
65-74	6	4	9	0	19
75+	19	1	8	0	28
TOTAL	38	10	22	1	71

Table G. Outdoor Heat-Associated Deaths* by Place of Injury and Age Group, Maricopa County, 2017

AGE GROUP	CAR	DESERT AREA	RESIDENCE	URBAN AREA	TOTAL
0-4	1	0	1	0	2
5-19	0	1	0	1	2
20-34	1	1	0	15	17
35-49	1	3	0	24	28
50-64	5	3	6	25	39
65-74	0	0	3	3	6
75+	1	0	5	6	12
TOTAL	9	8	15	74	106

*Excludes one case of unknown age and one case with unknown place of injury.

Table H. Heat-Associated Deaths* by Place of Injury, Age Group, and Gender, Maricopa County, 2017

AGE GROUP	INDOOR			OUTDOOR		
	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL
0-4	0	1	1	2	0	2
5-19	0	0	0	1	1	2
20-34	2	0	2	16	2	18
35-49	2	1	3	24	4	28
50-64	12	6	18	29	10	39
65-74	13	6	19	6	0	6
75+	11	17	28	10	2	12
TOTAL	40	31	71	88	19	107

*Excludes one case of unknown age.

Table I. Indoor Heat-Associated Deaths by Presence of an Air Conditioning (A/C) Unit and Age Group, Maricopa County, 2017

AGE GROUP	AC UNIT PRESENT	AC UNIT NOT PRESENT/UNKNOWN	TOTAL
0-4	0	1	1
5-19	0	0	0
20-34	1	0	2
35-49	1	2	3
50-64	13	4	18
65-74	14	4	19
75+	23	4	28
TOTAL	52	15	71

Table J. Indoor Heat-Associated Deaths with AC Unit Present by Air Conditioning (A/C) Status and Age Group, Maricopa County, 2017

AGE GROUP	NO ELECTRICITY	NON-FUNCTIONING	NOT IN USE	OTHER	UNKNOWN	TOTAL
0-4	0	0	0	0	0	0
5-19	0	0	0	0	0	0
20-34	0	0	0	0	1	1
35-49	0	1	0	0	0	1
50-64	1	6	5	1	0	13
65-74	0	10	4	0	0	14
75+	0	17	3	3	0	23
TOTAL	1	34	12	4	1	52

Table K. Heat-Associated Deaths by Substance Use* at Time of Death, Maricopa County, 2017

AGE GROUP	ALCOHOL USE	DRUG USE
0-4	0	0
5-19	0	0
20-34	3	14
35-49	5	21
50-64	6	21
65-74	1	1
75+	2	0
TOTAL	17	57

*Cases with more than one substance in use at time of death are included in each relevant column.

Table L. Heat-Associated Deaths among Homeless Individuals, Maricopa County, 2017

AGE GROUP	MALE (%)	FEMALE (%)	TOTAL (%)
0-4	0 (0%)	0 (0%)	0 (0%)
5-19	1 (2%)	1 (2%)	2 (4%)
20-34	1 (2%)	10 (18%)	11 (19%)
35-49	1 (2%)	14 (25%)	15 (26%)
50-64	5 (9%)	20 (35%)	25 (44%)
65-74	0 (0%)	1 (2%)	1 (2%)
75+	2 (4%)	0 (0%)	2 (4%)
Unknown	1 (2%)	0 (0%)	1 (2%)
TOTAL	9 (16%)	48 (84%)	57 (100%)

Table M. Heat-Associated Deaths by Education Level, Maricopa County, 2017

EDUCATION	CASES (%)
8th grade or less	14 (8%)
9th through 12th grade; no diploma	25 (14%)
High school graduate or GED completed	55 (31%)
Some college credit, but no degree	24 (13%)
Associate degree (e.g.AA,AS)	6 (3%)
Bachelor's degree (e.g.BA,BS)	14 (8%)
Master's degree (e.g.MA,MS,MEng,MEd,MSW,MBA)	5 (3%)
Doctorate (e.g.PhD,EdD) or Professional degree (e.g.MD,DDS,DVM,LLB,JD)	1 (<1%)
Unknown	35 (19%)
TOTAL	179 (100%)