

Heat-Associated Deaths in Maricopa County, AZ Final Report for 2018



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.

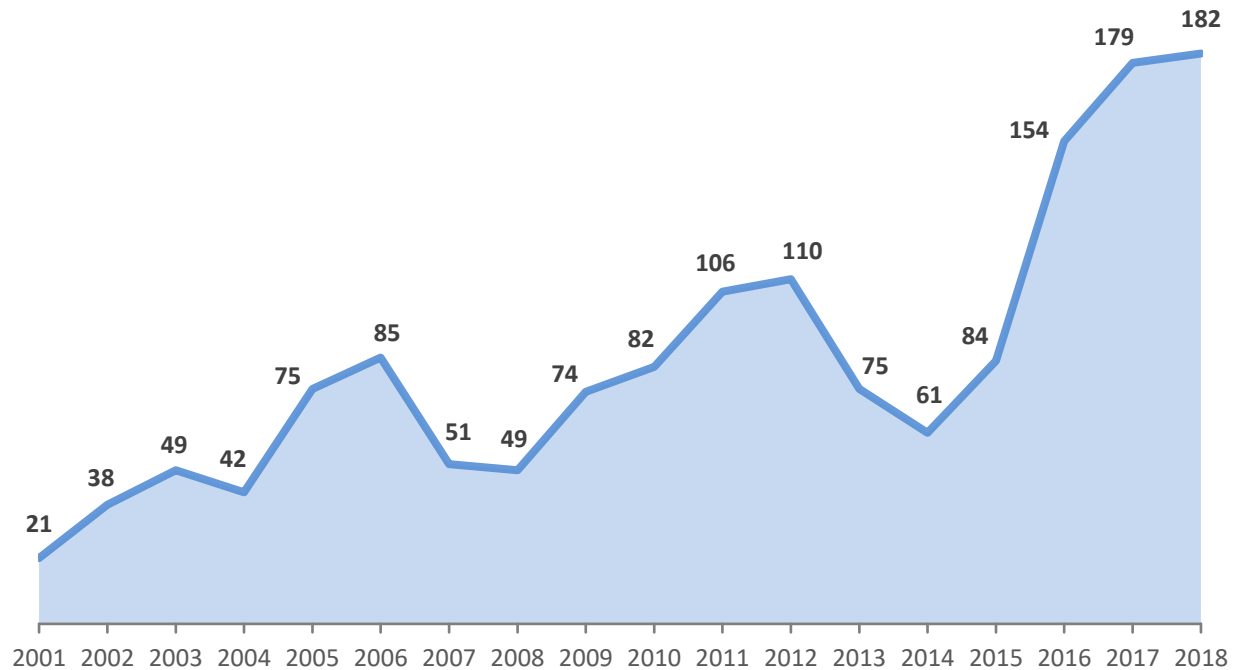
The two main sources of data for heat surveillance are: preliminary reports of death (PRODs) from the Office of the Medical Examiner (OME) and death certificates from the MCDPH Office of Vital Registration.

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 182 heat-associated deaths reported in 2018.

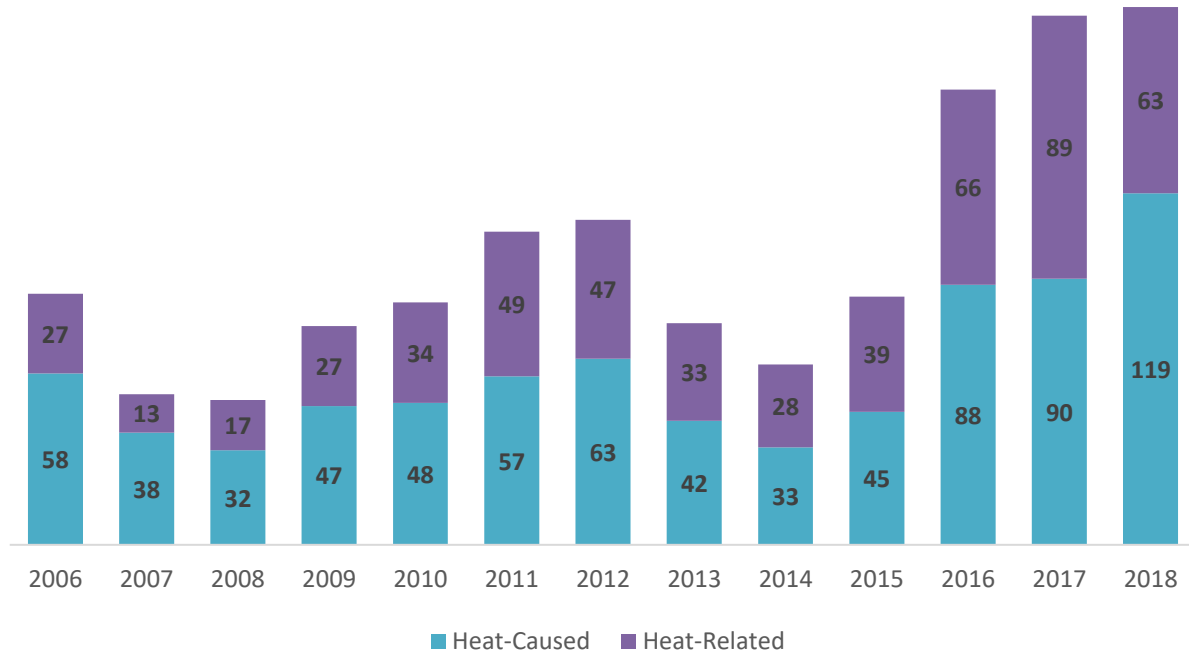


Data Sources: Maricopa County, Office of Vital Registration and Office of Medical Examiner; Arizona Department of Health Services, Office of Vital Registration

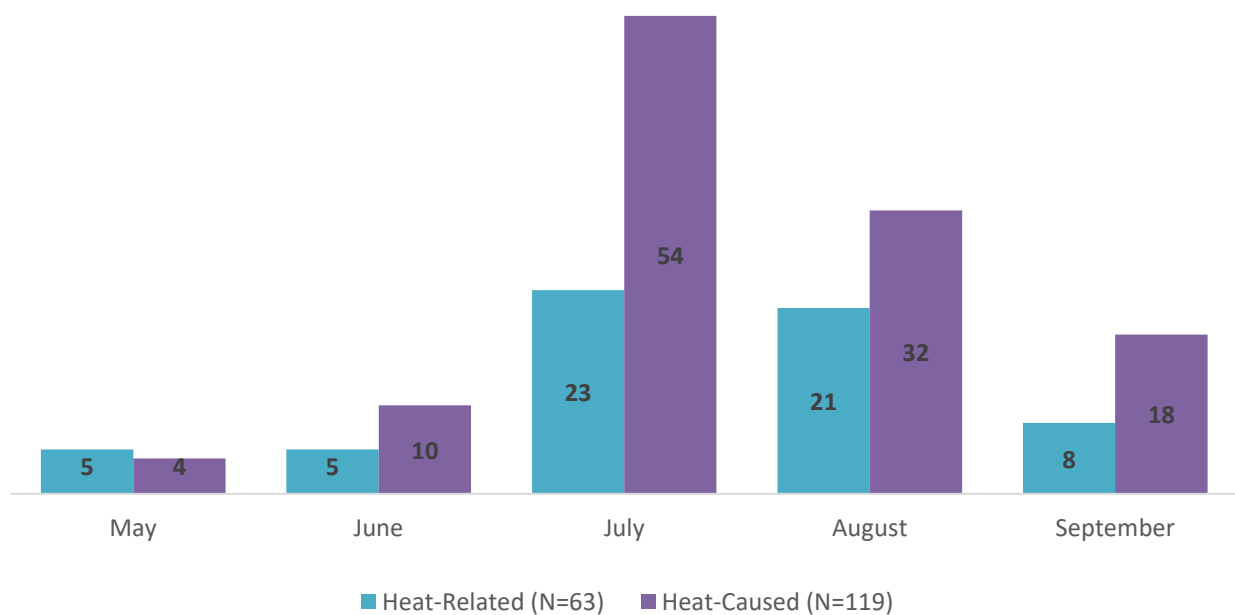
- See [Methodology](#) in the Appendix for more information about the number of confirmed, ruled-out, and pending cases by year.

Heat-Associated Deaths by Month

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



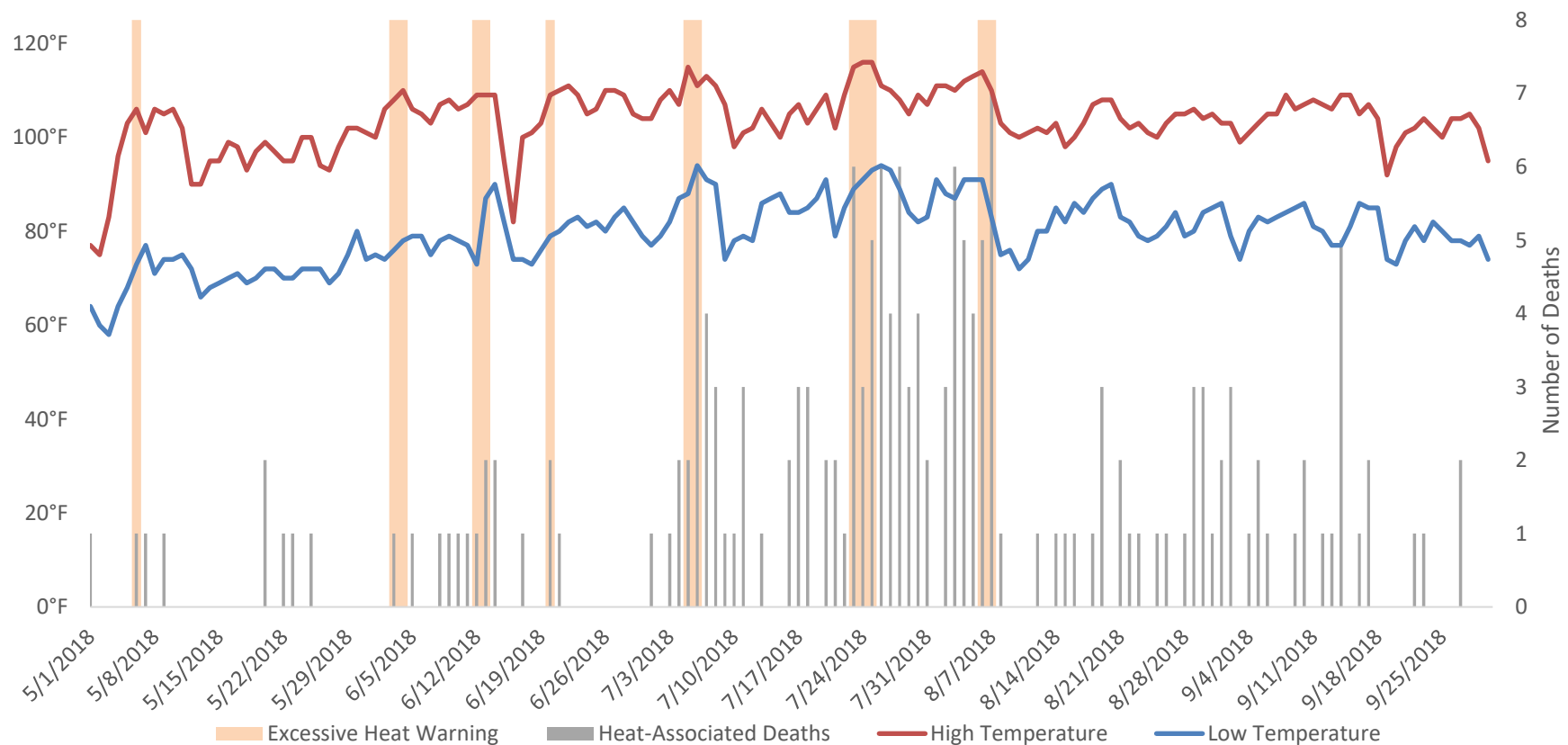
Graph 3. Eighty-six percent of all heat-associated deaths occurred in the months of July, August, and September (N=156).



Heat-Associated Deaths and Temperatures

- The National Weather Service issued seven excessive heat warnings for a total of thirteen days in 2018.
- The highest daily maximum temperature in 2018 was 116°F and occurred on July 24th and 25th.

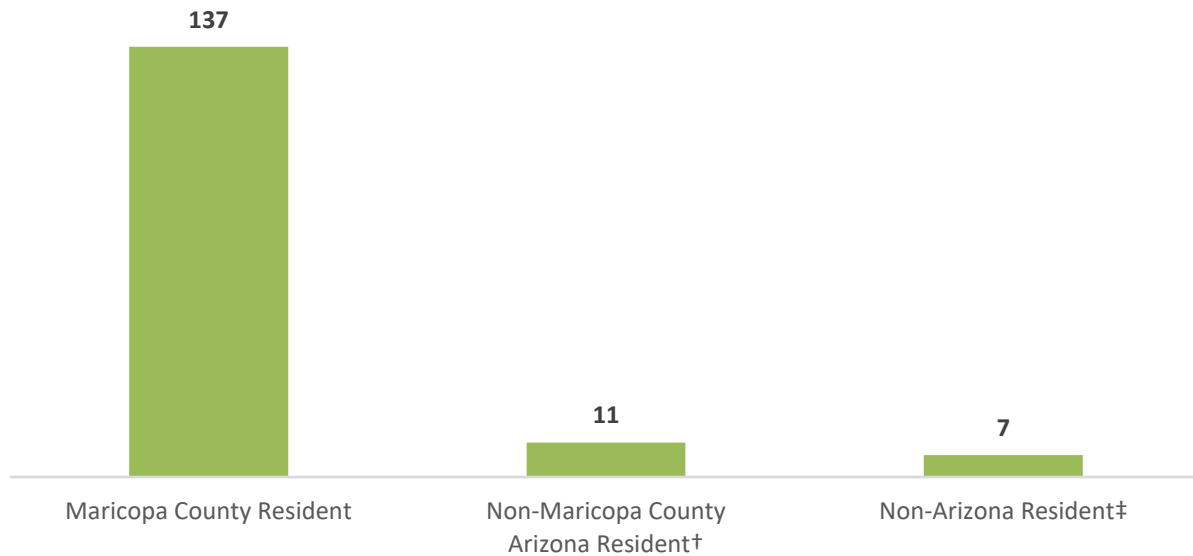
Graph 4. Twenty-three percent of heat-associated deaths occurred on days for which an excessive heat warning has been issued. (N=41)



*Two 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 eighty-eight percent of all heat-associated deaths with known county of residence.

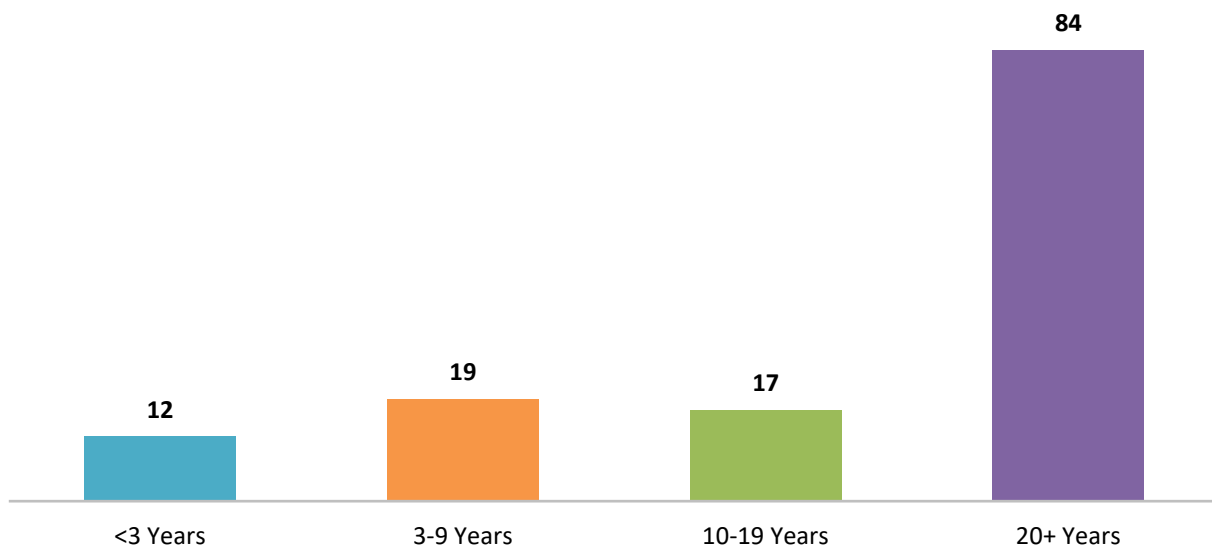


† Non-Maricopa County Arizona Resident cases include residents from Apache, Gila, Navajo, Pima, and Pinal, Counties and one case with unknown county of residency.

‡ Non-Arizona Resident cases include residents of California, Illinois, Iowa, Missouri, New Jersey, and Ohio.

Heat-Associated Deaths by Time Residing in Arizona*

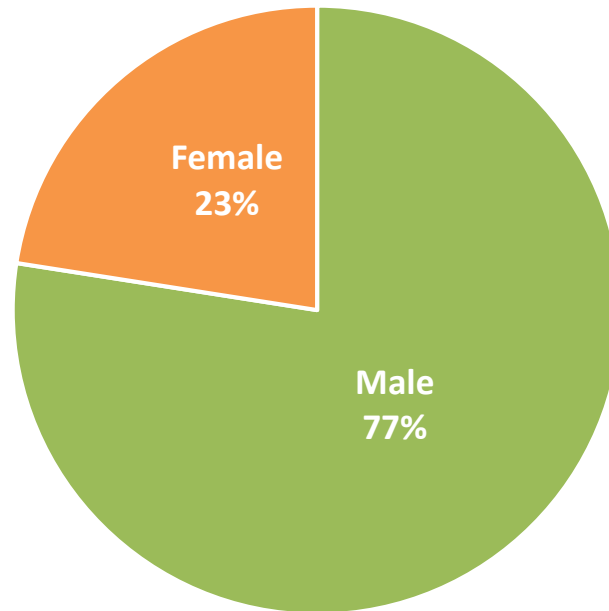
Graph 6. Sixty-four percent of heat-associated deaths with known residency history had lived in Arizona for 20 or more years at time of death.



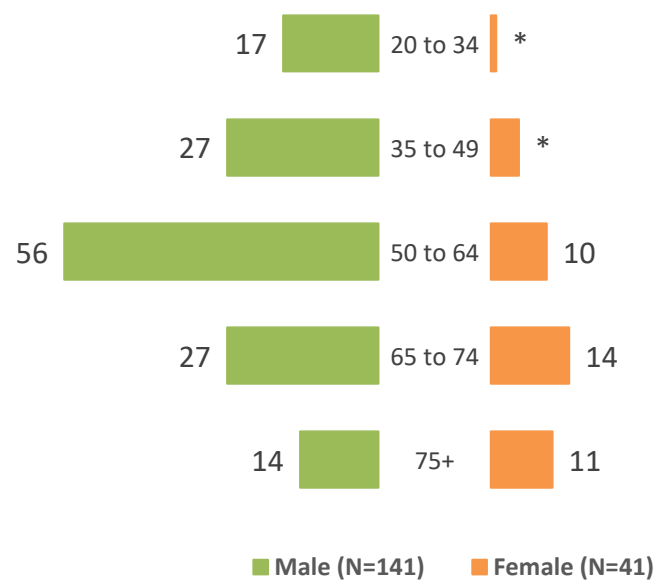
*Fifty cases for which time spent in Arizona was unknown were excluded from analysis.

Demographic Characteristics of Heat-Associated Deaths

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

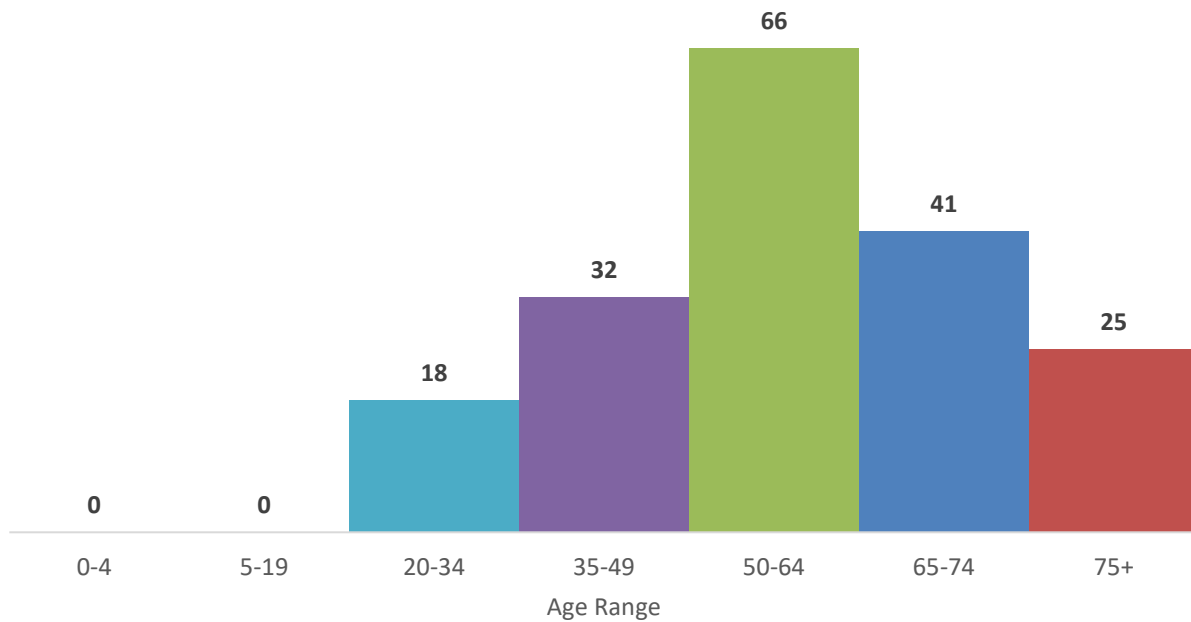


Graph 8. The largest proportion of deaths in males occurred in those under 65, while the largest proportion of deaths in females occurred in those over 65.

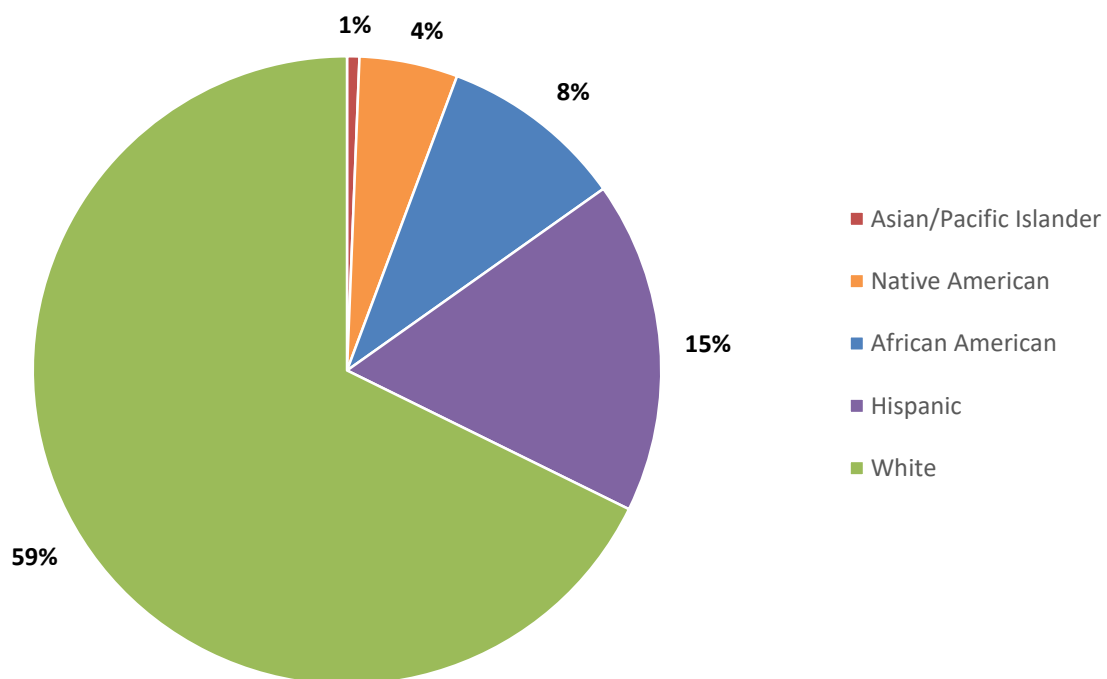


* Indicates suppressed value of ≤ 5 .

Graph 9. Seventy-three percent of heat-associated deaths were among those 50 and older. (N=132)



Graph 10. Fifty-nine percent of heat-associated deaths for which race and ethnicity are known occurred among whites. (N=107)



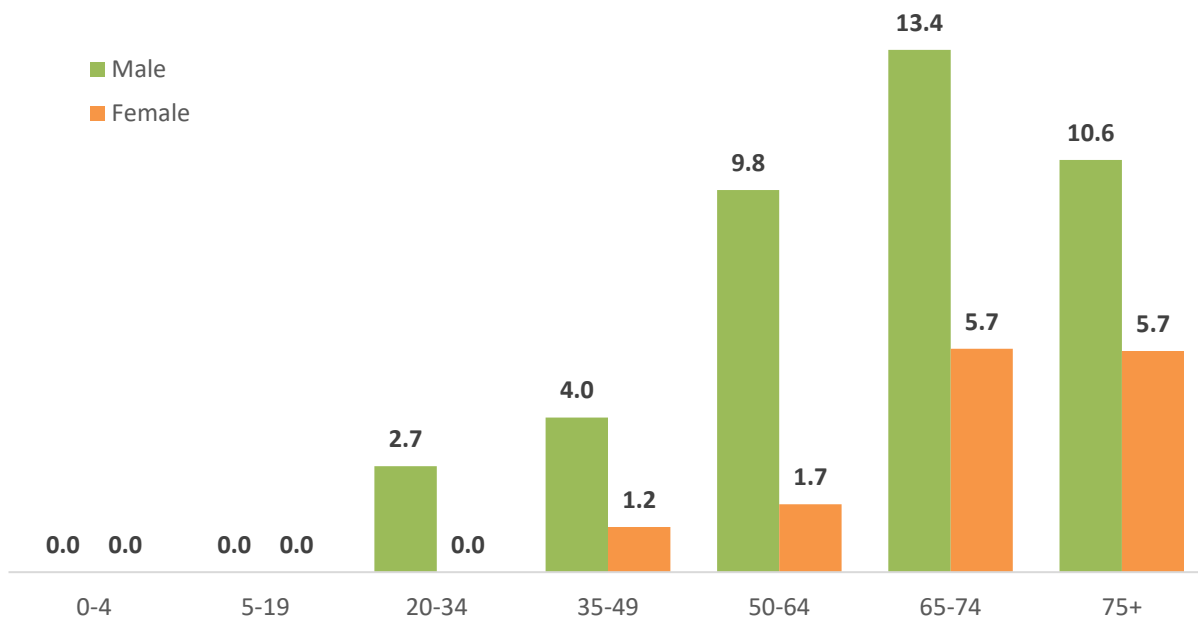
Heat-Associated Death Rates*

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

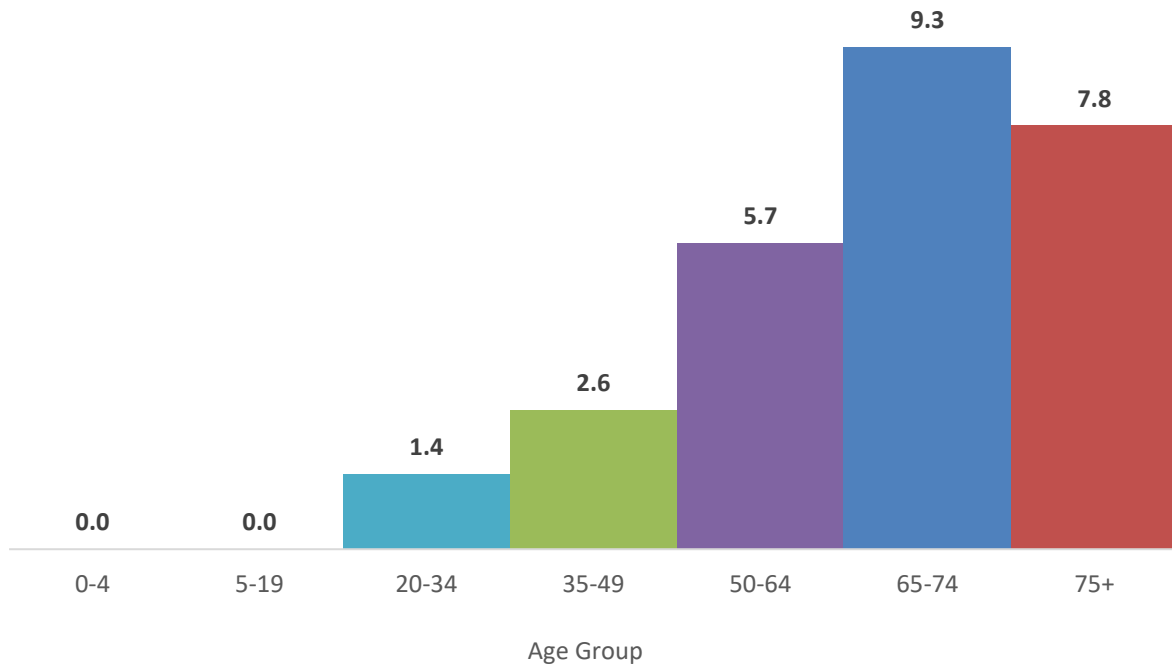
Graph 11. The heat-associated death rate for males was more than three times greater than the rate for females.



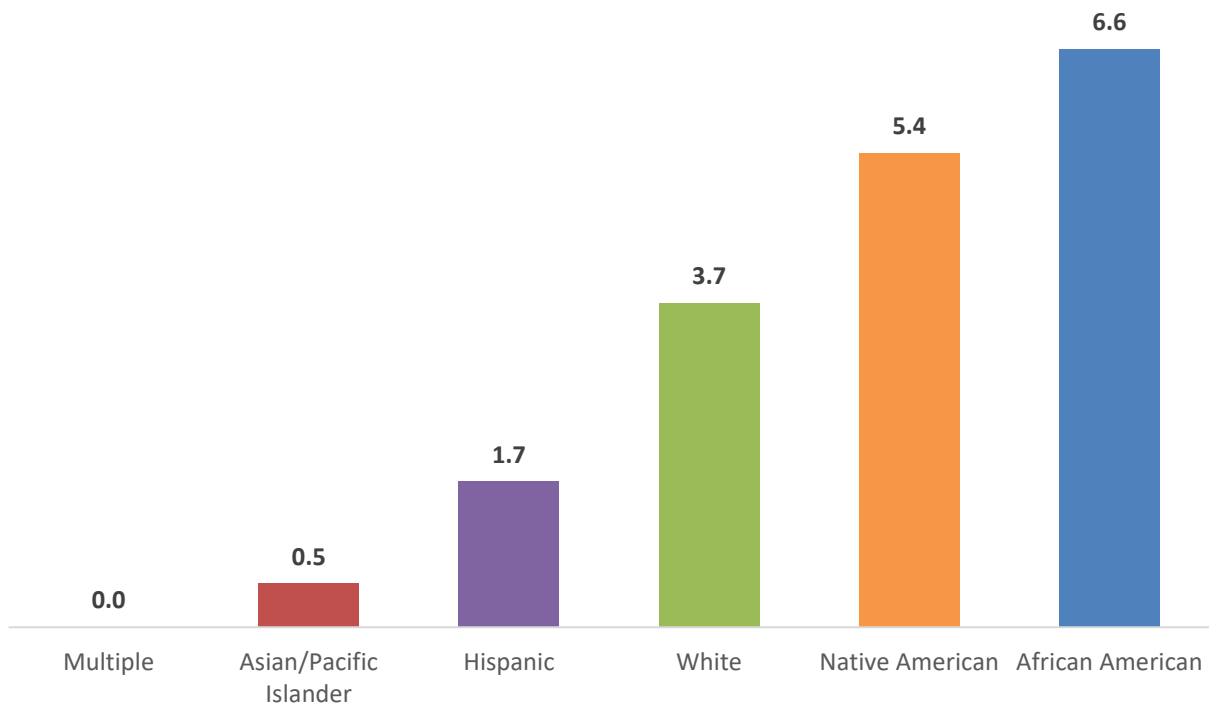
Graph 12. For both male and female residents, the heat-associated death rate was highest in those over the age of 65.



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

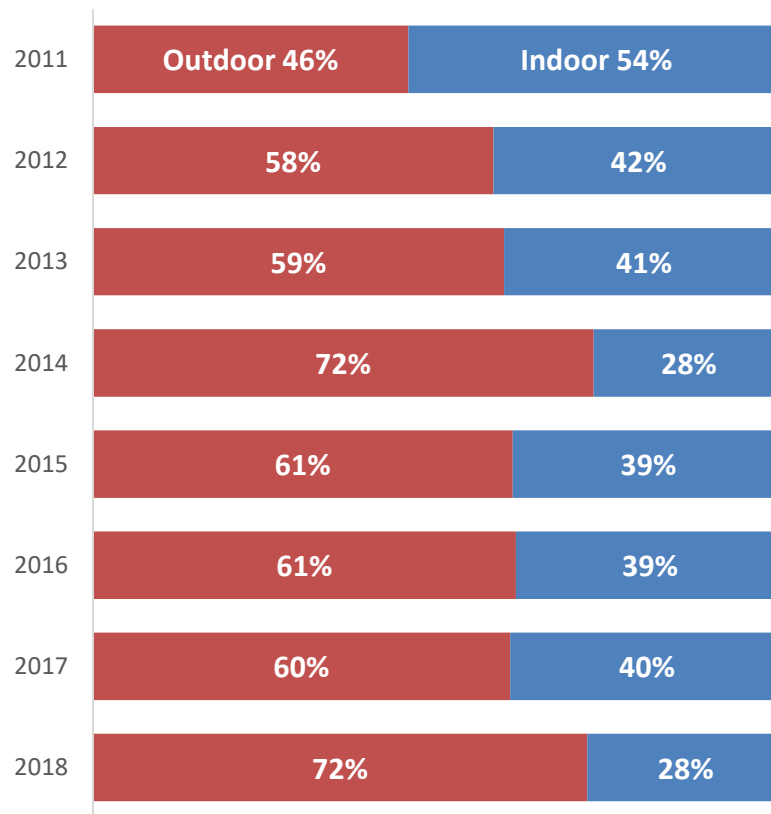


Graph 14. African Americans and Native Americans had the highest rates of heat-associated deaths per 100,000 residents.

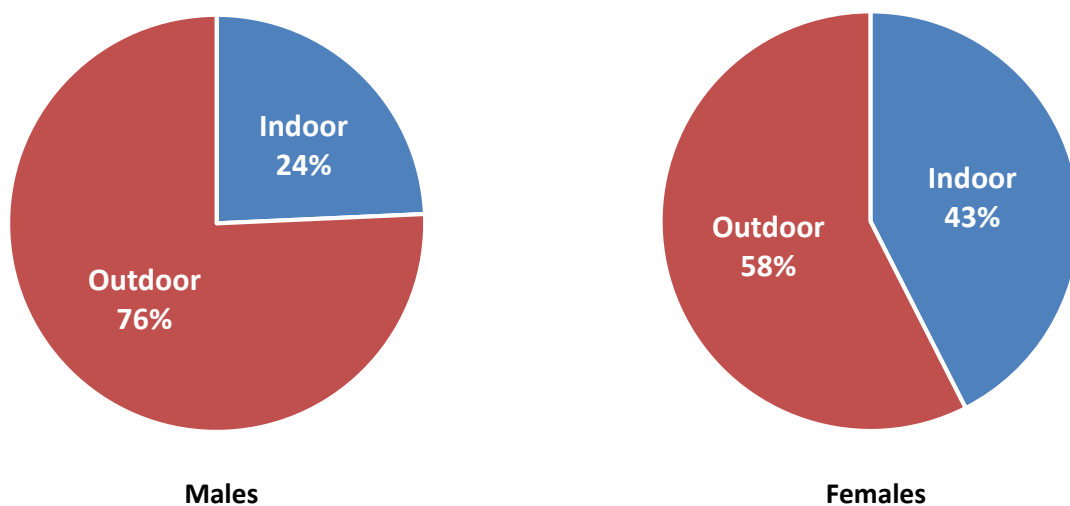


Heat-Associated Deaths by Place of Injury

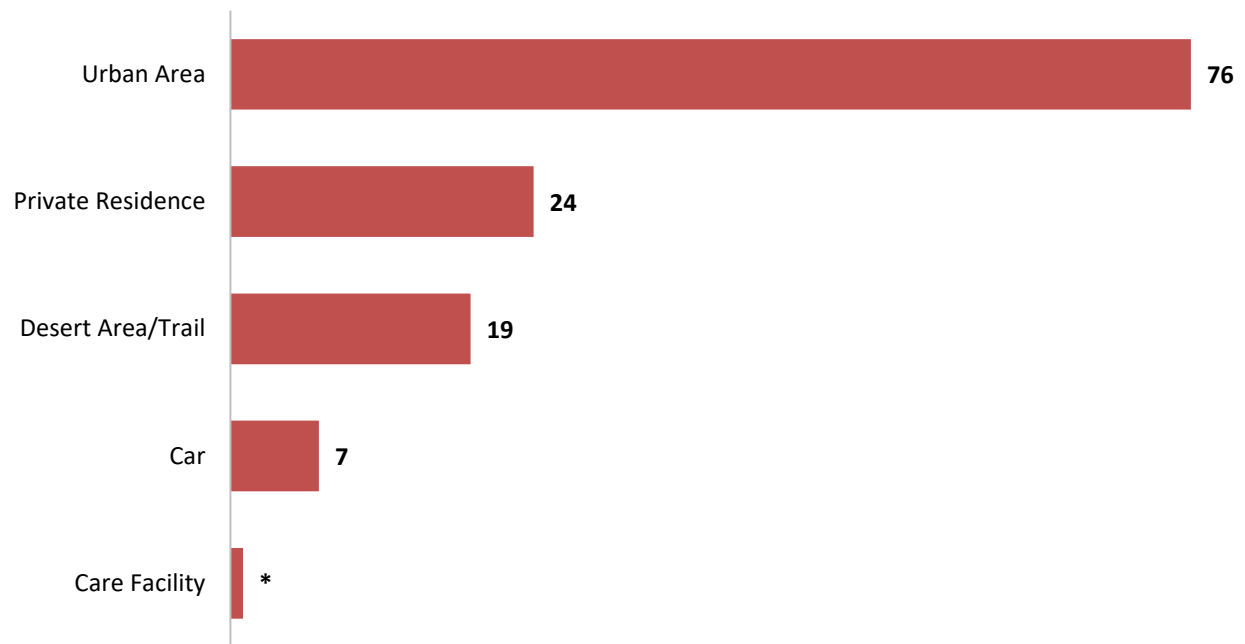
Graph 15. A lower proportion of deaths occurred indoors than in previous years.



Graph 16. A higher proportion of male deaths than female deaths occurred outdoors.

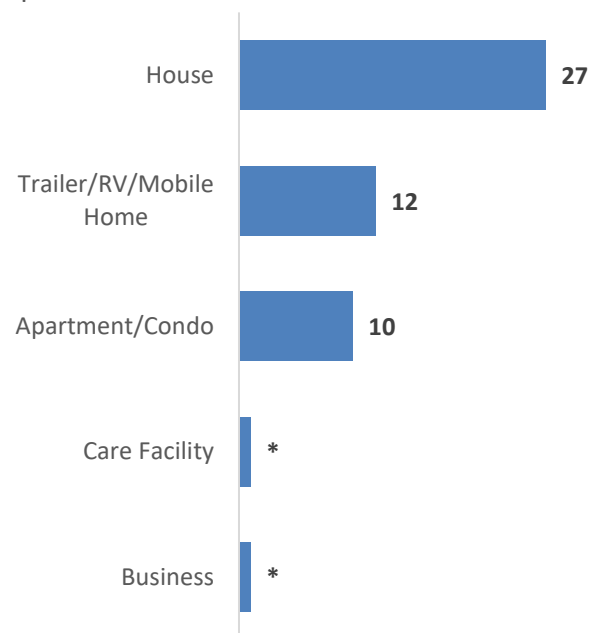


Graph 17. Sixty percent of outdoor deaths with a known location of injury occurred in an urban area.



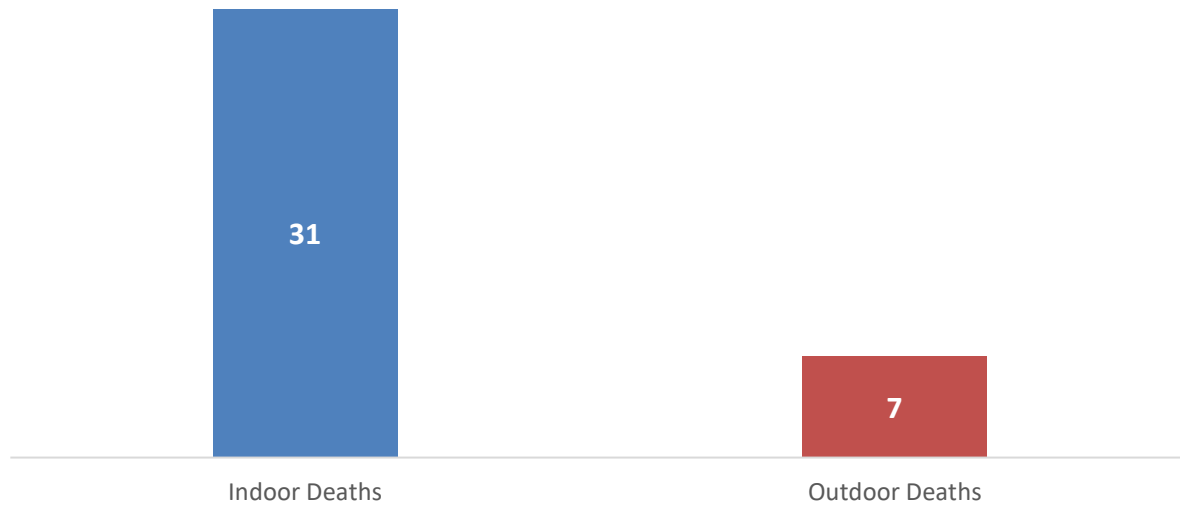
* Indicates suppressed value of ≤ 5 .

Graph 18. Seventy-three percent of indoor deaths occurred in a house or apartment.



* Indicates suppressed value of ≤ 5 .

Graph 19. Sixty-three percent of indoor deaths were discovered during a welfare check, compared to just seven percent of outdoor deaths.*

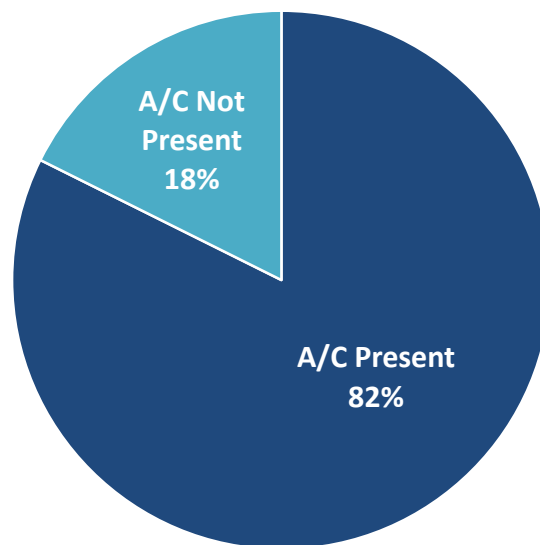


*Excludes forty cases for which welfare check status was not reported and one case for which place of injury is unknown.

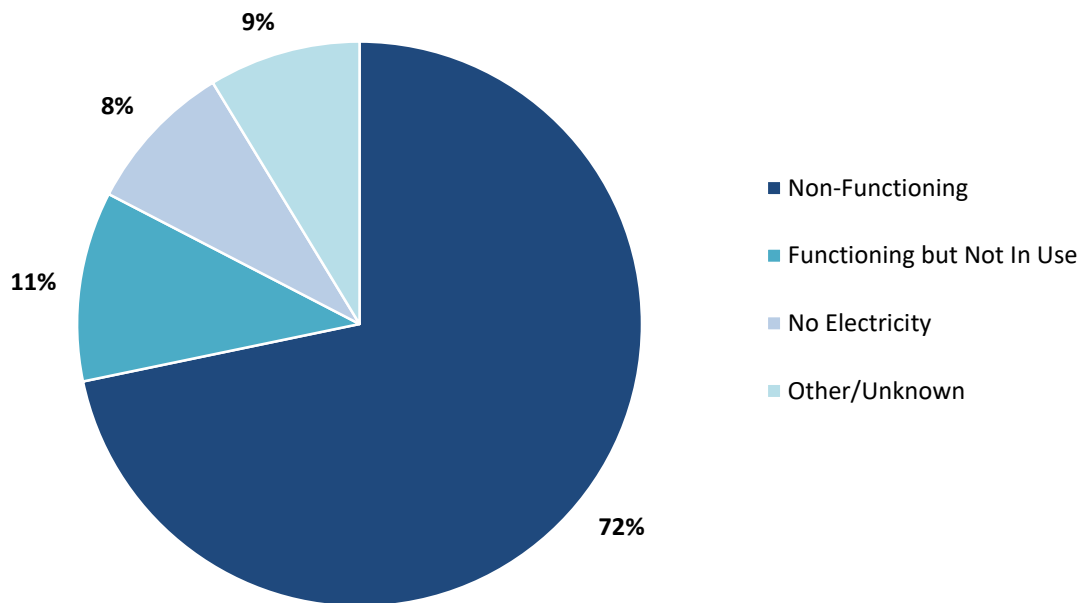
Air Conditioning Use for Indoor Deaths*

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

Graph 20. Eighty-two percent of indoor deaths had an air conditioning unit present at time of death. (N=42)

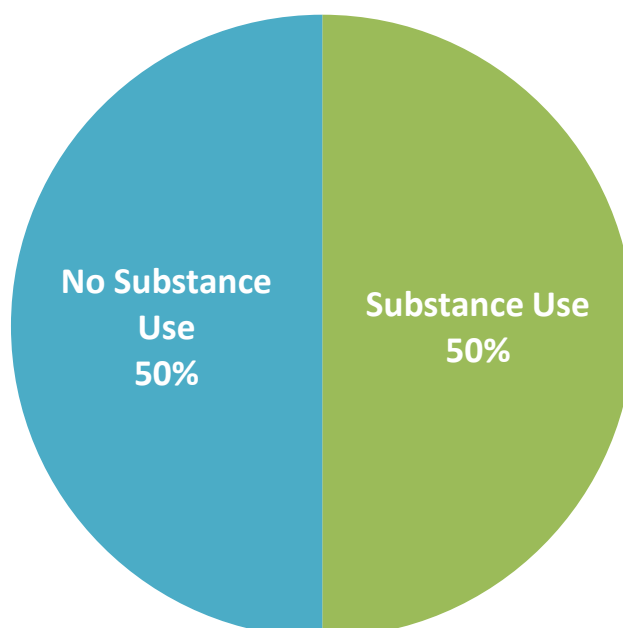


Graph 21. Among deaths where an A/C unit was present, a non-functioning A/C unit was the most common reason for not having a cooled environment at the time of death.

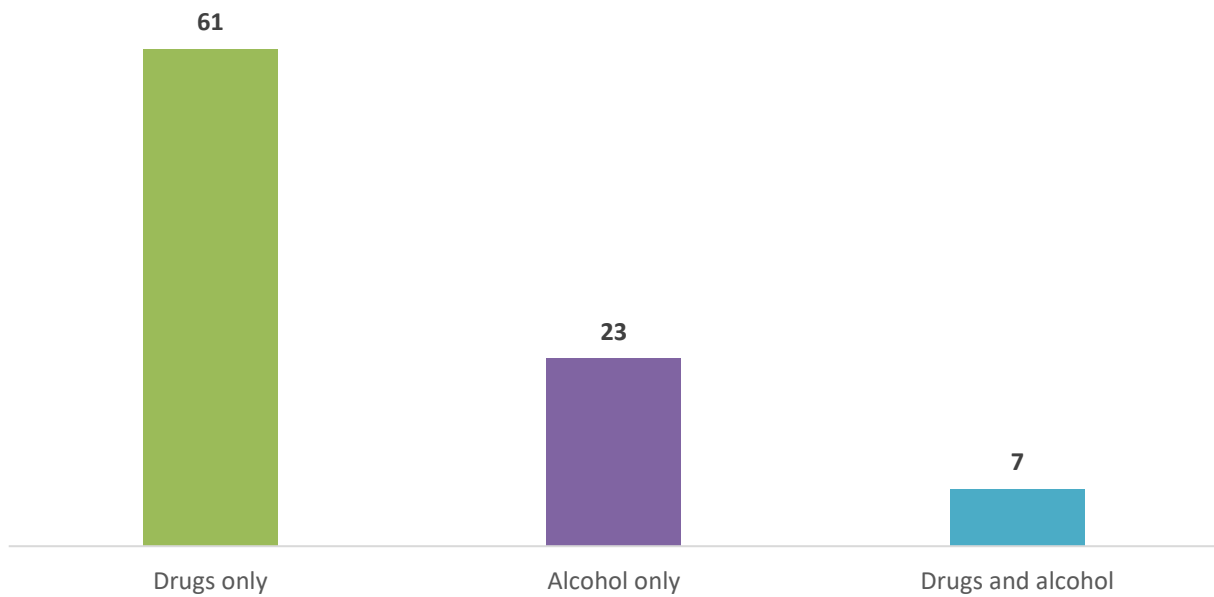


Substance Use among Heat-Associated Deaths

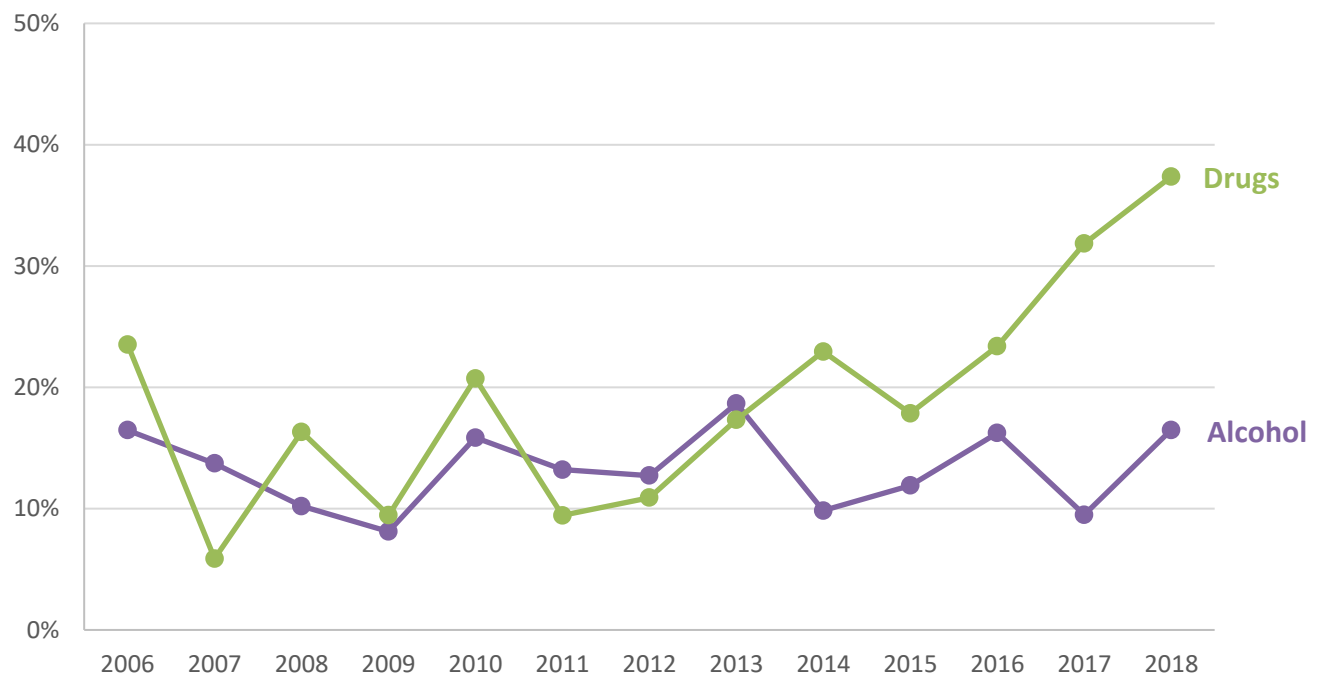
Graph 22. Half of all cases involved substance use as a cause of death or a contributing factor. (N=91)



Graph 23. In thirty-seven percent of cases, drug use was listed as either cause of death or a contributing factor. (N=68)



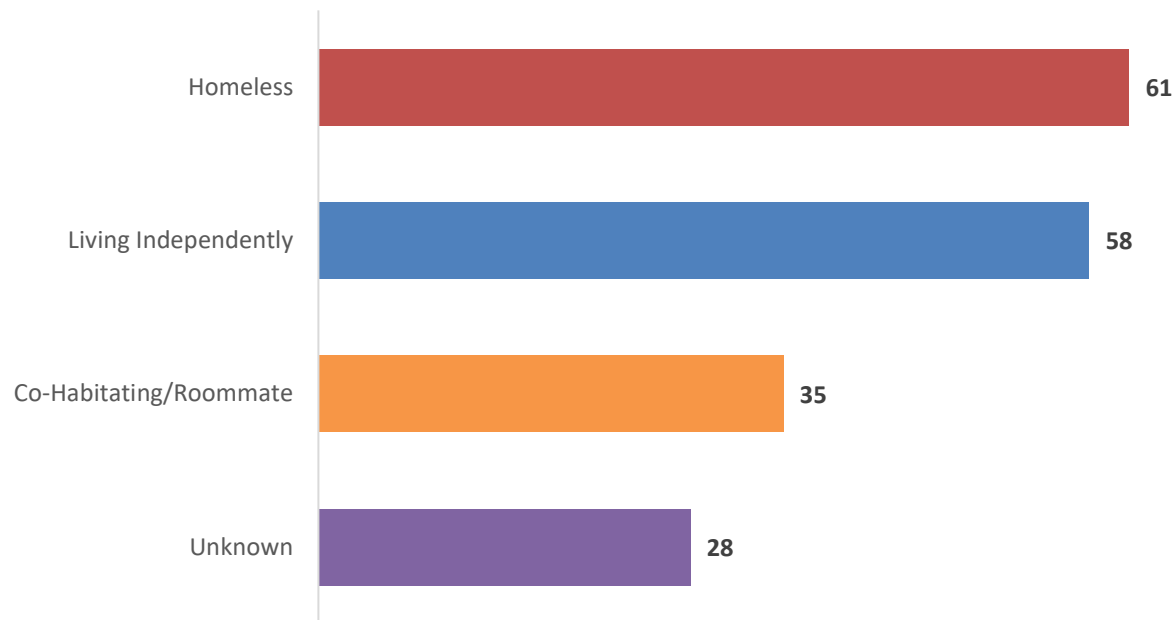
Graph 24. The proportion of heat-associated deaths involving drug use increased seventeen percent from the previous year.*



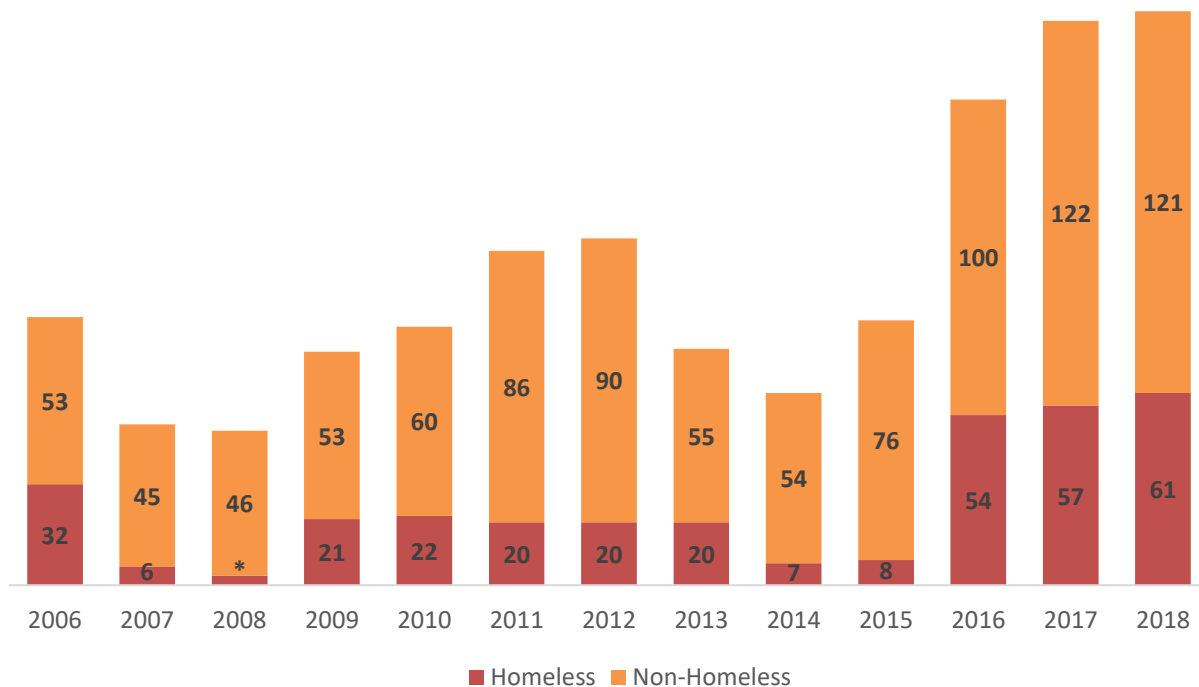
*Cases involving both drug and alcohol use are represented uniquely on each line.

Living Situation among Heat-Associated Deaths

Graph 25. Thirty-four 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.



* Indicates suppressed value of ≤ 5 .

Conclusions

- There was only a 1% increase in heat-associated deaths between 2017 and 2018.
- Seven excessive heat warnings were issued in 2018, and ranged in duration from 1 to 3 days. On those days, 23% of all heat-associated deaths occurred.
- For the first time on record, more heat deaths occurred in September than in June.
- 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, African Americans, Native Americans, and those 65 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 82% 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 18% of indoor cases did not have an A/C unit present.
- Drugs or alcohol were mentioned on the death certificate in half of all cases.
- Individuals experiencing homelessness accounted for 34% of heat-associated deaths.
- The average years of life lost for those with heat-related deaths was 23 years, with a median age at death of 60 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 I¹** 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 II²** 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, 2006-2018

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%)
2018	242	182 (75%)	60 (25%)	0 (0%)
TOTAL	1,549	931 (60%)	617 (40%)	0 (0%)

Table B. Heat-Associated Deaths by Gender and Age Group, Maricopa County, 2018

AGE GROUP	MALE CASES (%)	FEMALE CASES (%)	TOTAL CASES (%)
0-4	0 (0%)	0 (0%)	0 (0%)
5-19	0 (0%)	0 (0%)	0 (0%)
20-34	17 (9%)	*	*
35-49	27 (15%)	*	*
50-64	56 (31%)	10 (5%)	66 (36%)
65-74	27 (15%)	14 (8%)	41 (23%)
75+	14 (8%)	11 (6%)	25 (14%)
TOTAL	141 (100%)	41 (100%)	182 (100%)

* Indicates suppressed value of ≤ 5 or a value that would facilitate calculation of a suppressed value.

Table C. Heat-Associated Deaths Rates per 100,000 Residents** by Gender and Age Group, Maricopa County, 2018

AGE GROUP	MALE RATE (N)	FEMALE RATE (N)	TOTAL RATE (N)
0-4	0.0 (0)	0.0 (0)	0.0 (0)
5-19	0.0 (0)	0.0 (0)	0.0 (0)
20-34	2.7 (13)	0.0 (0)	1.4 (13)
35-49	4.0 (17)	1.2 (*)	2.6 (*)
50-64	9.8 (37)	1.7 (7)	5.7 (44)
65-74	13.4 (24)	5.7 (12)	9.3 (36)
75+	10.6 (13)	5.7 (9)	7.8 (22)
TOTAL	4.8 (104)	1.5 (*)	3.1 (137)

* Indicates suppressed value of ≤ 5 or a value that would facilitate calculation of a suppressed value.

**Based on 2018 census population estimates for Maricopa County. Forty-five cases that were not Maricopa County residents or had an unknown county of residence excluded.

Table D. Heat-Associated Deaths Rates per 100,000 Residents** by Age Group and Race/Ethnicity, Maricopa County, 2018

RACE/ETHNICITY	AGE GROUP RATE (N)							TOTAL
	0-4	5-19	20-34	35-49	50-64	65-74	75+	
WHITE	0.0 (0)	0.0 (0)	0.7 (*)	3.7 (17)	5.6 (29)	7.9 (24)	7.2 (17)	3.7 (90)
HISPANIC	0.0 (0)	0.0 (0)	1.5 (*)	1.1 (*)	4.7 (8)	10.0 (*)	7.5 (*)	1.7 (23)
BLACK	0.0 (0)	0.0 (0)	5.0 (*)	4.1 (*)	12.9 (*)	21.3 (*)	13.5 (*)	5.8 (14)
ASIAN/PACIFIC ISLANDER	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	13.0 (*)	0.5 (1)
NATIVE AMERICAN	0.0 (0)	0.0 (0)	9.5 (*)	0.0 (0)	9.9 (*)	31.3 (*)	0.0 (0)	5.4 (*)
MULTIPLE	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
TOTAL	0.0 (0)	0.0 (0)	1.4 (13)	2.6 (22)	5.7 (44)	9.3 (36)	7.8 (22)	3.1 (137)

* Indicates suppressed value of ≤ 5 or a value that would facilitate calculation of a suppressed value.

**Based on 2018 census population estimates for Maricopa County. Forty-five cases that were not Maricopa County residents or had an unknown county of residence excluded. Total includes five cases with unknown race/ethnicity.

Table E. Heat-Associated Deaths Rates per 100,000 Residents** by Gender and Race/Ethnicity, Maricopa County, 2018

RACE/ETHNICITY	MALE RATE (N)	FEMALE RATE (N)	TOTAL RATE (N)
White	5.4 (64)	2.1 (26)	3.7 (90)
Hispanic	3.0 (21)	0.3 (*)	1.7 (23)
Black	4.9 (6)	2.5 (*)	3.7 (9)
Asian/Pacific Islander	1.1 (*)	0.0 (0)	0.5 (*)
Native American	23.1 (8)	0.0 (0)	10.9 (8)
Multiple	4.2 (*)	0.0 (0)	2.1 (*)
TOTAL	4.8 (104)	1.5 (33)	3.1 (137)

* Indicates suppressed value of ≤ 5 or a value that would facilitate calculation of a suppressed value.

**Based on 2018 census population estimates for Maricopa County. Forty-five cases that were not Maricopa County residents or had an unknown county of residence excluded. Total includes five cases with unknown race/ethnicity.

Table F. Indoor Heat-Associated Deaths* by Place of Injury and Age Group, Maricopa County, 2018

AGE GROUP	PLACE OF INJURY TYPE					TOTAL
	HOUSE	APARTMENT	TRAILER/RV/ MOBILE HOME	BUSINESS	CARE FACILITY	
0-4	0%	0%	0%	0%	0%	0%
5-19	0%	0%	0%	0%	0%	0%
20-34	0%	4%	2%	0%	0%	6%
35-49	0%	2%	2%	0%	0%	4%
50-64	16%	4%	8%	0%	0%	27%
65-74	27%	8%	8%	2%	2%	47%
75+	10%	2%	4%	0%	0%	16%
TOTAL	53%	20%	24%	2%	2%	100%

Table G. Outdoor Heat-Associated Deaths* by Place of Injury and Age Group, Maricopa County, 2018

AGE GROUP	PLACE OF INJURY TYPE					TOTAL
	CAR	DESERT AREA	RESIDENCE	URBAN AREA	CARE FACILITY	
0-4	0%	0%	0%	0%	0%	0%
5-19	0%	0%	0%	0%	0%	0%
20-34	1%	4%	2%	6%	0%	12%
35-49	2%	5%	2%	15%	0%	23%
50-64	0%	4%	2%	33%	0%	39%
65-74	2%	1%	5%	6%	0%	13%
75+	2%	2%	9%	0%	1%	13%
TOTAL	6%	15%	19%	60%	1%	100%

*Two cases with unknown place of injury excluded from analysis. Outdoor total excludes two outdoor cases with unknown location type.

Table H. Heat-Associated Deaths* by Place of Injury, Age Group, and Gender, Maricopa County, 2018

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	6%	0%	6%	11%	<1%	12%
35-49	4%	0%	4%	19%	3%	22%
50-64	20%	8%	27%	35%	5%	40%
65-74	29%	18%	47%	9%	4%	13%
75+	8%	8%	16%	8%	5%	13%
TOTAL	67%	33%	100%	82%	18%	100%

*Total excludes two cases with unknown place of injury.

Table I. Indoor Heat-Associated Deaths by Presence of an Air Conditioning (A/C) Unit and Age Group, Maricopa County, 2018

AGE GROUP	AC UNIT PRESENT (%)	AC UNIT NOT PRESENT OR UNKNOWN (%)	TOTAL
0-4	0%	0%	0%
5-19	0%	0%	0%
20-34	4%	2%	6%
35-49	4%	0%	4%
50-64	22%	6%	27%
65-74	39%	8%	47%
75+	14%	2%	16%
TOTAL	82%	18%	100%

Table J. Indoor Heat-Associated Deaths with AC Unit Present by Air Conditioning (A/C) Status and Age Group, Maricopa County, 2018

A/C STATUS (%)						
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%	4%	2%	0%	0%	7%
35-49	0%	4%	0%	0%	0%	4%
50-64	2%	17%	2%	0%	2%	24%
65-74	7%	35%	4%	0%	2%	48%
75+	0%	11%	2%	2%	2%	17%
TOTAL	9%	72%	11%	2%	7%	100%

Table K. Heat-Associated Deaths by Substance Use at Time of Death, Maricopa County, 2018

SUBSTANCE USE (%)					
AGE GROUP	ALCOHOL	DRUG	BOTH	NEITHER	TOTAL
0-4	0%	0%	0%	0%	0%
5-19	0%	0%	0%	0%	0%
20-34	2%	5%	2%	1%	10%
35-49	3%	11%	<1%	3%	18%
50-64	5%	16%	<1%	15%	36%
65-74	2%	2%	<1%	18%	23%
75+	1%	0%	0%	13%	14%
TOTAL	13%	34%	4%	50%	100%

Table L. Heat-Associated Deaths among Homeless Individuals, Maricopa County, 2018

AGE GROUP	MALE	FEMALE	TOTAL
0-4	0%	0%	0%
5-19	0%	0%	0%
20-34	8%	2%	10%
35-49	25%	5%	30%
50-64	43%	7%	49%
65-74	11%	0%	11%
75+	0%	0%	0%
TOTAL	87%	13%	61%

Table M. Heat-Associated Deaths by Education Level, Maricopa County, 2018

EDUCATION	CASES (%)
8th grade or less	12 (7%)
9th through 12th grade; no diploma	18 (10%)
High school graduate or GED completed	51 (28%)
Some college credit, but no degree	24 (13%)
Associate degree (e.g.AA,AS)	15 (8%)
Bachelor's degree (e.g.BA,BS)	17 (9%)
Master's degree (e.g.MA,MS,MEng,MEd,MSW,MBA)	6 (3%)
Doctorate (e.g.PhD,EdD) or Professional degree (e.g.MD,DDS,DVM,LLB,JD)	0 (0%)
Unknown	39 (21%)
TOTAL	182 (100%)