Hotspotting Emergency Medical Service Calls for Heat Stroke

THE UNIVERSITY OF ARIZONA College of Medicine Phoenix
Valleywise Health You're more to us.

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Introduction

- Heat is the deadliest weather phenomenon in the United States, with up trending heat-related mortality from 1999-2023 and a staggering 645 heat related deaths in Maricopa county in 2023.
- Extreme heat events increase Emergency Medical Service (EMS) demand, with heat-related illness disproportionately affecting populations based personal risk including male sex, elderly individuals, people experiencing homelessness, substance use, cardiopulmonary disease, mental illness and other comorbidities coupled with broader demographic, and built environment factors.
- EMS dispatch data, combined with census tract-level information, can identify high-risk areas and guide targeted public health interventions and resource allocation such as cooling/ and heat-relief centers.

Research Question

How can the spatial distribution of EMS transports to a single health system for heat stroke help us to recognize vulnerable locations and communities and inform the distribution of public health resources?

Methods

Study Design: Retrospective review of adult EMS transports for heat stroke (≥40°C +AMS) to a single urban medical center in the American Southwest between June 1st and August 31st of 2023.

Data Collection:
- Clinical data chart review and summary by three EM physicians.

- Community data summarized from public sources: Census Tract Reporter and Maricopa County 2023 heat-relief dataset

Results and Analysis

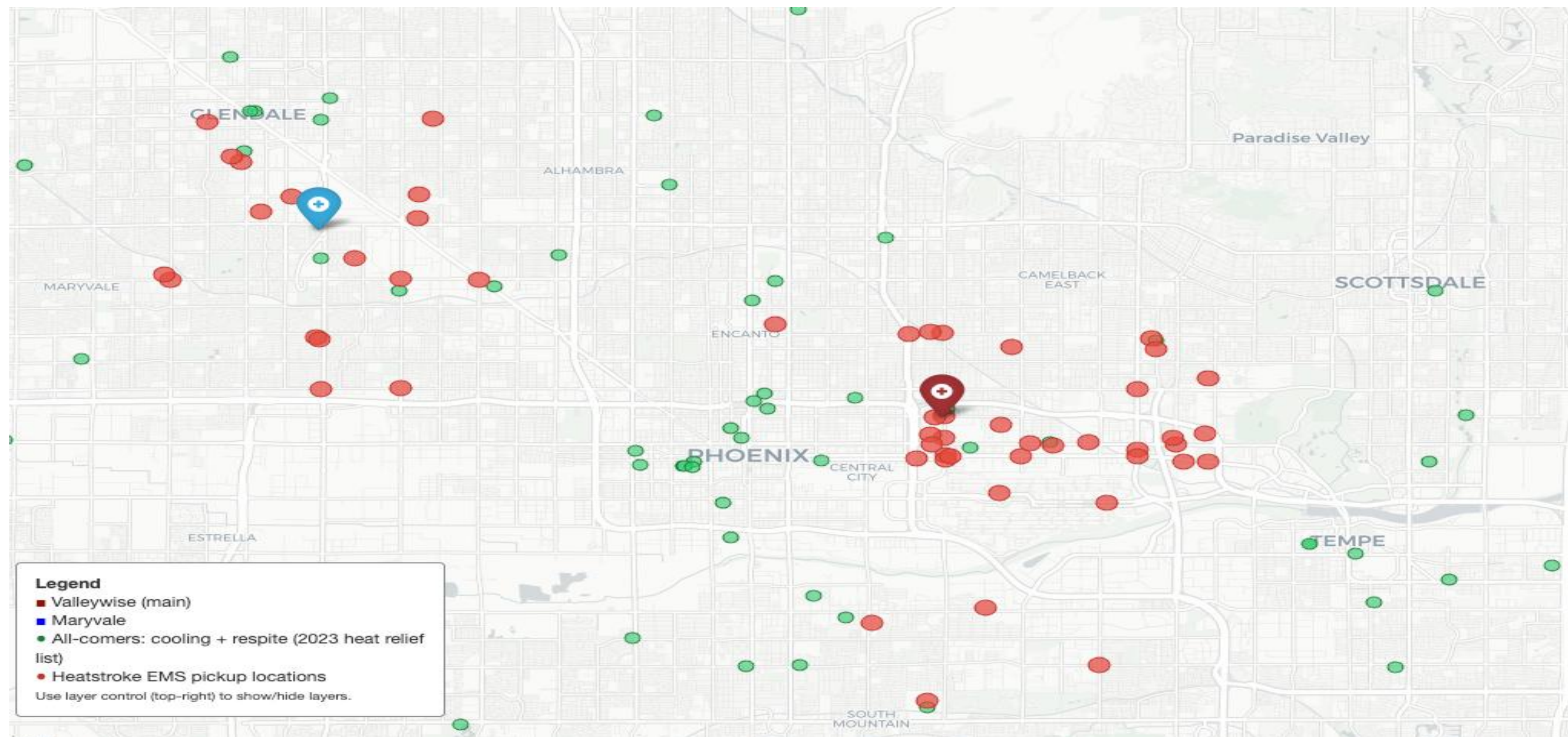

Figure 1: Map of Maricopa County area heat-relief resources and heat stroke incidents reported via EMS.. Red circles: Incident pickup locations. Green circles: Publicly listed cooling and respite centers. Red marker: Valleywise Roosevelt campus and blue marker: Maryvale campus.

Analysis

Geospatial Analysis:
Conducted using Geographic Information Systems (GIS) and Python (pandas, numpy, folium)
EMS incident coordinates used to calculate distance to:
- Cooling/respite centers
- Public transit stations

Great-circle distances computed using Haversine formula

Spatial Clustering:
Radius-based grouping (0.25, 0.5, 1.0 miles)
Connected-component labeling used to define clusters

Qualitative Analysis:
Thematic analysis of EMS run sheets to characterize:
- Patient pickup locations
- Environmental context (e.g., structures, surroundings)
- Circumstances leading to EMS activation

Results

We identified 54 cases of heat stroke transported via EMS, among those 77.8% were male, with mean age of 46.6%, 61.1% unsheltered, 63% had a positive drug screen and 79.6% patients not clearly discernable as classical or exertional heat stroke types.

Location	Mean (miles)	Median (miles)	Min (miles)	Max (miles)
Cooling/ Respite Center	0.96	0.94	0.07	2.34
Transit Center	1.00	0.07	0.01	0.43

Table 1: Distance in miles from incident pickup location to the nearest Cooling Center or Respite Center and distance in miles from incident pickup location to the nearest Transit Center.

- Most EMS pickups occurred outdoors and in public spaces, primarily streets (63.0%), with fewer at private residences (16.6%) and businesses (14.8%). Environmental context was often variably documented.
- Peak transport times were during the hottest afternoon hours (48.1% between 1100–1700; 38.8% between 1700–2300).
- Heat stroke cases demonstrated significant spatial clustering, with 83.3% occurring within 1-mile clusters . Incidents were frequently located near transit areas (61.1%) and public right-of-way settings (72.2%), often within ~1 mile of cooling centers and <0.1 miles from transit stops.
- EMS pickups were concentrated in three census tracts (1138, 1133.01, 1113), which showed marked socioeconomic heterogeneity ranging from relatively high income and education levels (1138, 1113) to significant socioeconomic disadvantage (1133.01). The highest-frequency tract (1138) is adjacent to the Roosevelt corridor and major referral centers

Conclusions

Prehospital heat stroke cases show clear geographic clustering in outdoor, high-exposure environments, highlighting the intersection of built environment and social vulnerability, as well as the need for targeted, data-driven interventions. Despite proximity to cooling resources and transportation, gaps in access and utilization persist. We offer this descriptive and thematic analysis to inform strategies for risk reduction in patients that are vulnerable to heat illness and heat stroke along with the strategies that inform allocation and spatial organization of resources for prevention.

Limitations include EMS report data as the primary data source, which were limited by variable documentation quality in emergent settings, with inconsistent detail on environmental context (e.g., indoor vs. outdoor, housed vs. unsheltered). Additionally, this was a single county, single health system design which limits external validity and generalizability to other regions and populations.

Summary

- Heat stroke EMS transports (n=54) were concentrated in outdoor, public settings and peaked during the hottest afternoon hours.
- Cases showed significant geographic clustering within a small number of census tracts, particularly in dense urban areas near transit corridors.
- Patterns suggest gaps in access or utilization

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References

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