

# Climate change and operational impacts on the emergency department

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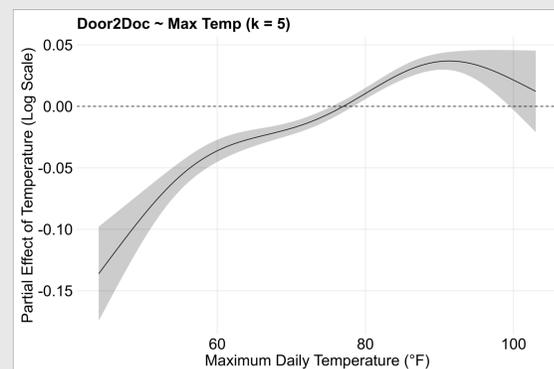
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## INTRODUCTION

- Extreme heat is becoming more frequent, prolonged, and extreme throughout the US.
- Heat increases **all-cause mortality**, rates of death from **cardiovascular** and **respiratory diseases**, **mental health** issues, accidental and non-accidental **trauma**.
- There is a relationship between higher temperatures and **increased overall emergency department utilization**.
- *Gap in knowledge:* Few studies have looked at how temperature affect important ED operational metrics.

## CASE STUDY 1

Does temperature influence **ED operational metrics**?

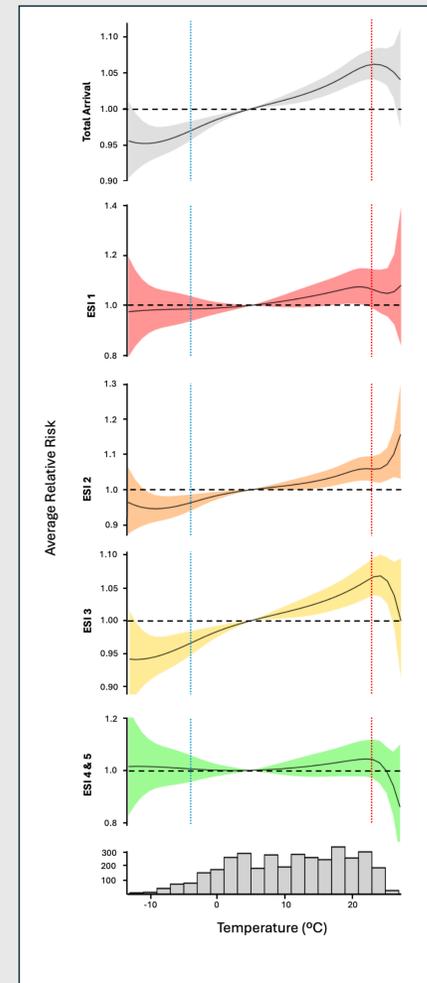


- Records for **484,282 ED visits** occurring during May through September, from 2002 to 2023.
- Main outcome: **total length of stay (LOS), door-to-doc time, doc-to-decision time, and boarding time**
- Nonlinear relationship assessed using **generalized additive models (GAMs) with Gamma distributions and log links**
- Analysis was controlled for age, sex, ESI acuity, imaging utilization, consults, day of week, month, and year.
- Statistically significant association observed between  $T_{max}$  and both total **ED length of stay (LOS)** ( $p = 0.033$ ) and **door-to-doc time** ( $p < 0.001$ )

## CASE STUDY 2

Does temperature affect the distribution of **patient acuity**?

- Time-series records for **556,663 daily ED arrivals** stratified by **Emergency Severity Index (ESI)** from 2010 to 2019.
- Main exposure: **wet-bulb temperature**.
- **Poisson model** fitted for each ESI category and **distributed lag non-linear model** applied with 3 days of lag.
- Analysis was controlled for precipitation, snow, wind speed, day of week, and Federal Holidays



**Figure 2.** Relative risk of ED presentation in relation to daily maximum temperature at lag 0, stratified by ESI category.

- At higher temperatures, ESI 2, ESI 3, and total arrivals showed an increased relative risk of arrival.
- While not statistically significant, ESI 1 arrivals increased slightly at the highest temperatures, while ESI 4 and 5 showed a small drop in risk during these times.

## DISCUSSION

**ED acuity:** Most of the temperature-responsiveness of ED arrivals was in medium- to high-acuity cases (ESI 2 and 3). Arrivals increased with temperature, even at temperatures well below the threshold typically associated with heat related illness

**Operations:** While the time-based operational impacts observed were modest, their cumulative effect across large volumes of patients and repeated hot days may be substantial, particularly in less-resourced settings.

## CONCLUSION

Warmer temperatures are associated with higher acuity arrivals as well as delays in ED throughput.

Understanding the impact of extreme heat on ED arrivals and healthcare utilization is crucial for development of data-informed climate change adaptation and preparedness strategies.

## REFERENCES

- Liu J, Varghese BM, Hansen A, et al. Heat exposure and cardiovascular health outcomes: a systematic review and meta-analysis. *Lancet Planet Health.* 2022;6(6):e484-e495.
- Nori-Sarma A, Sun S, Sun Y, et al. Association Between Ambient Heat and Risk of Emergency Department Visits for Mental Health Among US Adults, 2010 to 2019. *JAMA Psychiatry.* 2022;79(4):341-349.
- Otte im Kampe E, Kovats S, Hajat S. Impact of high ambient temperature on unintentional injuries in high-income countries: a narrative systematic literature review. *BMJ Open.* 2016;6(2):e010399.
- Sun S, Weinberger KR, Nori-Sarma A, et al. Ambient heat and risks of emergency department visits among adults in the United States: time stratified case crossover study. *BMJ.* 2021;375:e065653.
- Basu R, Pearson D, Malig B, et al. The effect of high ambient temperature on emergency room visits. *Epidemiology.* 2012;23(6):813-20.