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## Supplemental Material

# A Case-Crossover Analysis of Indoor Heat Exposure on Mortality and Hospitalizations among the Elderly in Houston, Texas

Cassandra R. O'Lenick, Amir Baniassadi, Ryan Michael, Andrew Monaghan, Jennifer Boehnert, Xiao Yu, Mary H. Hayden, Christine Wiedinmyer, Kai Zhang, Peter J. Crank, Jannik Heusinger, Paige Hoel, David J. Sailor, and Olga V. Wilhelmi

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**Figure S6.** Spearman correlations ($\varrho$) between daily maximum indoor Discomfort Index (°C) and daily maximum outdoor temperature (°C), June-September (2000-2015). Spearman correlations were not estimable in Census Block Groups (CBG) that reported 100% prevalence of central air conditioning (gray areas). Hatch-marked areas represent the 106 Census Block Groups (CBG) excluded from this study. For mapping purposes, Spearman Correlations were categorized by the following percentiles based on the distribution of correlation values: 0-25$^{th}$ percentile (0.55 to $\leq$0.71); 25$^{th}$-75$^{th}$ percentile (>0.71 to $\leq$0.74); and 75$^{th}$-100$^{th}$ percentile (>0.74 to 0.76).

**Figure S7.** Estimated odds ratios (OR) and 95% CIs between 3-day moving averages of maximum temperature and health outcomes stratified by individual and neighborhood factors for City of Houston residents (June-Sept, 2000-2015). Odds Ratios were derived from single-exposure, time-stratified case-crossover models (conditional logistic regression), that matched on census block group of subject residence, year, month, and weekday of the adverse health event. Models controlled for maximum ambient temperature, and maximum ambient dew point temperature (°C) with cubic polynomials, Federal holidays, day of the warm season, modeled as a smooth function with monthly knots across the summer season (June-September). An interaction term between year and day of the warm season was also included to capture between-year differences. Mortality data were available 2000-2015; EHA data were available 2004-2013. Abbreviations: CI: Confidence Interval; CIRC: circulatory diagnoses; DI: Discomfort Index; EHA: emergency hospital admissions; HEAT: heat-related diagnoses; min: minimum; OR: odds ratio. "% below poverty" represents Census block group percentage of households living below the Federal poverty line. "% African American" represents census block group percentage of the population that identifies as African American. "% live alone" represents the census block group percentage of the 65 and older population living alone. See Table S8 for corresponding numeric data (ORs and 95% CIs).

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**Figure S9.** Directed Acyclic Graphs (DAG) indicating (A) assumed relationships between ambient temperature, ambient ozone and health, and (B) assumed relationships between ambient temperature, indoor temperature, ambient ozone, indoor ozone and health. DAGs were adapted from concepts introduced by Reid et al. (2012) and Buckley et al. (2014). (Buckley et al. 2014; Reid et al. 2012).

**REFERENCES**

Table S1. Envelope properties of archetype buildings

| Envelope properties of archetypes | Building Quality (as described in HCAD database [a]) | | |
|---|---|---|---|
| | High | Medium | Low |
| Exterior wall insulation R-value (K. m²/W) [b] | 2 | 1.5 | 1 |
| Ceiling Insulation R-value (K. m²/W) [b] | 6 | 4 | 3 |
| Nominal air exchange rate (ACH) [c] | 0.4 | 0.9 | 1.4 |
| Window U-value (W/K. m²) [d] | 3 | 5 | 5 |
| Window Solar heat gain coefficient [e] | 0.25 | 0.4 | 0.4 |

Abbreviations: ACH: Air Change per Hour; HCAD: Harris County Appraisal District; K: Kelvin; m: meter; W: Watt
Note: Building envelop properties determine to what degree the indoor space is thermally isolated from outdoors. Envelope properties of archetypes were selected based on the descriptive quality of buildings reported in the 2017 Harris County Appraisal District (HCAD) Real & Personal Property Database. Descriptive qualities were converted to numerical values for different building properties and numerical values were informed by envelope properties reported in different versions of International Energy Conservation Code (IECC) for residential buildings in ASHRAE.
[a] 2017 Harris County Appraisal District Real & Personal Property Database
[b] Wall/Ceiling R-value is the thermal resistance per unit area of wall/ceiling
[c] The nominal air exchange rate is direct input to Energyplus, and is modified by the model based on indoor-outdoor temperature difference and wind velocity at each simulation time step. Air exchange rate values were informed by values reported by Yamamoto et al. (Yamamoto et al. 2010)
[d] Window U-value is the rate of heat transfer (conductive) through windows
[e] Solar Heat Gain Coefficient is the fraction of solar radiation admitted through the window

Table S2. Simulation Parameters used in EnergyPlus V.8.8.0

| Simulation parameter | Value / setting |
|---|---|
| Terrain | City |
| Load Convergence Tolerance | 0.04 |
| Temperature Convergence Tolerance Value, °C | 0.4 |
| Solar Distribution | Full Interior and Exterior |
| Maximum number of warm up days | 25 |
| Time step (minutes) | 15 |
| Surface Convection Algorithm | TARP |
| Heat Balance Algorithm | Conduction Transfer Functions |

Table S3: Spearman correlation coefficients between daily outdoor and indoor exposure metrics across Harris County Census Block Groups (June-Sept. 2000-2015)

| Daily ozone (ppb), meteorological & indoor exposure metrics (°C) | Outdoor | | | Indoor | | |
|---|---|---|---|---|---|---|
| | Amb. Max Temp | Amb. Min Temp | Amb Max DPT | Indoor Max DI | Indoor Max Temp | Indoor Min Temp |
| 8-hour maximum ozone | 0.18 | -0.24 | -0.32 | -0.01 | 0.00 | -0.06 |
| Max ambient temperature | 1 | | | | | |
| Min ambient temperature | 0.26 | 1 | | | | |
| Max ambient dew point temperature | 0.23 | 0.64 | 1 | | | |
| Indoor max Discomfort Index (DI) | 0.10 | 0.13 | 0.00 | 1 | | |
| Indoor max temperature | 0.11 | 0.13 | -0.01 | 1.00 | 1 | |
| Indoor min temperature | 0.18 | 0.25 | 0.10 | 0.94 | 0.93 | 1 |

Abbreviations: Amb: ambient; DI: Discomfort Index; DPT: Dew point temperature; max: maximum; min: minimum; temp: temperature

Table S4. Spearman correlation coefficients between daily indoor exposure metrics (°C) and census block group level indicators of socio-economic status across Harris County Census Block Groups (June-Sept. 2000-2015)

| | Max Indoor DI | Max Indoor Temp | Min Indoor Temp | % no AC | Median Year Built | % Below Poverty | % No HS Diploma | % White | % African American | % Owner | % Renter | Median Income |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % no AC | 1.00 | 0.99 | 0.92 | 1.00 | | | | | | | | |
| Year built | -0.55 | -0.55 | -0.52 | -0.55 | 1.00 | | | | | | | |
| % Below Poverty | 0.40 | 0.39 | 0.36 | 0.40 | -0.32 | 1.00 | | | | | | |
| % No HS Diploma | 0.45 | 0.45 | 0.41 | 0.45 | -0.37 | 0.68 | 1.00 | | | | | |
| % White | 0.02 | 0.02 | 0.02 | 0.01 | -0.07 | -0.38 | -0.25 | 1.00 | | | | |
| % African American | -0.08 | -0.08 | -0.07 | -0.07 | 0.15 | 0.29 | 0.10 | -0.79 | 1.00 | | | |
| % Owner | -0.10 | -0.10 | -0.09 | -0.10 | 0.05 | -0.54 | -0.29 | 0.32 | -0.30 | 1.00 | | |
| % Renter | 0.10 | 0.10 | 0.09 | 0.10 | -0.05 | 0.54 | 0.29 | -0.32 | 0.30 | -1.00 | 1.00 | |
| Median Income | -0.39 | -0.39 | -0.36 | -0.39 | 0.36 | -0.84 | -0.72 | 0.45 | -0.38 | 0.61 | -0.61 | 1.00 |

Abbreviations: Abbreviations: %: percentage; AC: air conditioning; DI: Discomfort Index (°C); HS: high school; max: maximum; min: minimum; temp: temperature (°C)

Table S5. Odds Ratio (95% CI) between respiratory disease and indoor heat exposure metrics (per 5 °C) for City of Houston (COH) and Harris County residents (June-Sept, 2000-2015[a])

| | RESP Diagnoses (COH) | | RESP Diagnoses (Harris County) | |
|---|---|---|---|---|
| | Mortality | EHA | Mortality | EHA |
| Indoor Max Discomfort Index (°C) | | | | |
| Lag 0 | 0.94 (0.69, 1.28) | 1.01 (0.84, 1.22) | 0.92 (0.69, 1.22) | 1.01 (0.85, 1.20) |
| Lag 1 | 0.93 (0.69, 1.26) | 1.10 (0.91, 1.32) | 0.89 (0.67, 1.19) | 1.08 (0.91, 1.29) |
| Lag 2 | 0.81 (0.60, 1.10) | 1.00 (0.83, 1.20) | 0.84 (0.63, 1.11) | 1.00 (0.85, 1.19) |
| Lag 3 | 0.94 (0.69, 1.28) | 0.98 (0.81, 1.18) | 0.98 (0.73, 1.30) | 0.99 (0.83, 1.17) |
| Lag 4 | 0.81 (0.60, 1.11) | 0.84 (0.70, 1.01) | 0.91 (0.68, 1.22) | 0.87 (0.73, 1.03) |
| Lag 5 | 0.94 (0.69, 1.28) | 0.87 (0.72, 1.04) | 0.88 (0.66, 1.18) | 0.86 (0.73, 1.03) |
| Lag 6 | 0.98 (0.72, 1.35) | 0.88 (0.73, 1.05) | 0.95 (0.71, 1.26) | 0.90 (0.76, 1.06) |
| Lag 0-2 | 0.85 (0.58, 1.24) | 1.05 (0.83, 1.32) | 0.84 (0.59, 1.19) | 1.05 (0.84, 1.30) |
| Indoor Max Temp (°C) | | | | |
| Lag 0 | 0.96 (0.78, 1.17) | 0.98 (0.87, 1.10) | 0.94 (0.78, 1.14) | 0.99 (0.88, 1.10) |
| Lag 1 | 0.92 (0.76, 1.12) | 1.03 (0.91, 1.17) | 0.91 (0.75, 1.09) | 1.04 (0.92, 1.16) |
| Lag 2 | 0.83 (0.68, 1.02) | 0.99 (0.88, 1.12) | 0.86 (0.71, 1.03) | 1.00 (0.89, 1.12) |
| Lag 3 | 0.94 (0.76, 1.15) | 0.99 (0.88, 1.12) | 0.97 (0.81, 1.17) | 0.99 (0.89, 1.11) |
| Lag 4 | 0.83 (0.68, 1.02) | 0.92 (0.82, 1.04) | 0.90 (0.75, 1.09) | 0.94 (0.84, 1.05) |
| Lag 5 | 0.90 (0.74, 1.10) | 0.95 (0.84, 1.07) | 0.87 (0.72, 1.04) | 0.95 (0.85, 1.06) |
| Lag 6 | 0.97 (0.79, 1.19) | 0.96 (0.85, 1.08) | 0.94 (0.78, 1.13) | 0.97 (0.87, 1.08) |
| Lag 0-2 | 0.86 (0.66, 1.11) | 0.99 (0.85, 1.16) | 0.85 (0.67, 1.08) | 1.00 (0.87, 1.16) |
| Indoor Min Temp (°C) | | | | |
| Lag 0 | 0.88 (0.53, 1.48) | 1.16 (0.87, 1.55) | 0.82 (0.51, 1.33) | 1.12 (0.85, 1.47) |
| Lag 1 | 1.14 (0.69, 1.89) | 1.01 (0.76, 1.35) | 1.13 (0.71, 1.81) | 0.97 (0.75, 1.27) |
| Lag 2 | 1.12 (0.67, 1.85) | 1.00 (0.75, 1.33) | 1.13 (0.71, 1.81) | 1.00 (0.76, 1.31) |
| Lag 3 | 0.93 (0.55, 1.57) | 0.84 (0.63, 1.12) | 1.00 (0.62, 1.61) | 0.86 (0.66, 1.14) |
| Lag 4 | 0.99 (0.60, 1.64) | 1.02 (0.77 ,1.36) | 0.93 (0.58, 1.47) | 0.95 (0.73 ,1.24) |
| Lag 5 | 1.18 (0.71, 1.98) | 0.90 (0.68, 1.19) | 1.13 (0.70, 1.81) | 0.83 (0.64, 1.08) |
| Lag 6 | 2.13 (1.28, 3.56) | 0.92 (0.69, 1.22) | 1.94 (1.21, 3.12) | 0.90 (0.69, 1.16) |
| Lag 0-2 | 1.08 (0.58, 2.01) | 1.08 (0.75, 1.55) | 1.06 (0.59, 1.89) | 1.04 (0.74, 1.46) |

Odds Ratios were derived from single-exposure, time-stratified case-crossover models (conditional logistic regression), that matched on census block group of subject residence, year, month, and weekday of the adverse health event. Models controlled for maximum ambient temperature and maximum ambient dew point temperature (°C) with cubic polynomials, Federal holidays, day of the warm season, and interaction between year and day of the warm season.

[a] Mortality data were available 2000-2015; EHA data were available 2004-2013

Abbreviations: CI: Confidence Interval; COH: City of Houston; EHA: Emergency hospital admission; Max: maximum; Min: minimum; RESP: Diseases of the respiratory system

Table S6: Odds Ratios (95% CI) between select health outcomes and 3-day moving averages of indoor heat exposure metrics (per 5 °C) for primary models and models that controlled for ambient ozone exposure.

| | | Primary Model | | Controlling for daily 8-hour maximum ozone | |
|---|---|---|---|---|---|
| Outcome | Indoor Exposure Metric (°C) | OR (95% CI) | p-value | OR (95% CI) | p-value |
| HEAT deaths | Max Temp (lag 0-2) | 1.10 (0.99, 1.22 | 0.065 | 1.11 (0.99, 1.23) | 0.059 |
| HEAT deaths | Max Discomfort Index (lag 0-2) | 1.20 (1.02, 1.40) | 0.023 | 1.21 (1.03, 1.41) | 0.018 |
| HEAT EHAs | Max Temp (lag 0-2) | 1.08 (0.99, 1.17) | 0.075 | 1.07 (0.99, 1.16) | 0.089 |
| HEAT EHAs | Max Discomfort Index (lag 0-2) | 1.12 (0.99, 1.26) | 0.077 | 1.11 (0.98, 1.25) | 0.108 |

Odds Ratios were derived from single-exposure, time-stratified case-crossover models (conditional logistic regression), that matched on census block group of subject residence, year, month, and weekday of the adverse health event. All models controlled for maximum ambient temperature and maximum ambient dew point temperature (°C) with cubic polynomials, Federal holidays, day of the warm season, and interaction between year and day of the warm season.
Abbreviations: CI: Confidence Interval; HEAT: heat-related outcomes; EHA: emergency hospital admissions; maximum indoor Discomfort Index, °C; Max Temp: maximum indoor dry-bulb temperature, °C; OR: odds ratio
Note: Analyses were restricted to heat-related deaths and heat-related EHAs among City of Houston residents.
Note: For indoor exposure metrics, we used 3-day moving averages (lag 0-2) as the exposure period

Table S7. Results of Likelihood Ratio Tests (LRT) between Primary Models and Alternative Models

| Model Name | Model Description | Health Outcome | LRT between Primary Models and Alternative Models | DOF between Primary Models and Alternative Models | LRT p-value |
|---|---|---|---|---|---|
| Primary Model | Indoor maximum Discomfort Index as the indoor exposure metric. Control for maximum ambient temperature (°C) with cubic polynomials | NA | NA | NA | NA |
| Alternative Model 1 | Primary Model without indoor exposure | HEAT deaths | 5.17 | 1 | 0.023 |
| Alternative Model 1 | Primary Model without indoor exposure | HEAT EHAs | 3.134 | 1 | 0.077 |

Abbreviations: DOF: Degrees of Freedom; HEAT: heat-related outcomes; EHA: emergency hospital admissions; LRT: likelihood Ratio Test; Max DI: maximum indoor Discomfort Index, °C
Note: Analyses were restricted to heat-related deaths and heat-related EHAs among City of Houston residents.
Note: All models included additional control for maximum ambient dew point temperature (°C) with cubic polynomials, Federal holidays, day of the warm season, and interaction between year and day of the warm season.

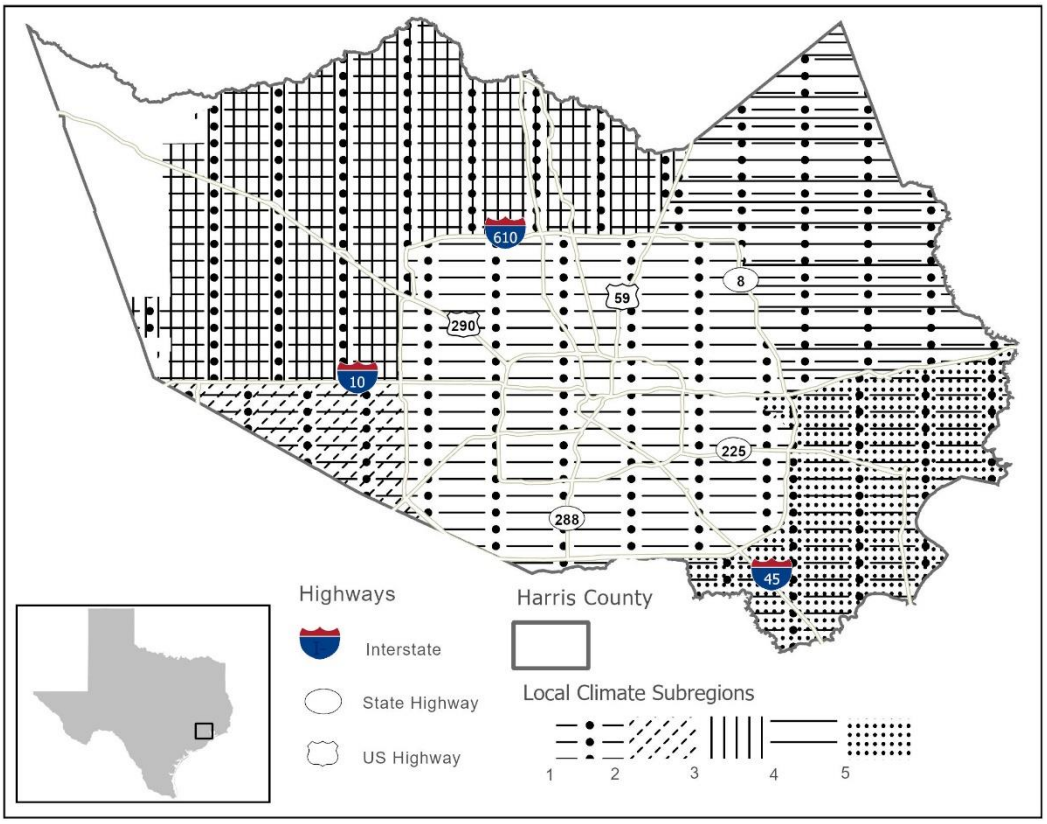



Figure S1. Spatial representation of the five local climate subregions used in indoor heat exposure simulations in Houston.

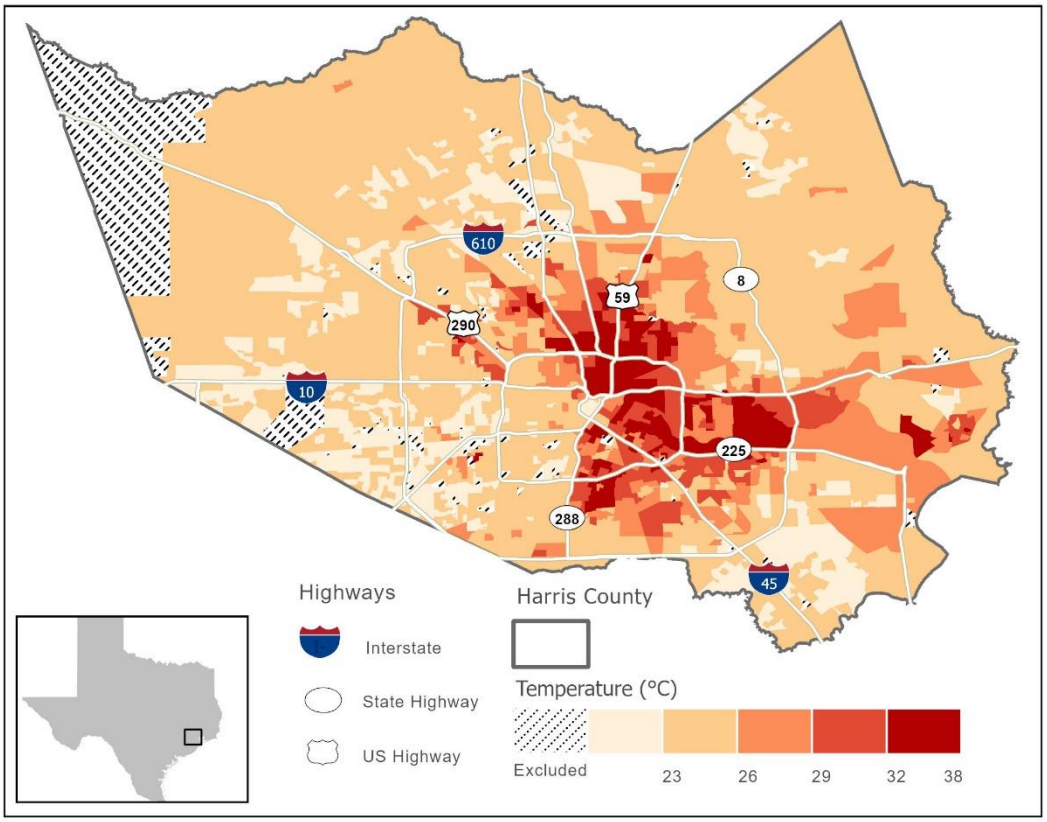
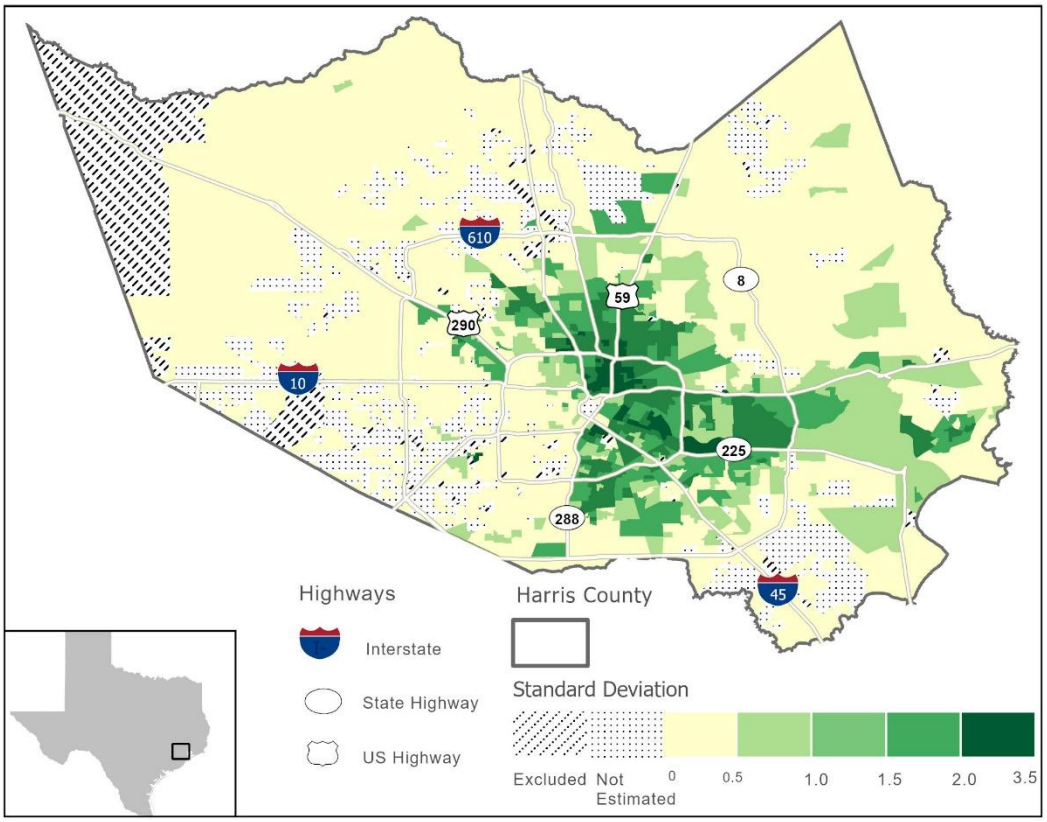



Figure S2. Spatial representation of daily maximum indoor temperature (°C) for Harris County, averaged across all summer months (June-September) from 2000-2015. Hatch-marked areas represent the 106 Census Block Groups (CBG) excluded from this study (n=86 excluded because they are non-residential CBGs, n=16 excluded because building stock in these CBGs could not be categorized into one of the 144 building archetypes used in our indoor modeling work, n=4 excluded because of missing meteorological data).

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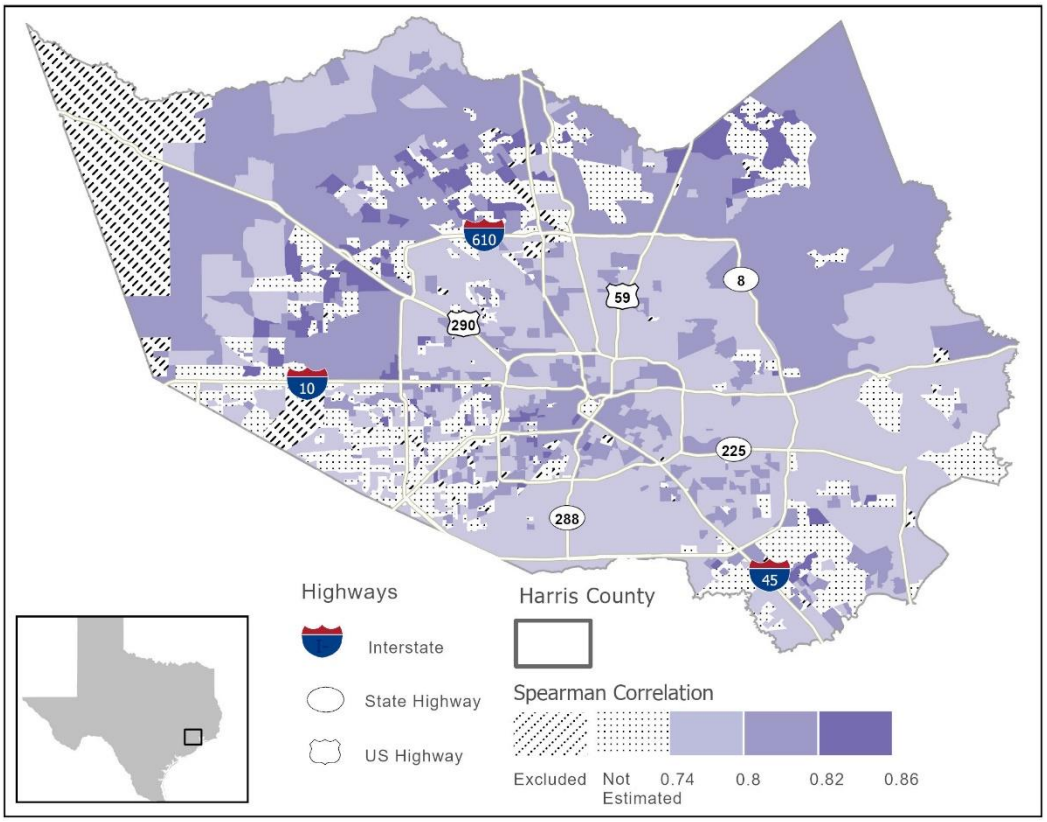
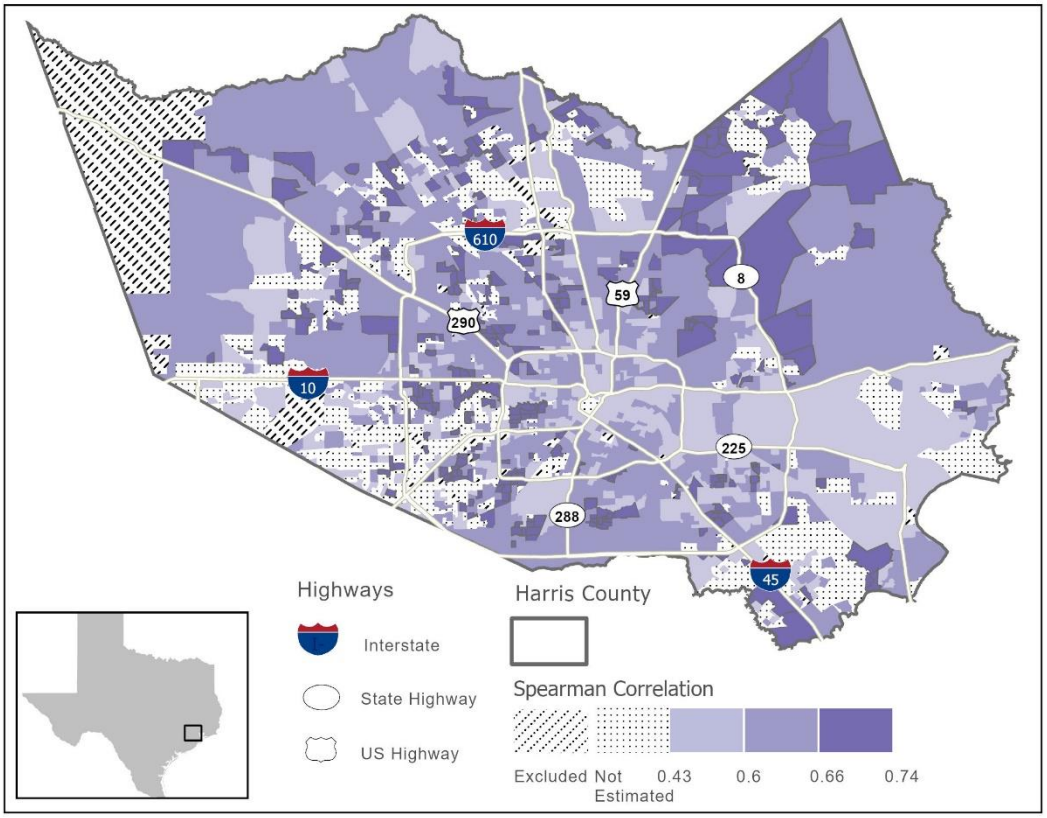



Figure S4. Spearman correlations (ϱ) between daily maximum indoor temperature (°C) and daily maximum outdoor temperature (°C), June-September (2000-2015). Spearman correlations were not estimable in Census Block Groups (CBG) that reported 100% prevalence of central air conditioning (gray areas). Hatched-marked areas represent the 106 Census Block Groups (CBG) excluded from this study. For mapping purposes, Spearman Correlations were categorized by the following percentiles based on the distribution of correlation values: 0-25$^{th}$ percentile (0.74 to ≤0.8); 25$^{th}$-75$^{th}$ percentile (>0.8 to ≤0.82); and 75$^{th}$-100$^{th}$ percentile (>0.82 to 0.86).

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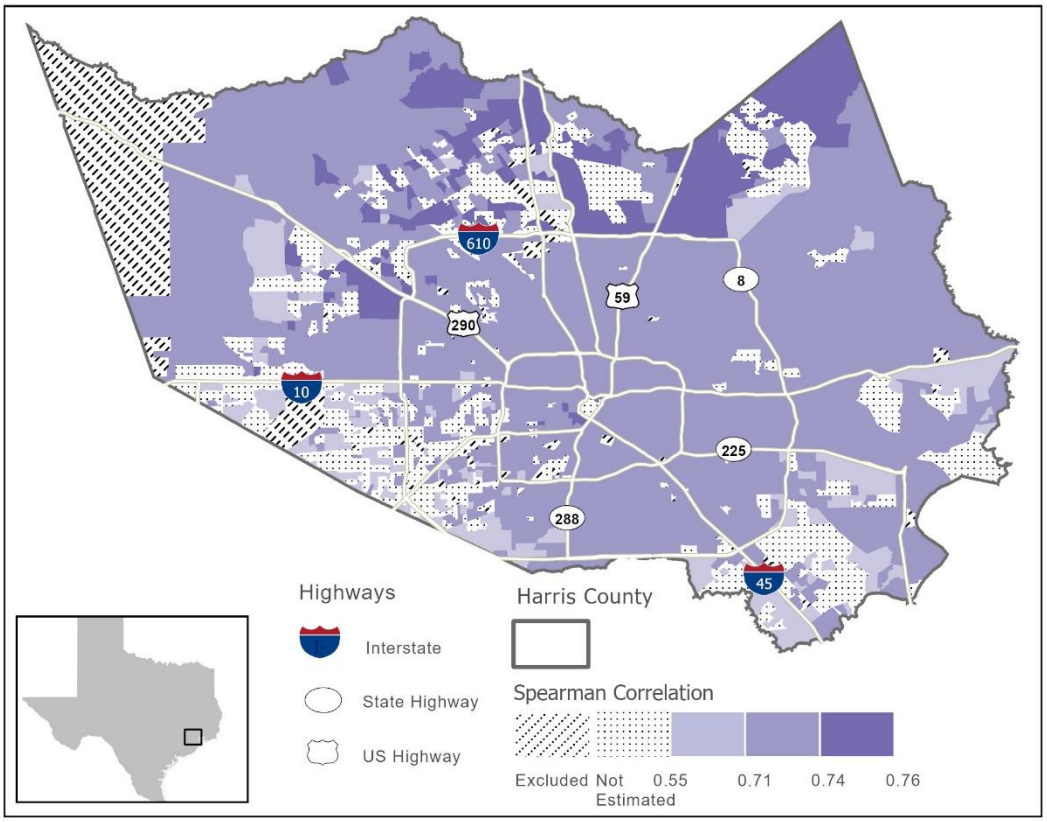


Figure S6. Spearman correlations (ϱ) between daily maximum indoor Discomfort Index (°C) and daily maximum outdoor temperature (°C), June-September (2000-2015). Spearman correlations were not estimable in Census Block Groups (CBG) that reported 100% prevalence of central air conditioning (gray areas). Hatch-marked areas represent the 106 Census Block Groups (CBG) excluded from this study. For mapping purposes, Spearman Correlations were categorized by the following percentiles based on the distribution of correlation values: 0-25$^{th}$ percentile (0.55 to ≤0.71); 25$^{th}$-75$^{th}$ percentile (>0.71 to ≤0.74); and 75$^{th}$-100$^{th}$ percentile (>0.74 to 0.76).

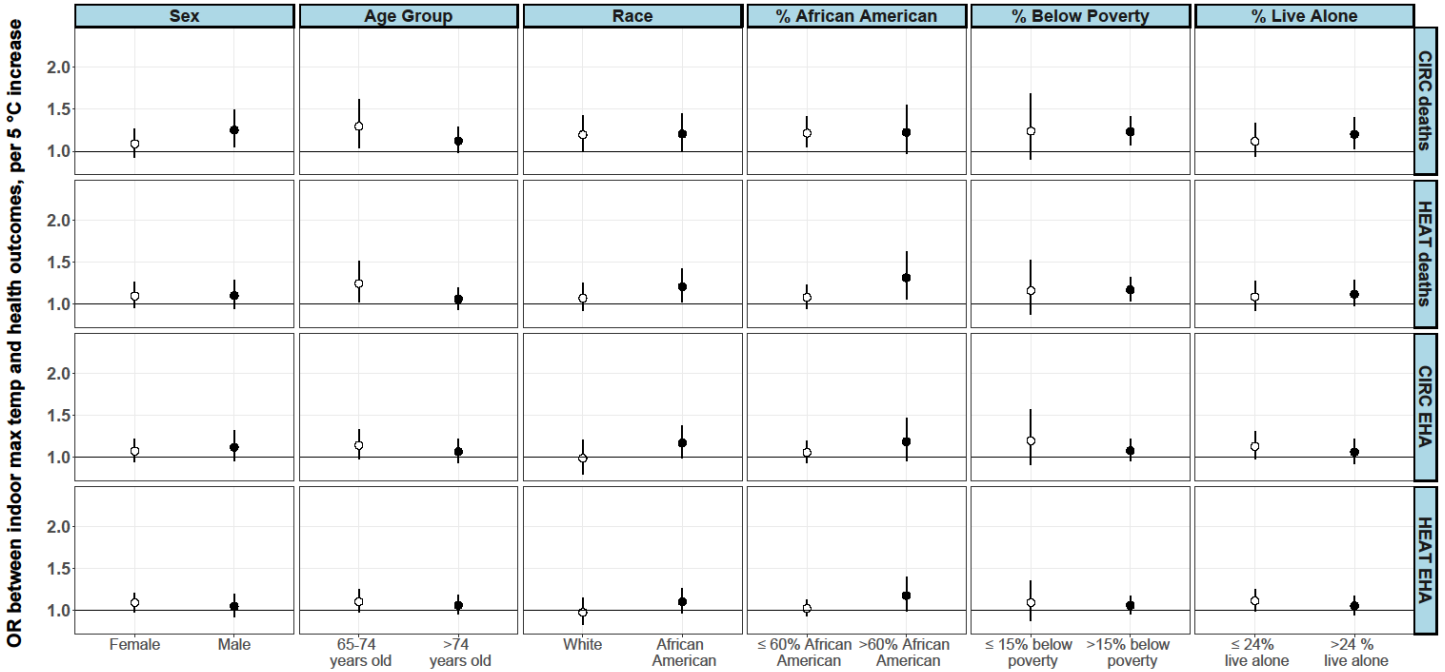


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Table S8. Odds Ratio (95% CI) between 3-day moving averages of maximum temperature and health outcomes stratified by individual and neighborhood factors for City of Houston (COH) residents (June-September, 2000-2015[a])

| Strata | CIRC Deaths | p-value [e] | HEAT Deaths | p-value [e] | CIRC EHA | p-value [e] | HEAT EHA | p-value [e] |
|---|---|---|---|---|---|---|---|---|
| Sex | | | | | | | | |
| Female | 1.09 (0.93, 1.27) | | 1.10 (0.96, 1.26) | | 1.08 (0.95, 1.22) | | 1.09 (0.98, 1.21) | |
| Male | 1.25 (1.05, 1.49) | 0.24 | 1.10 (0.95, 1.29) | 0.96 | 1.12 (0.95, 1.32) | 0.69 | 1.05 (0.93, 1.19) | 0.64 |
| Age Group | | | | | | | | |
| 65-74 | 1.30 (1.04, 1.62) | | 1.25 (1.02, 1.52) | | 1.14 (0.98, 1.34) | | 1.11 (0.98, 1.25) | |
| >74 | 1.12 (0.98, 1.29) | 0.28 | 1.06 (0.94, 1.20) | 0.17 | 1.07 (0.94, 1.22) | 0.51 | 1.06 (0.96, 1.18) | 0.63 |
| Race | | | | | | | | |
| White | 1.20 (1.01, 1.42) | | 1.07 (0.92, 1.25) | | 0.99 (0.81, 1.21) | | 0.98, (0.83, 1.15) | |
| African American | 1.21 (1.00, 1.45) | 0.95 | 1.21 (1.03, 1.43) | 0.29 | 1.17 (1.00, 1.38) | 0.20 | 1.10 (0.97, 1.26) | 0.25 |
| CBG % African American[b] | | | | | | | | |
| ≤60 % African American | 1.22 (1.05, 1.41) | | 1.08 (0.95, 1.23) | | 1.06 (0.94, 1.20) | | 1.02 (0.93, 1.13) | |
| >60% African American | 1.23 (0.97, 1.55) | | 1.32 (1.07, 1.63) | 0.12 | 1.19 (0.96, 1.46) | 0.35 | 1.18 (0.99, 1.40) | 0.17 |
| | | 0.95 | | | | | | |
| CBG % Poverty[c] | | | | | | | | |
| ≤15 % below poverty | 1.24 (0.91, 1.69) | | 1.16 (0.89, 1.53) | | 1.20 (0.91, 1.57) | | 1.09 (0.88, 1.36) | |
| >15% below poverty | 1.23 (1.07, 1.42) | 0.98 | 1.17 (1.04, 1.33) | 0.95 | 1.08 (0.96, 1.22) | 0.49 | 1.06 (0.96, 1.17) | 0.79 |
| CBG % living Alone[d] | | | | | | | | |
| ≤24% live alone | 1.12 (0.94, 1.34) | | 1.09 (0.93, 1.27) | | 1.13 (0.98, 1.31) | | 1.12 (0.99, 1.26) | |
| >24 live alone | 1.20 (1.03, 1.40) | 0.54 | 1.12 (0.98, 1.28) | 0.79 | 1.06 (0.93, 1.22) | 0.56 | 1.06 (0.95, 1.18) | 0.50 |

Odds Ratios were derived from single-exposure, time-stratified case-crossover models (conditional logistic regression), that matched on census block group of subject residence, year, month, and weekday of the adverse health event. All models controlled for maximum ambient temperature and maximum ambient dew point temperature (°C) with cubic polynomials, Federal holidays, day of the warm season, and interaction between year and day of the warm season.

Abbreviations: CBG: Census Block Group; CI: Confidence Interval; CIRC: Diseases of the circulatory system; EHA: Emergency hospital admission; HEAT: heat-related illnesses;

[a] Mortality data were available 2000-2015; EHA data were available 2004-2013

[b] Census block group percentage of households living below the Federal poverty line

[c] Census block group percentage of the 65 and older population living alone

[d] Census block group percentage of the population that identifies as African American

[e] Statistical evidence for effect modification was assessed by estimating the degree of heterogeneity between stratum-specific ORs in pairwise comparisons (Kaufman and MacLehose 2013). Referent groups for each stratum were female sex, 65-74 age group, White race, ≤60 % African American, ≤15% below poverty, ≤24 % live alone

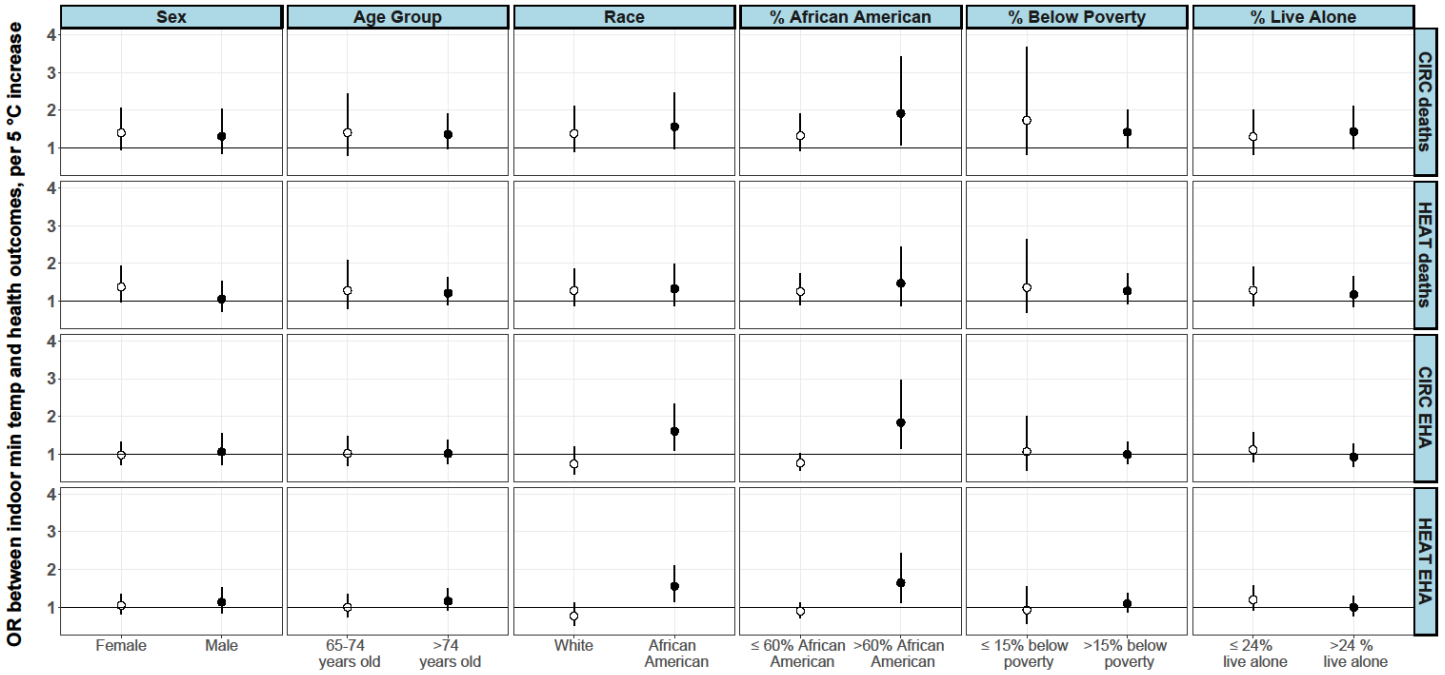


Figure S8. Estimated odds ratios (OR) and 95% CIs between 3-day moving averages of minimum temperature and health outcomes stratified by individual and neighborhood factors for City of Houston residents (June-Sept, 2000-2015). Odds Ratios were derived from single-exposure, time-stratified case-crossover models (conditional logistic regression), that matched on census block group of subject residence, year, month, and weekday of the adverse health event. Models controlled for maximum ambient temperature, and maximum ambient dew point temperature (°C) with cubic polynomials, Federal holidays, day of the warm season, modeled as a smooth function with monthly knots across the summer season (June-September). An interaction term between year and day of the warm season was also included to capture between-year differences. Mortality data were available 2000-2015; EHA data were available 2004-2013. Abbreviations: CIRC: circulatory diagnoses; DI: Discomfort Index; EHA: emergency hospital admissions; HEAT: heat-related diagnoses; min: minimum; OR: odds ratio. . "% below poverty" represents Census block group percentage of households living below the Federal poverty line. "% African American" represents census block group percentage of the population that identifies as African American. "% live alone" represents the census block group percentage of the 65 and older population living alone. See Table S9 for corresponding numeric data (ORs and 95% CIs).

Table S9. Odds Ratio (95% CI) between 3-day moving averages of minimum temperature and health outcomes stratified by individual and neighborhood factors for City of Houston (COH) residents (June-September, 2000-2015[a]).

| Strata | CIRC Deaths | p-value [e] | HEAT Deaths | p-value [e] | CIRC EHA | p-value [e] | HEAT EHA | p-value [e] |
|---|---|---|---|---|---|---|---|---|
| Sex | | | | | | | | |
| Female | 1.40 (0.96, 2.6) | | 1.38 (0.98, 1.94) | | 0.98 (0.73, 1.32) | | 1.05 (0.83, 1.34) | |
| Male | 1.32 (0.86, 2.03) | 0.83 | 1.06 (0.73, 1.54) | 0.31 | 1.07 (0.73, 1.56) | 0.74 | 1.14 (0.85, 1.53) | 0.68 |
| Age Group | | | | | | | | |
| 65-74 | 1.41 (0.82, 2.44) | | 1.28 (0.79, 2.08) | | 1.03 (0.71, 1.48) | | 1.01 (0.75, 1,34) | |
| >74 | 1.36 (0.97, 1.91) | 0.91 | 1.22 (0.90, 1.64) | 0.85 | 1.02 (0.75, 1.39) | 0.99 | 1.17 (0.91, 1.49) | 0.44 |
| Race | | | | | | | | |
| White | 1.39 (0.91, 2.12) | | 1.29 (0.89, 1.86) | | 0.75 (0.47, 1.20) | | 0.78 (0.54, 1.13) | |
| African American | 1.57 (0.99, 2.48) | 0.70 | 1.33 (0.89, 1.99) | 0.90 | 1.61 (1.11, 2.34) | 0.01 | 1.56 (1.16, 2.10) | <0.01 |
| CBG % African American[b] | | | | | | | | |
| ≤60 % African American | 1.33 (0.93, 1.91) | | 1.26 (0.91, 1.73) | | 0.77 (0.58, 1.02) | | 0.91 (0.72, 1.14) | |
| >60% African American | 1.92 (1.07, 3.43) | 0.29 | 1.47 (0.88, 2.45) | 0.61 | 1.84 (1.15, 2.97) | <0.01 | 1.65 (1.12, 2.43) | 0.01 |
| CBG % Poverty[c] | | | | | | | | |
| ≤15 % below poverty | 1.74 (0.82, 3.67) | | 1.37 (0.71, 2.63) | | 1.07 (0.58, 2.00) | | 0.94 (0.57, 1.55) | |
| >15% below poverty | 1.42 (1.01, 2.01) | 0.64 | 1.27 (0.94, 1.72) | 0.85 | 1.00 (0.76, 1.32) | 0.83 | 1.10 (0.88, 1.38) | 0.56 |
| CBG % living Alone[d] | | | | | | | | |
| ≤24% live alone | 1.30 (0.84, 2.02) | | 1.29 (0.88, 1.90) | | 1.12 (0.80, 1.59) | | 1.20 (0.91, 1.59) | |
| >24 live alone | 1.44 (0.98, 2.10) | 0.74 | 1.18 (0.84, 1.65) | 0.73 | 0.93 (0.68, 1.28) | 0.43 | 1.01 (0.78, 1.30) | 0.35 |

Odds Ratios were derived from single-exposure, time-stratified case-crossover models (conditional logistic regression), that matched on census block group of subject residence, year, month, and weekday of the adverse health event. All models controlled for maximum ambient temperature and maximum ambient dew point temperature (°C) with cubic polynomials, Federal holidays, day of the warm season, and interaction between year and day of the warm season.

Abbreviations: CBG: Census Block Group; CI: Confidence Interval; CIRC: Diseases of the circulatory system; EHA: Emergency hospital admission; HEAT: heat-related illnesses;

[a] Mortality data were available 2000-2015; EHA data were available 2004-2013

[b] Census block group percentage of households living below the Federal poverty line

[c] Census block group percentage of the 65 and older population living alone

[d] Census block group percentage of the population that identifies as African American

[e] Statistical evidence for effect modification was assessed by estimating the degree of heterogeneity between stratum-specific ORs in pairwise comparisons (Kaufman and MacLehose 2013). Referent groups for each stratum were female sex, 65-74 age group, White race, ≤60 % African American, ≤15% below poverty, ≤24 % live alone

Table S10. Sensitivity of covariate control on estimated associations (odds ratios and 95% CI per 1°C) between indoor maximum Discomfort Index (lag 0-2) and health outcomes among city of Houston residents (June-September, 2000-2015[a]).

| | Model Description | Heat-related Mortality OR (95% CI) | Heat-related Emergency Hospital Admissions OR (95% CI) |
|---|---|---|---|
| 1. | Primary Model | 1.04 (1.00, 1.07) | 1.02 (1.00, 1.05) |
| 2. | Primary model without ambient max dew point temperature control | 1.03 (1.00, 1.07) | 1.02 (1.00, 1.04) |
| 3. | Primary model without ambient max temperature control | 1.02 (0.99, 1.05) | 1.02 (1.00, 1.05) |
| 4. | Primary model, no ambient meteorological control | 1.02 (0.99, 1.05) | 1.02 (1.00, 1.04) |

Odds Ratios were derived from single-exposure, time-stratified case-crossover models (conditional logistic regression), that matched on census block group of subject residence, year, month, and weekday of the adverse health event. All models controlled for maximum ambient temperature and maximum ambient dew point temperature (°C) with cubic polynomials, Federal holidays, day of the warm season, and interaction between year and day of the warm season.

[a] Mortality data were available 2000-2015; EHA data were available 2004-2013

Abbreviations: CI: Confidence Interval; OR: odds ratio

Note: Analyses were restricted to heat-related deaths and heat-related EHAs among City of Houston residents.

Note: For indoor exposure metrics and relevant meteorological covariates, we used 3-day moving averages (lag 0-2) as the exposure period

Table S11. Estimated associations (odds ratios and 95% CI per 1°C) between indoor maximum Discomfort Index and health outcomes, and outdoor maximum temperature and health outcomes among city of Houston residents (June-September, 2000-2015[a]).

| | Exposure Metric | Heat-related Mortality | Heat-related Emergency Hospital Admissions |
|---|---|---|---|
| 1. | Indoor maximum Discomfort Index | 1.023 (0.994, 1.051) | 1.023 (1.001, 1.045) |
| 2. | Ambient maximum temperature | 0.995 (0.987, 1.004) | 1.004 (0.998, 1.011) |

Odds Ratios were derived from single-exposure (continuous, linear), time-stratified case-crossover models (conditional logistic regression), that matched on census block group of subject residence, year, month, and weekday of the adverse health event. All models controlled for maximum ambient dew point temperature (°C) with cubic polynomials, Federal holidays, day of the warm season, modeled as a smooth function with monthly knots across the summer season (June-September). An interaction term between year and day of the warm season was also included to capture between-year differences.

[a] Mortality data were available 2000-2015; EHA data were available 2004-2013

Note: Analyses were restricted to heat-related deaths and heat-related Emergency Hospital Admissions among City of Houston residents.

Note: For exposure metrics, we used 3-day moving averages (lag 0-2) as the exposure period

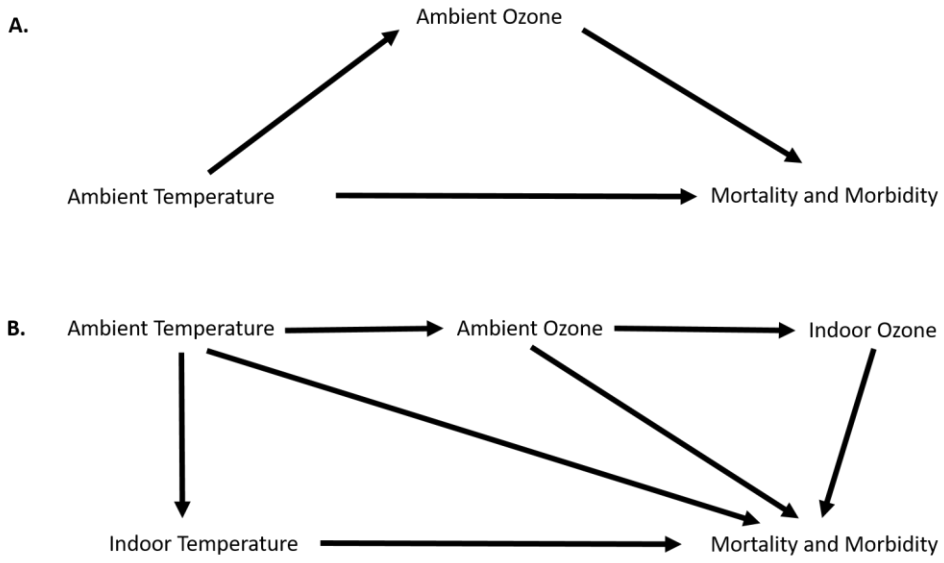


Figure S9. Directed Acyclic Graphs (DAG) indicating (A) assumed relationships between ambient temperature, ambient ozone and health, and (B) assumed relationships between ambient temperature, indoor temperature, ambient ozone, indoor ozone and health. DAGs were adapted from concepts introduced by Reid et al. (2012) and Buckley et al. (2014). (Buckley et al. 2014; Reid et al. 2012)

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