



MICHAEL & SUSAN DELL
CENTER *for* HEALTHY LIVING

Healthy children in a healthy world.

We advance health and healthy living for children and families through cutting-edge research, innovative community-based programs, and dissemination of evidence-based practices.



CENTER RESOURCES



WEBSITE

msdcenter.org



WEBINARS

go.uth.edu/webinars



NEWSLETTER

bit.ly/MSDCenterNewsletter



EXPERT BLOGS

go.uth.edu/CenterBlogs



SOCIAL MEDIA

[@msdcenter](https://www.instagram.com/msdcenter)



RESEARCH AND RESOURCE STATIONS

go.uth.edu/CenterResources



TX CHILD HEALTH STATUS REPORTS AND TOOLKITS

go.uth.edu/TexasChildHealth



TEXAS RESEARCH-TO-POLICY COLLABORATION PROJECT

go.uth.edu/TXRPCProject



TEXAS IS UNIQUE



State in the U.S.



35% of population speaks languages other than English at home



10% of U.S. births occurred in TX (2021-2024)



Texas has a greater population than 18 states **combined**



Every **80 seconds** a child is born somewhere in Texas



5 million Texas residents live in rural areas, more than any other state



Hispanics account for **the largest share** of Texas' total population



7 out of 10 Texans live within the Texas Triangle



DISCLOSURES & ACCREDITATION

This webinar awards **1.0 Entry-Level CHES/MCHES® credit.**

Requirements for Completion: Attend the session in its entirety

An evaluation form with instructions will be sent via email within one week following the webinar to registrants who signed up for credit.

The Michael & Susan Dell Center for Healthy Living is a Designated Provider of continuing education contact hours (CECH) for Certified Health Education Specialists (CHES®) and Master Certified Health Education Specialists (MCHES®) through The National Commission for Health Education Credentialing, Inc. (NCHEC®).

Extreme Heat & Outdoor Physical Activity of Texas Children: Health Risks & Potential Adaptations

Suzanna Metcalf, MPH in Epidemiology Candidate
UTHealth Houston School of Public Health in Austin



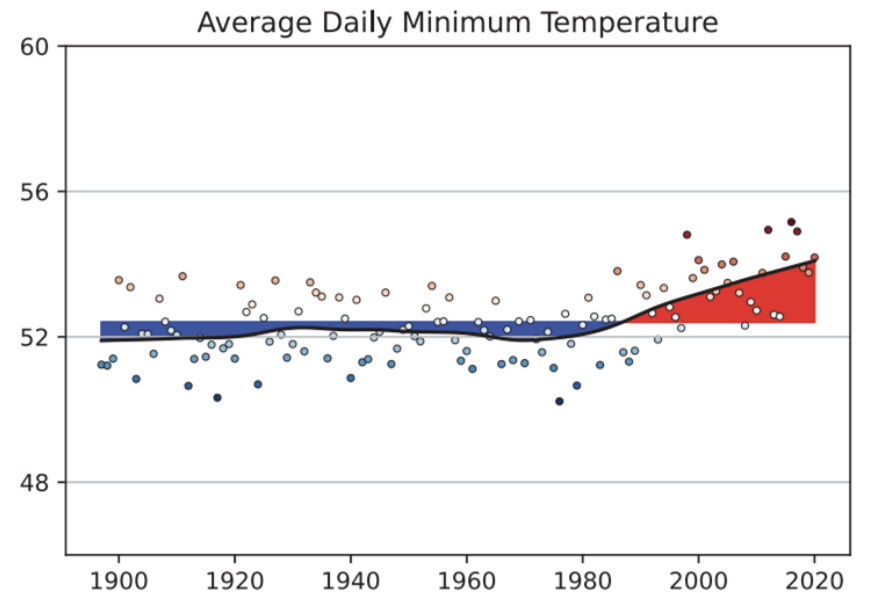
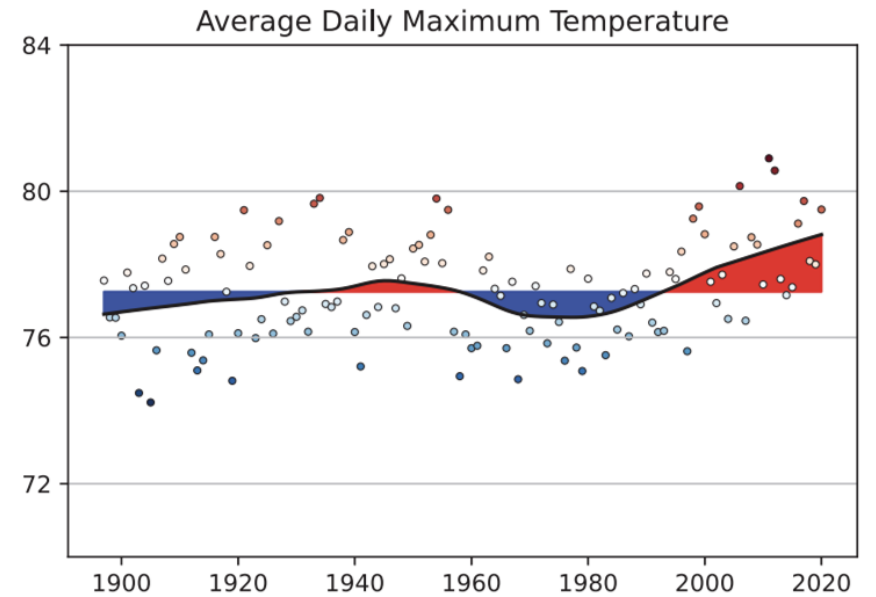
Presentation Overview

- Context - Heat and physical activity (PA) in Texas
- Child health risks of extreme heat
- Our Study
- What more must be done
- Ways we measure heat risk
- Adaptations to children's outdoor play
- Q&A



Extreme Heat Trends in Texas

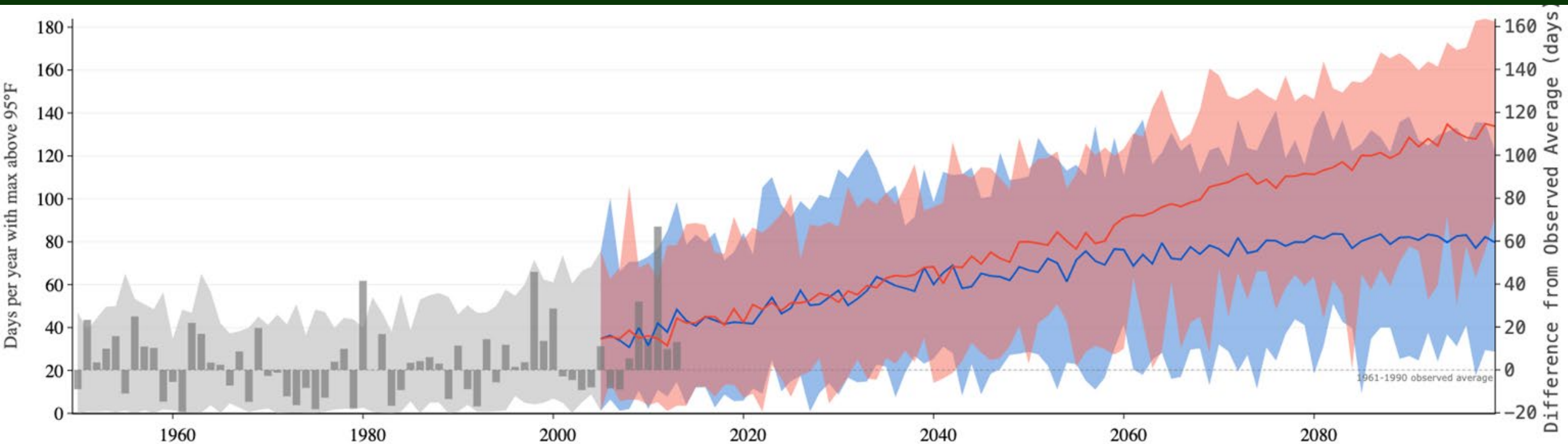
- By 2036, average Texas temperatures are projected to be ~ 1.8 °F warmer than the 1991-2020 average and 3.0 °F warmer than the 1950-1999 average.
- By 2036, a standard year in Texas is projected to be warmer than all but the hottest year from 1895 to 2020.
- Urban heat island effect exacerbates hot conditions



Texas annual average statewide temperatures (°F)

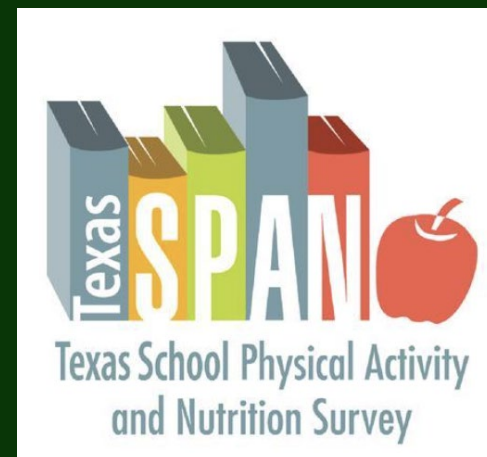
Climate models predict more extreme heat days in the future

Days per Year with Average Daily Maximum Temperature $>95^{\circ}\text{F}$ in Harris County, TX



Child Physical Activity Outcomes in Texas:

Texas children fail to meet benchmarks



Guidelines

60+ minutes of moderate to vigorous PA daily

(HHS, 2018; Zhang et al., 2025)

Performance

In 2021-2023, Texas children met PA guidelines only 4.3 days/week.

Only 23% did 60+ minutes/day every day of the week.

(Zhang et al., 2025)

Performance Cont.

2nd graders more active than older students

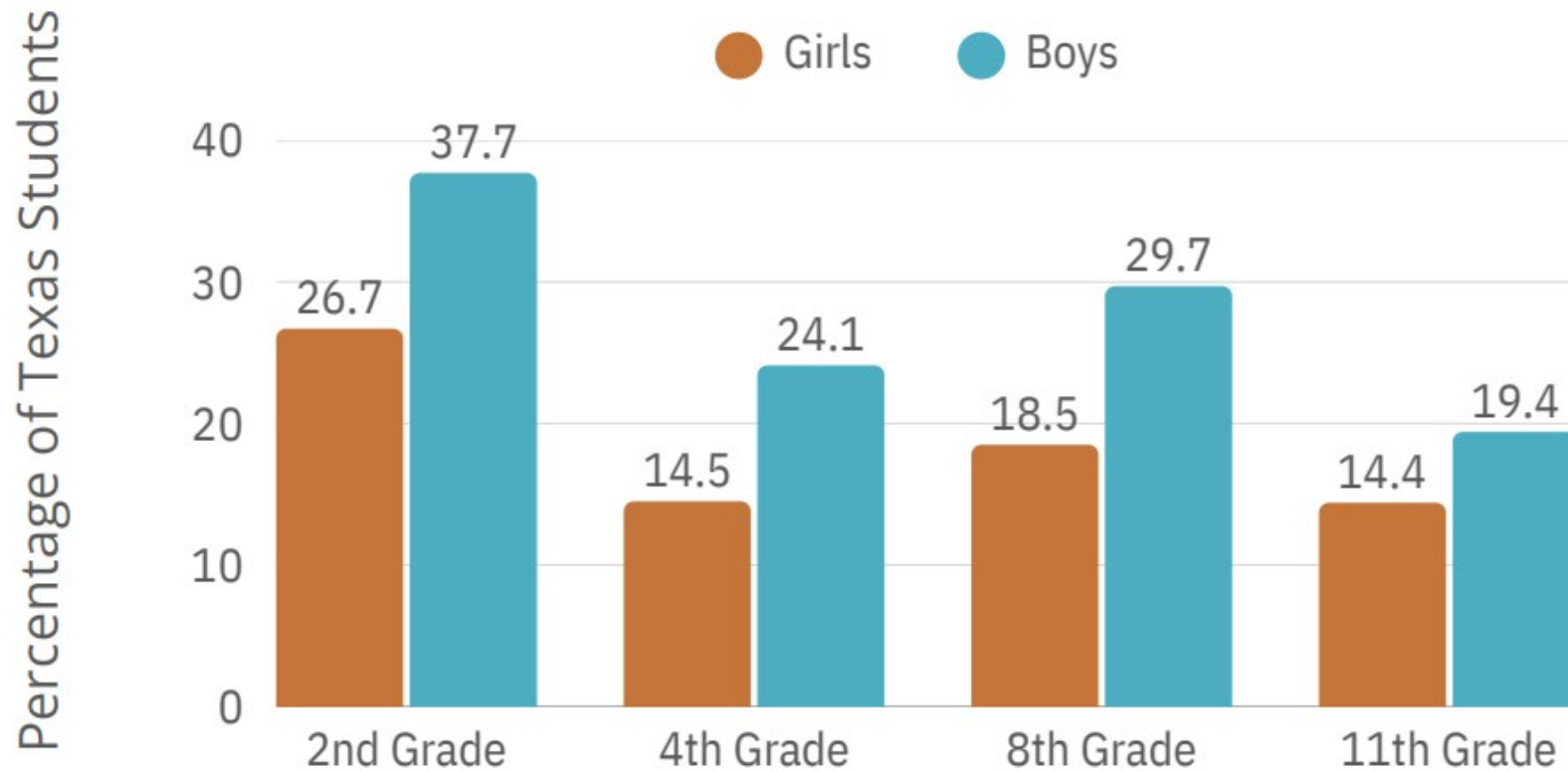
Boys more active than girls

Below benchmarks across all groups surveyed

(Zhang et al., 2025)



Students who are physically active 60+ minutes/day for 7 days/week



2021-2023 Texas School Physical Activity and Nutrition (Texas SPAN) Project (Zhang et al., 2025)

Adequate physical activity is critical for children's health and well-being

- Protects against obesity and obesity-related chronic conditions
- Promotes proper musculoskeletal development
- Fosters good cardiometabolic health
- Supports cognitive function
- Protects against depression
- May contribute to academic performance

(Biddle et al., 2029; Wang et al., 2024)



Image: StockCake (Public Domain)



Image: Mary Taylor via Pexels

Health risks of extreme heat exposure:

Children are uniquely vulnerable

Acute heat-induced health risks:

Heat rash, dehydration, heat exhaustion, heat stroke, fever, asthma attacks, death

Long-term heat-induced health consequences:

Chronic dehydration and resulting kidney failure, chronic respiratory conditions, gastrointestinal disease, cognitive impairment, harm to mental health

(UNICEF, n.d.; Principi et al., 2025)



Our Study

Extreme Temperature Exposure
and Outdoor Physical Activity Outcomes
Among 2nd Grade Children in Texas

Study	Temperature/Weather Exposure Metric	Association with outdoor PA	Study Design	Population	Location
Al-Mohannadi et al., 2016	Average temperature and humidity (continuous), and Wet bulb Globe Temperature (WbGT) (continuous)	Negative	Prospective cohort	Adults (n = 2088)	Qatar
Edwards et al., 2015	Daily mean temperature < 65°F	Negative	Prospective cohort	Young children (n = 372)	Urban U.S.
	Daily mean temperature ≥ 65°F	Negative			
Fan et al., 2023	hourly temperatures above 30 °C and above 35 °C	Negative	Longitudinal observational	All park-goers	China
Lanza et al., 2022	Ambient temperature (continuous)	Nonlinear; peak activity at moderate temperatures	Longitudinal observational	All trail-users	Austin, TX, U.S.
	Temperature extremes	Negative			
Feinglass et al., 2011	Daily mean temperature ≥ 75°F	Negative	Longitudinal observational	Adults with arthritis (n = 241)	Chicago, U.S.
	Daily mean temperature <20°F	Negative			
Vecellio et al., 2024	Humid conditions	Negative	Longitudinal observational	Young adults (n = 81)	Pennsylvania, U.S.
	Warm dry conditions	Positive			
Zheng et al., 2019	Ambient temperature (continuous)	Positive	Longitudinal observational	Adolescents (n = 740)	Hong Kong, China
	Relative humidity (%) (continuous)	Negative			
	Sunlight duration (continuous)	Negative			
Duncan et al., 2008	Mean ambient temperature (continuous)	Positive	Longitudinal observational	Children (n = 1115)	New Zealand
Button et al., 2021	Daily ambient temperature (continuous)	Positive	Longitudinal observational	Children (n = 90)	Ontario, Canada
Yildirim et al., 2014	Daily maximum temperature (continuous)	Positive	Cross-sectional	Children (n = 722)	Europe

Summary of the Literature:

Associations between temperature and outdoor PA

Study purpose:

To evaluate the effects of extreme temperatures on the outdoor physical activity of Texas 2nd graders and determine whether effects were moderated by various predictive factors

Exposures

Number of days in the week preceding the survey date with:

- an average county-level daily maximum feels-like temperature **at or above 86°F**
- an average county-level daily maximum feels-like temperature **at or below 41°F**

Outcome (OPdays)

Number of days in previous week 2nd graders played outdoors for ≥ 30 minutes

“Last week, how many days did your 2nd grade child play outdoors for 30 minutes or more?”

Multiple choice: 0 to 7 days

Covariates

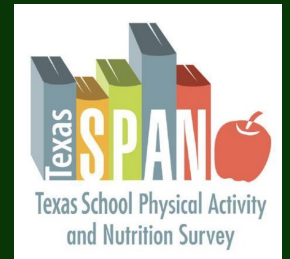
- Sex
- Age
- Obesity status
- Race/ethnicity (White/other, Black, or Hispanic)
- Community type (rural, urban, or major urban)
- Public health region

Study population and data collection methods



- **2021-2023 Texas SPAN survey data:**

- 2,108 2nd grade parents at 90 schools in 36 TX counties (probability sample)
- 75 dates, March 2022 to May 2023. No data collected in June, July, or August



- **Daily county-level weather data:**

- Visual Crossing station-based data aggregated to generate county-level indicators
- Indicators: daily max, min, and mean temperatures and daily max, min, and mean feels-like temperatures (temperature/relative humidity/wind chill)

Descriptive statistics $n = 2108$

Variable Name	Description	Summary Statistics
OPdays (dependent variable)	Number of days in the previous week in which 2nd grade children played outdoors for 30 minutes or more	Mean: 4.37 (SD: 2.06) Min: 0, Max: 7
feelslikemax86days	Number of days in the week preceding the survey date with an average county-level daily maximum feels-like temperature at or above 86°F	Mean: 1.39 (SD: 2.13) Min: 0, Max: 7
feelslikemax41days	Number of days in the week preceding the survey date with an average county-level daily maximum feels-like temperature at or below 41°F	Mean: 0.14 (SD: 0.52) Min: 0, Max: 4
Sex	1 = female, 0 = male	Female: $n = 1094$ (52%) Male: $n = 1014$ (48%)
Age	Age of second-grade child (in completed years) at survey date	Mean: 7.49 (SD: 0.54) Min: 7, Max: 10
Obese	1 = obese (BMI $\geq$ 95th percentile BMI) 0 = not obese (underweight, healthy weight, or overweight)	Not obese: 1582 (75%) Obese: 526 (25%)
White	Parent-reported ethnicity of child White, Caucasian, Anglo, or other	473 (22%)
Black	Parent-reported ethnicity of child Black or African-American	118 (6%)
Hispanic	Parent-reported ethnicity of child Latino, Hispanic, or Mexican-American	1517 (72%)
Rural	Community type classified as rural	631 (30%)
Urban	Community type classified as urban	620 (29%)
Major Urban	Community type classified as major urban	857 (41%)
North TX	Texas Public Health Regions 1 and 2/3	395 (19%)
West TX	Texas Public Health Region 9/10	328 (15%)
South TX	Texas Public Health Regions 8 and 11	690 (33%)
East Central TX	Texas Public Health Regions 4/5N, 6/5S, and 7	695 (33%)



Percent of participants with temperature exposures of interest in the previous week

Temperature threshold variable	% of participants exposed to this temperature
feelslikemax41days	9%
feelslikemax86days	48%
feelslikemax95days	24%



Image: Olowoleni Tosin via Pexels

Results

2nd graders decreased their outdoor physical activity when it was cold and increased slightly when it was hot.

Younger 2nd graders had fewer OP days than older, girls fewer than boys, and Black and Hispanic students fewer than White/other.



Results:

Weighted
multivariable linear
regression model
with exposures:

feelslikemax41days,
feelslikemax86days

Independent Variable	Regression Coefficient $\pm$ SE	P-value
feelslikemax41days	-0.41 ± 0.15	0.007
feelslikemax86days	0.09 ± 0.06	0.143
Sex (female)	-0.29 ± 0.06	<0.001
Age	0.34 ± 0.14	0.018
Black	-0.69 ± 0.28	0.015
Hispanic	-0.45 ± 0.21	0.033

Results:

Weighted
multivariable linear
regression model
with exposures:

feelslikemax41days,
feelslikemax95days

Independent Variable	Regression Coefficient $\pm$ SE	P-value
feelslikemax41days	-0.45 $\pm$ 0.15	0.004
feelslikemax95days	0.20 $\pm$ 0.12	0.101
Sex (female)	-0.30 $\pm$ 0.06	<0.001
Age	0.35 $\pm$ 0.14	0.012
Black	-0.66 $\pm$ 0.29	0.028
Hispanic	-0.43 $\pm$ 0.21	0.040



Results:

Weighted
multivariable linear
regression model
with exposures:

feelslikemax41days,
feelslikemax86days

Independent Variable	Regression Coefficient $\pm$ SE	P-value
feelslikemax41days	-0.41 ± 0.15	0.007
feelslikemax86days	0.09 ± 0.06	0.143
Sex (female)	-0.29 ± 0.06	<0.001
Age	0.34 ± 0.14	0.018
Black	-0.69 ± 0.28	0.015
Hispanic	-0.45 ± 0.21	0.033



Limitations

No data for summer months

Data were only collected during the academic year

PA data in #days/week

No account for PA schedule modification within a day

Recall bias

Student's PA was retrospectively parent-reported

County-level weather data

No account for temp variations within a single county

No built environment

No account for effects of built environment

Discussion - What could our results mean for children's extreme heat risk in outdoor PA?

- Without outdoor PA adaptation in heat, short and long-term heat health risk may increase
- Adaptations must be made to outdoor play routines and environments



Image: Aleksandar Andreev via Pexels



What more must be done in Public Health research and practice?



More research is needed that...

- Studies children and adolescents
- Incorporates data for summer months
- Evaluates heat-resilience of school PA
- Measures PA objectively (accelerometers)
- Collects hourly rather than daily PA data
- Uses hyper-local place-based weather data
- Evaluates effects of the built-environment
- Investigates cumulative health effects of heat
- Informs regulatory action for child health!

More promotion is needed that...



Image: Raginda Firdaus via Unsplash

- Creates climate-resilient outdoor play environments
(shade structures, tree canopy, heat-tolerant building materials, safe urban green spaces)
- Programmatically adapts PA schedules based on conditions
- Reevaluates school protocols for PA in extreme temperatures
- Outfits schools and community centers with tools and resources

(Lanza et al., 2022; Joshi et al., 2024)

More promotion is needed that...



Image: Lin via Pexels

- Implements *equitable* sustainable urban development
(forested urban parks and gardens, well- insulated buildings, walkable/bikeable neighborhoods)
- Incorporates technological innovation for extreme heat management
- Prioritizes community participation in program planning
- Lobbies for policy action for child health in context of climate change

(Lanza et al., 2022; Joshi et al., 2024)



Image: Vika Glitter via Pexels

What metrics do we use to monitor heat risk?

Heat index
(feels-like temp)

Wet Bulb Globe Temperature
(WBGT)

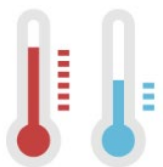
NWS Heat Risk Level

Heat Index health risk thresholds

Temperature & Relative Humidity

Classification	Heat Index/Apparent Temperature	General Affect on People in High Risk Groups
Extremely Hot	$\geq 130^{\circ}\text{F}$	Heat/Sunstroke HIGHLY LIKELY with continued exposure
Very Hot	$105^{\circ}\text{F} - 129^{\circ}\text{F}$	Sunstroke, heat cramps, or heat exhaustion LIKELY , and heatstroke POSSIBLE with prolonged exposure and/or physical activity
Hot	$90^{\circ}\text{F} - 104^{\circ}\text{F}$	Sunstroke, heat cramps, or heat exhaustion POSSIBLE with prolonged exposure and/or physical activity
Very Warm	$80^{\circ}\text{F} - 89^{\circ}\text{F}$	Fatigue POSSIBLE with prolonged exposure and/or physical activity

VARIABLES INCLUDED



temperature



solar radiation



relative humidity



wind speed

Wet Bulb Globe Temperature (WBGT)

The gold standard for outdoor PA in heat

	WBGT	HEAT INDEX
Measured in the sun	●	●
Measured in the shade	●	●
Uses temperature	●	●
Uses relative humidity	●	●
Uses wind	●	●
Uses cloud cover	●	●
Uses sun angle	●	●

(National Weather Service, n.d.)

(National Weather Service, 2020)

Interactive digital heat risk tracking tools

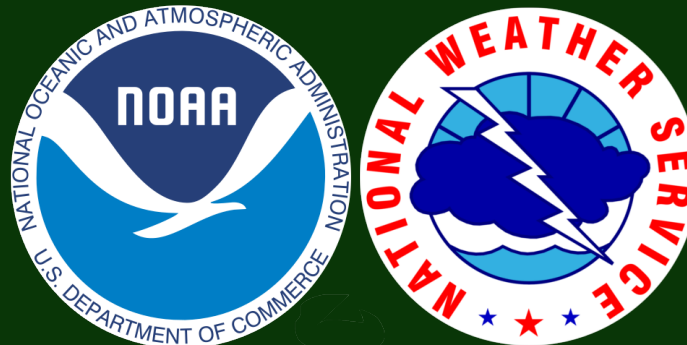
CDC

Daily Heat Risk Tool



NWS

Graphical Forecast



NWS

Local Forecasts





Home

Guidance for
Healthcare
Professionals

About Heat and Your
Health

Share on Your Site

About the Data



HeatRisk

Home

Hot days can affect anyone. If you are pregnant, are a child or teen with asthma, or have a heart condition or other chronic health conditions, heat can make your health worse.

Enter your zip code below to get the *HeatRisk* for this week and actions you can take to keep you and your family safe.



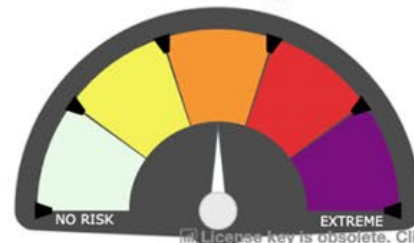
Get Your Local *HeatRisk*

78701: Travis County, TX



Today's *HeatRisk*

Travis County, TX



Moderate

Friday, July 24, 2026

Source: [NOAA/NWS](#)

Today's *HeatRisk* is **Moderate**.

Today is an okay day to be outside for most people.

People who are outside for a long time or who are [sensitive to heat](#) could have health impacts.



Actions you can take to protect your health

Even a few hours in a cool location can lower your risk of harm from heat. Stay hydrated, stay cool.



Heat Risk Levels

0	Little to no risk from expected heat.
1	Minor - This level of heat affects primarily those individuals extremely sensitive to heat, especially when outdoors without effective cooling and/or adequate hydration.
2	Moderate - This level of heat affects most individuals sensitive to heat, especially those without effective cooling and/or adequate hydration. Impacts possible in some health systems and in heat-sensitive industries.
3	Major = This level of heat affects anyone without effective cooling and/or adequate hydration. Impacts likely in some health systems, heat-sensitive industries and infrastructure.
4	Extreme = This level of rare and/or long-duration extreme heat with little to no overnight relief affects anyone without effective cooling and/or adequate hydration. Impacts likely in most health systems, heat-sensitive industries and infrastructure.

Small images for low-bandwidth users are available at <https://graphical.weather.gov/>.

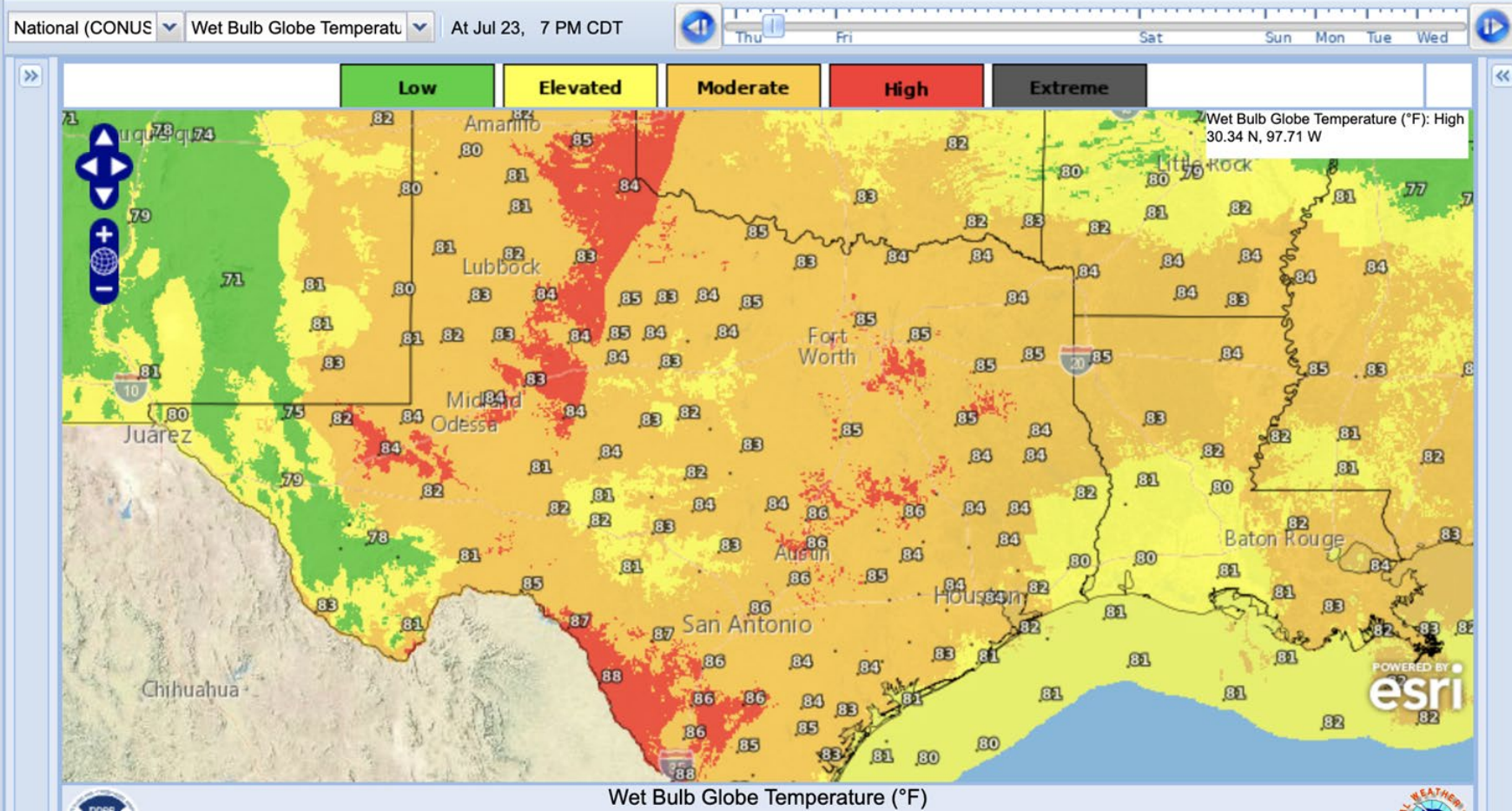
National Weather Service
National Headquarters

Graphical Forecasts

Weather.gov - National Digital Forecast Database Graphical Forecasts

NOTE: Digital display of new NWS forecasts can be delayed by several minutes or more from local issuance.

National Digital Forecast Database Display



<https://digital.weather.gov/>

- Update on ENSO and Impacts on South-Central Texas

Austin/San Antonio, TX

- Heat Advisory until July 23, 08:00 PM CDT

Lat: 30.32°N **Lon:** 97.76°W **Elev:** 656ft.



Humidity 45%
Wind Speed N 8 G 17 mph
Barometer 29.88 in (1010.0 mb)
Dewpoint 72°F (22°C)
Visibility 10.00 mi
Heat Index 106°F (41°C)
Last update 23 Jul 3:51 pm CDT

[Hourly Weather Forecast](#)

Austin TX



Time Period	Temperature	Weather	Other
NOW until 8:00pm Thu	Heat Advisory		
This Afternoon	High: 101 °F	Hot	
Tonight	Low: 80 °F	Partly Cloudy then Chance Showers	30 %
Friday	High: 96 °F	Decreasing Clouds	
Friday Night	Low: 77 °F	Mostly Clear	
Saturday	High: 97 °F	Mostly Sunny	
Saturday Night	Low: 76 °F	Mostly Clear	
Sunday	High: 98 °F	Sunny	
Sunday Night	Low: 77 °F	Mostly Clear	

A resource for parents and guardians:

Adaptations to make
to children's outdoor
PA according to heat
risk level



CHILDREN'S OUTDOOR PLAY: STAYING SAFE IN EXTREME HEAT



Outdoor playtime is important for your child every day, but when temperatures are high, it is critical to adapt to keep your child safe. Children are more vulnerable to extreme heat than adults.



ACROSS TEXAS, CHILDREN ARE NOT GETTING ENOUGH DAILY EXERCISE

Children should get at least 60 minutes of physical activity every day. However, in 2021-2023, only 26% of Texas elementary-aged children were physically active for 60 minutes per day every day in the past week.

ACUTE HEALTH IMPACTS OF HEAT ON CHILDREN

- Heat rash and cramps
- Heat exhaustion or heat stroke
- Dehydration and kidney issues
- Asthma attacks

Certain medical conditions or medications may affect heat tolerance. Talk to your doctor about how to keep your child safe in the heat.

SYMPTOMS OF HEAT-RELATED ILLNESS

- Heavy sweating
- Muscle cramping or weakness
- Headaches
- Disorientation
- Shortness of breath
- Nausea or dizziness
- High body temperature
- Goose bumps or cool, damp skin

ADAPTATIONS TO CHILDREN'S OUTDOOR PLAY BASED ON HEAT RISK LEVEL

Little to No Risk	• Play outside as usual (at least 60 minutes/day every day) • Take breaks every 20 minutes
Minor Risk	• Take breaks and drink water every 20 minutes • Play in a shaded area
Moderate Risk	• Move outdoor activity to the coolest parts of the day, if possible • Play outside no more than 45 minutes at a time • Take breaks and drink water every 15 minutes • Play in a shaded area
Major Risk	• Avoid outdoor activity entirely during late morning to late afternoon hours (when weather is hottest) • Play outside no more than 30 minutes at a time • Take breaks and drink water every 5-10 minutes • Play in a shaded area
Extreme Risk	• Do not play outdoors • Move all physical activity to a safe, air-conditioned space • Drink plenty of water
Other Tips	• Wear loose, lightweight, light-colored clothing or uniforms • Carry a reusable waterbottle. Drink throughout the day • Drink water, not energy drinks, sports drinks, or soda

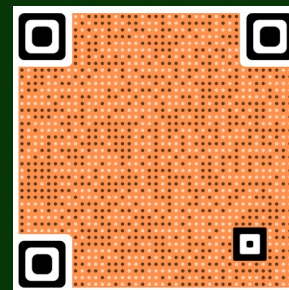
CHECK YOUR AREA'S HEAT RISK DAILY.
SCAN AND ENTER YOUR ZIPCODE!



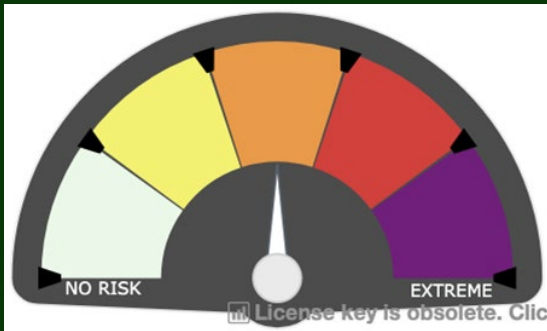
References:

- Austin Independent School District. (n.d.). Health services. <https://www.austinisd.org/health-services>
- California Department of Public Health. (2024, July 1). Extreme heat guidance for schools (Revised from June 30, 2023). <https://www.cdph.ca.gov/Programs/EPO/Pages/Extreme%20Heat%20Pages/extreme-heat-guidance-for-schools.aspx>
- Centers for Disease Control and Prevention. (n.d.). About heat and health. <https://www.cdc.gov/heat-health/about/index.html>
- United Nations Children's Fund. (n.d.). Heat waves are having a devastating impact on children. <https://www.unicef.org/stories/heat-waves-impact-children>
- U.S. Department of Health and Human Services. (2018). Physical activity guidelines for Americans (2nd ed.). Office of Disease Prevention and Health Promotion. https://odphp.health.gov/sites/default/files/2019-09/Physical_Activity_Guidelines_2nd_edition.pdf

Access a copy of this flyer in
English and Spanish on the
Michael & Susan Dell Center for
Healthy Living website:



Adaptations to outdoor play based on heat risk level:



(Austin Independent School District, n.d.)

(California Department of Public Health, 2024)

(Centers for Disease Control and Prevention, n.d.)

Little to No Risk	● Play outside as usual (at least 60 minutes/day every day) ● Take breaks every 20 minutes
Minor Risk	● Take breaks and drink water every 20 minutes ● Play in a shaded area
Moderate Risk	● Move outdoor activity to the coolest parts of the day, if possible ● Play outside no more than 45 minutes at a time ● Take breaks and drink water every 15 minutes ● Play in a shaded area
Major Risk	● Avoid outdoor activity entirely during late morning to late afternoon hours (when weather is hottest) ● Play outside no more than 30 minutes at a time ● Take breaks and drink water every 5-10 minutes ● Play in a shaded area
Extreme Risk	● Do not play outdoors ● Move all physical activity to a safe, air-conditioned space ● Drink plenty of water



New developments in
the news just this
summer...



WBGT Activity Guidelines		
Class 3	Class 2	Activity Guidelines
< 82.0	<79.7	Normal Activities - Provide at least three separate rest breaks each hour with a minimum duration of 3 min each during the workout.
82.0 - 86.9	79.7 - 84.6	Use discretion for intense or prolonged exercise; Provide at least three separate rest breaks each hour with a minimum duration of 4 min each. MANDATORY ONSITE RAPID COOLING ZONE (INCLUDING TUB OR TARP)
87.0 - 90.0	84.7 - 87.6	Maximum practice time is 2 hours; For Football : players are restricted to helmet, shoulder pads, and shorts during practice. If the WBGT rises to this level during practice, players may continue to work out wearing football pants without changing to shorts. For All Sports : Provide at least four separate rest breaks each hour with a minimum duration of 4 min each. MANDATORY ONSITE RAPID COOLING ZONE (INCLUDING TUB OR TARP)
90.1 - 92.0	87.7 - 89.7	Maximum practice time is 1 hour; For Football : No protective equipment may be worn during practice, and there may be no conditioning activities. For All Sports : There must be 20 min of rest breaks distributed throughout the hour of practice. MANDATORY ONSITE RAPID COOLING ZONE (INCLUDING TUB OR TARP)
≥92.1	≥89.8	No outdoor workouts. Delay practices until a cooler WBGT is reached.

**Values in the above chart are WBGT measurements (not temperature or heat index measurements).*

Conclusions

- Extreme heat is worsening in Texas
- Children's health is at risk
- More research, promotion, advocacy, and policy is needed now
- Adaptations must be made to protect children's health in heat - while keeping them active
- Multiple tools are available to track heat risk
- Commitment to health equity!





Thank you!

Please post your questions
in the Q&A!

Suzanna Metcalf, MPH in Epidemiology Candidate
UTHealth Houston School of Public Health in Austin
Suzanna.G.Metcalf@uth.tmc.edu

CONTINUING EDUCATION

This webinar awards **1.0 Entry-Level CHES/MCHES® credit.**

You will receive an evaluation within one week following the webinar if you indicated upon registering that you would like to request CHES/MCHES® credit.



THANK YOU FOR ATTENDING.



Scan the QR code
to view more
webinars and
register for
upcoming ones!