Exposure to extreme heat events is associated with increased hay fever prevalence among nationally representative sample of US adults: 1997–2013

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Abstract

Background—Warmer temperature can alter seasonality of pollen as well as pollen concentration, and may impact allergic diseases such as hay fever. Recent studies suggest that extreme heat events will likely increase in frequency, intensity, and duration in coming decades in response to changing climate.

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Objective—The overall objective of this study is to investigate if extreme heat events are associated with hay fever.

Methods—We linked National Health Interview Survey (NHIS) data from 1997 to 2013 (N=505,386 respondents) with extreme heat event data, defined as days when daily maximum temperature (TMAX) exceeded the 95th percentile values of TMAX for a 30-year reference period (1960–1989). We used logistic regression to investigate the associations between exposure to annual and seasonal *extreme heat events* and adult hay fever prevalence among the NHIS respondents.

Results—During 1997–2013, hay fever prevalence among adults 18 years and older was 8.43%. Age, race/ethnicity, poverty status, education, and sex were significantly associated with hay fever status. We observed that adults in the highest quartile of exposure to extreme heat events had a 7% increased odds of hay fever compared to those in the lowest quartile of exposure (Odds Ratios 1.07, 95% Confidence Interval: 1.02–1.11). This relationship was more pronounced for extreme heat events that occurred during spring season, with evidence of an exposure-response relationship (P_{trend} <0.01).

Conclusion—Our data suggest that exposure to extreme heat events is associated with increased prevalence of hay fever among US adults.

Introduction

Hay fever affects 17.6 million (7.5%) adults in the United States (US) annually and can have an impact on their quality of life.[1–3] In 2005, hay fever-related medical expenses in the United States amounted to $11.2 billion.[4,5]

Hay fever, a term often used for seasonal allergic rhinitis, is a chronic condition caused by an inflammatory response to seasonal allergens, and is characterized by nasal congestion, clear rhinorrhea (runny nose), sneezing, and itching.[6–10] Hay fever is frequently under recognized, misdiagnosed, and ineffectively treated.[11] The causes and triggers of hay fever are seasonal exposure to mold or trees, grass and weed pollens.[6–10] Previous studies have linked rise in ambient temperature with increases in respiratory diseases,[12–16] but no studies to date have investigated the role of extreme heat events on respiratory outcomes such as hay fever on a national scale.

An increasing body of literature suggests that the frequency, intensity, and duration of extreme weather events will continue to rise in the near future in response to changing climate.[17–19] The potential impact of these increases on allergic diseases is a growing concern that has not been empirically assessed for the contiguous US. Prior studies have shown that increases in temperature and CO_2 concentrations affect plant phenology as well as concentration, distribution and allergenicity of pollen.[20–22] This dynamic may worsen the burden of hay fever by increasing both the pollen season length and the potency of pollen.[22–24] An increased burden may differentially impact people living in urban versus

rural areas, and those of low socioeconomic status, children, and older adults[18], because of the urban heat island effect,[25] poor housing conditions[26] and limited adaptive responses.[27]

Using 17 years of health outcome data (NHIS 1997–2013; N=505,386 respondents), we explored the association between exposures to increased frequency of extreme heat events and hay fever among a nationally representative sample of the adult civilian non-institutionalized US population aged 18 years and older.

Methods

Meteorological data

Daily weather data was obtained from two systems within the National Centers For Environmental Information (NCEI)—formerly known as the National Climatic Data Center) —for the 1960–2013 period.[28] Data for the years 1960–2010 were extracted from the DSI-3200 data set. The DSI-3200 data set was discontinued in 2010 and replaced with the Global Historical Climatology Network (GHCN) data set that consists of additional stations that are not part of the original DSI-3200 network. Therefore, for the 2011–2013 period, we identified the DSI3200 stations within the GHCN network using unique station identification and extracted information from this subset of stations to maintain consistency.

Exposure metric

Using daily TMAX for the 1960–1989 reference period, county-specific 30-year baselines for each calendar month were computed. Based on the distribution of this data, we identified the 95th percentile values of TMAX, referred to as Extreme Temperature Threshold 95th percentile (ETT_{95}) as previously described.[29] Daily TMAX values for each county were compared to their respective calendar-month-specific ETT_{95} and assigned a value of "1" if they exceeded the thresholds, and "0" otherwise. The ETT_{95} exceedences —referred to as *extreme heat events (EHE_{95})*— were summed over each calendar month for each county during the 1997–2013 period for which NHIS hay fever prevalence data was available.

Extreme heat event values were assigned to individual NHIS records for each survey year in two ways: 1) the cumulative number of *extreme heat events* for the county of residence in a 12 month window, which include the month of interview and the preceding 11 months; and, 2) the cumulative number of *extreme heat events* for the county of residence in each of the four complete seasons over the 12-month window preceding the month of interview. Seasons were categorized as: Winter – December, January, February; Spring – March, April, May; Summer – June, July, August; Fall – September, October, November.

National Health Interview Survey (NHIS), 1997–2013 data

We combined NHIS data for 1997–2013 for this analysis. The NHIS is a nationally representative cross-sectional household interview survey of the civilian non-institutionalized population of the United States that has been conducted since 1957, although the survey design and questionnaire have changed over time[30]. The NHIS is conducted continuously throughout the year. Between 1997–2013, about 40,000 households were sampled each year, with some households having multiple families. In each family, a

sample adult is selected for detailed questions on health and health care[30]. During the 17-year period, the sample adult response rates ranged from 60.8% to 80.4%.

We used the restricted-use NHIS files geocoded to county FIPS. These files are available through the NCHS Research Data Center (RDC). There are 516,140 sample adults 18 years of age or older in the 1997–2013 NHIS. Respondents were excluded from the analysis if they: 1) resided in a county that had less than 12 months of extreme heat data and had at least one non-valid month for the development of the baseline (n=1,185); 2) resided outside the 48 contiguous states at the time of the interview (n=5,334); or, 3) had missing data for any of the variables used in the analysis (n=4,235), for a total of 10,754 (2%) excluded respondents.

Hay fever was identified using responses to the question: "During the past 12 months, have you been told by a doctor or other health professional that you had hay fever?" Demographic characteristics considered included age (18–34, 35–49, 50–64, 65+ years), race/ethnicity (Hispanic, non-Hispanic black, non-Hispanic white, all other races and ethnicities), sex (female, male), education level (less than high school/GED, high school/GED, some college, Bachelor's degree, Graduate degree), and family income relative to poverty threshold (less than 100%, 100% to less than 200%, 200% to less than 400%, 400% or above the poverty threshold)[31,32]. We used the NHIS multiple-imputed income data to assign poverty status level to records with missing values (percent missing ranged from 4.5% to 10.0% over 1997–2013) using NCHS-recommended methods[33].

We also included a county-level geographical covariate describing urban-rural classification with four urban and two rural categories (urban: large central, large fringe, medium and small metro; rural: micropolitan and non-core).[34] Large central metro counties are counties in Metropolitan Statistical Areas (MSAs) of 1 million or more population that contain the largest principal city of the MSA, are contained within the MSA's largest principal city, or contain at least 250,000 residents of any principal city. Large fringe metro counties are counties in MSAs of 1 million or more population that do not qualify as large central metro. They are considered to be "suburbs" of large cities. Medium and small metro counties are counties in MSAs of 250,000–999,999 and less than 250,000 population, respectively. Micropolitan and noncore counties are nonmetropolitan counties that are not in MSAs.

Statistical analysis

Associations between annual and seasonal total *extreme heat events* and adult hay fever were evaluated using logistic regression models in SUDAAN which accounts for the complex clustered sample design of the NHIS[35]. Unadjusted and adjusted models were fitted separately for each overall annual cumulative lag and seasonal cumulative lag of *extreme heat events*. We fitted additional models for *seasonal extreme heat events* separately based on interview season defined in the description of the survey. The quartiles for overall exposure and seasonal exposure were based on the distribution of extreme heat events for all 3,109 counties in the contiguous United States. Because the actual cutoff point for seasonal quartiles varied by season, we decided to use same approximate cutoff for all season to maintain comparability.

RESULTS

Among adults aged 18 years and older, 8.43% (n=42,601) reported being told they had hay fever within the previous 12 months for the period 1997 to 2013 (Table I). All characteristics shown in Table I, except urban-rural classification, were significantly associated with hay fever status. After full adjustment, women have a 30% (OR: 1.30, 95% CI: 1.27–1.33) increased odds of being diagnosed with hay fever compared to men. Compared to Hispanics, non-Hispanic whites and non-Hispanic blacks have a 44% (OR: 1.44, 95% CI: 1.37–1.33) and a 9% (OR: 1.09, 95% CI: 1.03–1.15) increased odds of receiving a hay fever diagnosis. Likewise, compared to 18–34 year olds, those in 35–49, 50–64 and >=65 year age groups had a 67%, 59%, and a 13% increased odds of receiving a hay fever diagnosis, respectively. Also, as education and income increases the odds of hay fever diagnosis increases.

Extreme heat events (approximate quartiles of the cumulative number of *extreme heat events* in the 12 months preceding the survey) were significantly associated with hay fever prevalence in an unadjusted analysis (Table II, Model 1). When adjusting for demographic characteristics (Table II, Model 2), the association between extreme heat events and hay fever persisted, i.e., compared to adults in the lowest quartile of exposure to extreme heat events (0 to 10 events), adults in the higher quartiles of exposures had higher odds of reporting a diagnosis of hay fever in the previous 12 months. This increase in odds ranged from 5% (OR 1.05, 95% CI: 1.01–1.09) for adults in the 2nd quartile to 7% (OR 1.07, 95% CI: 1.03–1.11) for adults in the 4th quartile. Additional adjustment for urbanicity did not change the observed association (Table II, Model 3).

When we analyzed by timing (season) of extreme heat events, we observed a clear exposure-response relationship for associations between springtime extreme heat events and odds of hay fever ($P_{trend} < 0.01$, Table III). For springtime extreme heat events, the increases in odds of hay fever ranged from 2% (OR 1.02, 95% CI: 0.98–1.06) for adults in the 2nd quartile to 7% (OR 1.07, 95% CI: 1.03–1.12) for adults in the 4th quartile (Table III). For extreme heat events that occurred during summer and winter, the increases in the odds of hay fever was significant only among those in the highest quartile of exposure (Table III). Such associations were not observed for extreme heat events that occurred during fall.

Sensitivity analyses using both more liberal (90th percentile threshold) and more conservative (99th percentiles threshold) exposure metrics did not alter our overall findings related to extreme heat events and hay fever prevalence (Supplementary Tables 1 & 2). Additional sensitivity analysis looking at the seasonal differences also showed more pronounced and consistent effect associated with springtime extreme heat events (Supplementary Table 3). The effects of extreme heat events remained significantly associated with hay fever prevalence when all models were additionally adjusted for the month or year of interview (data not shown).

Discussion

We evaluated the relationship between exposures to annual and seasonal extreme heat events and the prevalence of hay fever among a nationally representative sample of civilian non-

institutionalized US adults using NHIS data collected between 1997 to 2013. This analysis builds upon previous work that has shown an association between increasing temperature and longer pollen seasons for important allergens such as ragweed.[22,23,36]

The present study found a modest positive association between exposures to extreme heat events, particularly during spring, and the prevalence of hay fever.. For the extreme heat events during summer and fall, findings were significant only among individuals in the highest quartile of exposure. Our findings regarding exposures to extreme heat events and hay fever prevalence were not substantially affected by adjustment for demographic factors and county urbanicity. The magnitude of the association, while small, has implications on a population level. That is, while individual clinicians may not observe dramatic increases in the number of affected patients, the US burden of hay fever could be significantly affected by an increase in extreme heat events. While the exact mechanisms by which long-term exposures to extreme heat events increase the risk of hay fever remain unclear, one potential explanation is changes in plant phenology. Higher frequency of extreme heat events, particularly those occurring in winter and spring season may lead to earlier onset of greening and flowering of plants including trees that are major sources of pollen.[22,23] This is supported by a more recent study that showed the spring flowering taxa encountered the most pronounced increasing trend for pollen production compared to other season.[37] Earlier onset of spring effectively increases the duration of exposure to pollen, which is an important risk factor for hay fever.[21–23] Others have shown higher pollen production associated with warmer temperatures.[38,39] Increased frequency of extreme heat events may lead to higher concentration of pollen in the environment—in addition to increasing the possible duration of exposure.[38,40,41] Our findings that show a positive association between extreme heat events during winter and spring seasons and hay fever prevalence support the aforementioned two hypotheses of longer duration and greater concentration of pollen exposure. When temperatures in winter and spring are unusually warm, individuals may spend more time outdoors, bringing them in closer contact with outdoor pollen as well as other pollutants; however, national patterns of time spent outdoors are unknown.

Regardless of the exact underlying mechanism, our study is the first to link exposures to extreme heat events and increased odds of hay fever in the Contiguous US. Previous studies have shown that the frequency and intensity of such extreme events are increasing and will continue to do so in the coming decades.[19] Our data show the potential impact of such increases on allergic diseases such as hay fever. Our study relied on a large (n=505,386) nationally representative sample of the civilian non-institutionalized US population. Our county-specific and calendar month-specific exposure metric generated using the 30-year of baseline data (1960–1989) enabled us to focus on changes in frequency of extreme events relative to 30-year baseline rather than short-term weather phenomena. Furthermore, we were able to control for several socioeconomic characteristics including educational level, family income relative to the poverty threshold, and the urban-rural classification of the county; but they were not sensitive to further adjustment for region. Finally, we performed several sensitivity analyses, which established the robustness of our findings.

Our study also has several limitations. The term hay fever is a lay term used synonymously with seasonal allergic rhinitis.[10] However, it is unknown how often this term is used for

general allergic rhinitis, which can include perennial symptoms caused aeorallergens. Imprecise use of the term hay fever may be reflected in the NHIS. Furthermore, it is not clear if there are cultural, geographic, or other differences in how survey participants use the term 'hay fever,' and if use of a more general term such as 'seasonal allergic rhinitis' would have yielded different prevalence estimates. However, the NHIS includes two questions for children, one with the term "hay fever" and the other with the term "respiratory allergy," and similar magnitudes of differences by race/ethnicity are observed when responses to both questions are combined to estimate overall respiratory allergy (http://www.cdc.gov/nchs/products/databriefs/db121.htm).

The NHIS is a multipurpose health survey, and as such, lacked information needed to more fully examine the effects of extreme heat events on hay fever. For instance, the NHIS survey does not collect exact date of onset of outcomes, degree of hay fever symptoms, or clinical indicators of allergen sensitization. In addition, we have no information on local pollen levels, which may have improved our understanding of the association between extreme heat events and reported allergies. From the cross-sectional design of the NHIS we cannot establish a clear temporality in exposure to extreme heat event and hay fever, and our results may be affected by the length of time between exposure to extreme heat events and the recall of hay fever.[42] Moreover, hay fever may not capture the full spectrum of seasonal allergic rhinitis—a more complete measurement of seasonal respiratory allergies could result in a different observed association. Another limitation is the use of county of residence to define exposure for the NHIS respondents. However, this likely resulted in non-differential measurement error, so the observed associations are an underestimation of the true measure. Finally, our study did not include additional risk factors including air pollution and pollen measurements in this multidimensional issue involving climate–pollution–allergen effect.[43]

Conclusions

We investigated the impact of extreme heat events on the prevalence of hay fever among a nationally representative sample of the civilian non-institutionalized US population from 1997 to 2013. We observed a modest, but significant, association between exposures to extreme heat events and hay fever prevalence. The findings were more pronounced for springtime extreme heat events. Our results provide empirical evidence of how extreme heat events, projected to increase in frequency, duration and intensity in the future, adversely impact allergic disease among US adults.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Abbreviations Used

AOR	Adjusted Odds Ratio
CI	Confidence Interval
DSI-3200	Data Set 3200
EHE	Extreme Heat Events
GED	General Education Development
GHCN	Global Historical Climatology Network
MSA	Metropolitan Statistical Area
NCEI	National Centers For Environmental Information
NHIS	National Health Interview Survey
OR	Odds Ratio
RDC	Research Data Center
TMAX	Daily Maximum Temperature
US	United States

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Highlight Box

1. What is already known about this topic? Extreme heat events are projected to increase in frequency, duration and intensity in coming decades in response to changing climate

2. What does this article add to our knowledge? We show that exposure to extreme heat event is associated with increased hay fever prevalence among US adults.

3. How does this study impact current management guidelines? Future clinical guidance on allergen avoidance and medication initiation may need to consider frequency and timing of extreme heat events.

Table I

Characteristics of adults 18 years and older[*], NHIS 1997–2013

Variables	Categories	All	Hay Fever	EHE$_{95}$ Quartiles[§]			
				0–10 days	11–16 days	17–24 days	25 days or more
		(n=505,386)	(n=42,601)	(n=111,524)	(n=113,255)	(n=123,998)	(n=156,609)
Total Percent		100	8.43	21.91	22.49	24.65	30.94
Hay Fever							
	No	91.57	-----	21.99	22.47	24.66	30.88
	Yes	8.43	-----	21.05	22.72	24.61	31.61
Race/ethnicity							
	non-Hispanic white	71.28	9.20	22.46	23.07	24.33	30.14
	non-Hispanic black	11.50	6.78	22.55	20.99	24.81	31.66
	Hispanic	12.52	5.73	18.98	20.65	25.81	34.56
	All other races and ethnicities	4.70	8.05	19.78	22.33	26.17	31.71
Sex							
	Male	48.13	7.45	21.89	22.54	24.77	30.80
	Female	51.87	9.35	21.93	22.45	24.55	31.08
Age							
	18–34 years	31.27	6.21	21.69	22.58	25.04	30.69
	35–49 years	29.40	10.34	21.86	22.50	24.76	30.88
	50–64 years	22.86	10.07	21.66	22.59	24.31	31.43
	65 years and older	16.48	6.98	22.78	22.16	24.21	30.85
Education							
	<High school/GED	16.24	6.00	21.92	22.12	25.19	30.77
	High school/GED	28.65	6.89	22.65	22.52	24.47	30.36
	Some college	29.48	9.19	22.11	22.57	24.55	30.78
	Bachelor's degree	16.83	10.29	21.11	22.56	24.59	31.74
	Graduate degree	8.79	11.88	20.36	22.7	24.75	32.19
Poverty Status[^]							

Variables	Categories	All	Hay Fever	EHE₉₅ Quartiles§			
				0–10 days	11–16 days	17–24 days	25 days or more
	Less than 100%	12.33	6.92	21.99	21.92	24.88	31.22
	100 to less than 200%	18.40	6.96	22.79	21.91	24.70	30.60
	200 to less than 400%	31.17	7.99	22.55	22.48	24.51	30.46
	400% or greater	38.09	10.00	20.94	22.97	24.67	31.42
Urban-rural classification[+]							
	Large central metro	28.22	8.09	17.93	22.68	27.43	31.97
	Large fringe metro	24.00	9.08	23.10	22.94	23.39	30.57
	Medium metro	20.99	8.63	22.27	21.85	23.37	32.51
	Small metro	10.13	8.56	23.00	23.26	24.63	29.12
	Micropolitan	10.20	7.86	25.52	20.43	23.83	30.22
	Non-core	6.46	7.55	26.34	24.14	22.76	26.75

All percentages were weighted using NHIS survey weights.

[*] Includes sample adults 18 years and older with complete data for analytic covariates.

§ The categories of days represent the quartiles of exposure based on county of residence

[+] Counties were classified into urbanization levels based on the 2006 NCHS Urban-Rural Classification Scheme for Counties.

^ Family income as a percent of Poverty Threshold

EHE₉₅: Extreme heat events – days where the daily TMAX value exceeded the county and calendar month specific 95th percentile threshold, calculated using 30 year of baseline data.

Table II

Unadjusted (Model 1) and adjusted (Models 2 and 3) odds ratios for hay fever among US adults[*], NHIS 1997–2013

Variables	Categories	Model 1	Model 2	Model 3
		OR (95% CI)	OR (95% CI)	OR (95% CI)
EHE_{95}		$P_{trend} <0.001$	$P_{trend} <0.05$	$P_{trend} <0.05$
	Q1 (0–10 days)[#]	1.00	1.00	1.00
	Q2 (11–16 days)	1.06 (1.02–1.10)	1.05 (1.01–1.09)	1.05 (1.00–1.09)
	Q3 (17–24 days)	1.04 (1.00–1.08)	1.05 (1.00–1.09)	1.04 (1.00–1.09)
	Q4 (25 days)	1.07 (1.03–1.11)	1.07 (1.03–1.11)	1.07 (1.02–1.11)
Sex			$P_{trend} <0.001$	$P_{trend} <0.001$
	Male[#]		1.00	1.00
	Female		1.30 (1.27–1.33)	1.30 (1.27–1.33)
Race/ethnicity			$P_{trend} <0.001$	$P_{trend} <0.001$
	non-Hispanic white		1.42 (1.35–1.49)	1.44 (1.37–1.51)
	non-Hispanic black		1.09 (1.03–1.15)	1.09 (1.03–1.15)
	Hispanic[#]		1.00	1.00
	All other races and ethnicities		1.19 (1.10–1.28)	1.19 (1.10–1.29)
Age			$P_{trend} <0.001$	$P_{trend} <0.001$
	18–34 years[#]		1.00	1.00
	35–49 years		1.66 (1.61–1.72)	1.67 (1.61–1.73)
	50–64 years		1.59 (1.53–1.65)	1.59 (1.53–1.65)
	65 years and older		1.12 (1.08–1.17)	1.13 (1.08–1.18)
Education			$P_{trend} <0.001$	$P_{trend} <0.001$
	<High school/GED[#]		1.00	1.00
	High school/GED		1.02 (0.98–1.07)	1.02 (0.98–1.07)
	Some college		1.40 (1.33–1.46)	1.39 (1.33–1.45)
	Bachelor's degree		1.50 (1.42–1.57)	1.48 (1.41–1.56)
	Graduate degree		1.68 (1.59–1.78)	1.67 (1.57–1.77)
Poverty Status			$P_{trend} <0.001$	$P_{trend} <0.001$
	Less than 100%[#]		1.00	1.00
	100 to less than 200%		0.96 (0.92–1.00)	0.96 (0.92–1.00)
	200 to less than 400%		0.98 (0.94–1.02)	0.98 (0.94–1.02)
	400% or greater		1.05 (1.01–1.10)	1.04 (1.00–1.09)
Urban-rural classification[+]				$P_{trend} <0.1$
	Large central metro			0.99 (0.94–1.03)
	Large fringe metro			1.00 (0.96–1.05)
	Medium metro[#]			1.00
	Small metro			0.99 (0.91–1.08)

Variables	Categories	Model 1	Model 2	Model 3
		OR (95% CI)	OR (95% CI)	OR (95% CI)
	Micropolitan			0.92 (0.85–1.00)
	Non-core			0.89 (0.82–0.98)

#Reference Category

*Includes sample adults 18 years and older with complete data for analytic covariates

Model 1: Unadjusted; Model 2: adjusted for gender, race/ethnicity, age, education and poverty threshold; Model 3: additionally adjusted for urban-rural classification.

^Family income as a percent of Poverty Threshold

+Counties were classified into urbanization levels based on the 2006 NCHS Urban-Rural Classification Scheme for Counties.

EHE95: Extreme heat events – days where the daily TMAX value exceeded the county and calendar month specific 95th percentile threshold, calculated using 30 year of baseline data.

Table III

Adjusted odds ratios [AORs (95% CIs)] for hay fever in adults[*], NHIS 1997–2013, by season

Season	EHE$_{95}$ Categories	P$_{trend}$	AOR (95% CI)	Percent
Spring		<0.01		
	Q1 (0–2 days)[#]		1.00	32.19
	Q2 (3–4 days)		1.02 (0.98–1.06)	20.49
	Q3 (5–8 days)		1.04 (1.00–1.07)	28.25
	Q4 (9 days)		1.07 (1.03–1.12)	19.07
Summer		>0.05		
	Q1 (0–2 days)[#]		1.00	41.46
	Q2 (3–4 days)		1.01 (0.97–1.05)	14.51
	Q3 (5–8 days)		1.02 (0.99–1.06)	21.09
	Q4 (9 days)		1.04 (1.00–1.07)	22.94
Fall		>0.05		
	Q1 (0–2 days)[#]		1.00	35.14
	Q2 (3–4 days)		1.01 (0.97–1.04)	19.99
	Q3 (5–8 days)		1.00 (0.97–1.04)	29.63
	Q4 (9 days)		1.02 (0.98–1.07)	15.24
Winter		<0.01		
	Q1 (0–2 days)[#]		1.00	32.72
	Q2 (3–4 days)		0.95 (0.92–0.99)	18.55
	Q3 (5–8 days)		0.98 (0.94–1.01)	28.84
	Q4 (9 days)		1.05 (1.01–1.09)	19.88

Adjusted for sex, age, race/ethnicity, education, family income as percent of poverty threshold, urban-rural classification, and month of interview.

[#]Reference Category

[*] Includes sample adults 18 years and older with complete data for analytic covariates.

All percentages were weighted using NHIS survey weights.

EHE95: Extreme heat events – days where the daily TMAX value exceeded the county and calendar month specific 95th percentile threshold, calculated using 30 year of baseline data.