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The Relation of Gestation Length to Short-Term Heat Stress

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ABSTRACT

Objectives. This study examined the association between gestation length and heat exposure during the summer months of the Chicago heat wave of 1995.

Methods. Birth data from Illinois vital records containing 11 792 singleton vaginal births were analyzed to calculate mean gestational ages.

Results. No evidence was found to suggest an association between shortened gestation and increased maximum apparent temperature.

Conclusions. The data propose no special precautions for pregnant women exposed to short-term heat stress of the intensity evaluated in this study. However, the possible effects of chronic heat exposure on gestation cannot be ruled out. (*Am J Public Health.* 1999;89: 1090–1092)

On the basis of previous physiological studies linking heat exposure to increased uterine contractility and oxytocin release,[1,2] a recent journal article presented a preliminary analysis of the relationship between the heat–humidity index and preterm labor and delivery.[3] The analysis was preliminary because data were limited to 1 hospital and 4 weeks of data collection.

As our group and others have previously reported, the July 1995 heat wave that struck Chicago and other parts of the midwestern United States was one of the most deadly on record.[4,5] Data from that experience afforded a natural opportunity to examine the relationship between gestation length and heat exposure in a large population.

Methods

Study Population

Birth data were abstracted from Illinois vital records files for 1995. We included singleton vaginal births to Chicago residents during the months of June to August. The data set contained 11 792 observations.

Measures

The outcome variable was mean gestational age (in weeks). Gestational age was based on the mother's most recent menstrual period and the infant's birthweight as referenced in the natality data manual of the Centers for Disease Control and Prevention.[6] The independent variable was maximum apparent temperature, sometimes referred to as the "maximum heat index." This index is an indication of what a combination of dry-bulb temperature and dew-point temperature feels like to the typical person.[7]

Three variables were chosen as possible confounding factors: maternal race/ethnicity, educational status (less than 12 years of education vs 12 or more years of education), and community area median household income. We divided the 77 officially designated Chicago community areas into 2 groups on the basis of 1989 median household incomes. One group comprised the 20 community areas with the lowest median household incomes (less than $20 500); the second group comprised the remaining 57 community areas, those with average or high median incomes. Data on median household income were extracted from 1990 US Census Summary Tape File 3A.

Local climatological data on daily maximum and average daily dew-point temperatures at Chicago's O'Hare Airport in 1995 were obtained from the National Climatic Data Center (Asheville, NC). A heat index table consisting of dew-point and dry-bulb temperatures was obtained from the National Weather Service. Temperatures derived from the daily Chicago climatological data were matched to those on the heat index scale to determine the daily maximum

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apparent temperatures for the study period. National Weather Service guidelines use "extreme" and "hazardous" to describe apparent temperatures above 90°F and above 100°F, respectively. For our study, maximum apparent temperatures were used to group days into the following categories: less than 90°F, 90°F to 99°F, 100°F to 109°F, and 110°F or higher.

We calculated mean gestational ages by each stratum of confounders and temperature combinations. With temperatures less than 90°F as the baseline category, *t* tests for independent means were conducted, and a 95% significance level was used in these analyses. Because our hypothesis was that the heat wave shortened gestation, we used a 1-tailed test. To assess the possibility of a delayed adverse heat response resulting in shortened gestation, we performed 1- and 2-day lag time analyses; such lagged responses were employed in a previous analysis of mortality associated with the heat wave.[4]

Results

Table 1 displays the distribution of days with maximum apparent temperatures that fell within each of the 4 temperature categories and the corresponding average maximum apparent temperature by month. Forty-nine percent of the days in the study period had maximum apparent temperatures below 90°F, 36% had maximum apparent temperatures of 90°F to 99°F, 12% had maximum apparent temperatures of 100°F to 109°F, and 3% had maximum apparent temperatures 110°F or higher.

Sample characteristics are presented in Table 2. The largest percentage of births was to non-Hispanic Black women, while the smallest percentage was to non-Hispanic White women. Forty-one percent of the women had less than 12 years of education. These distributions were comparable to Chicago data for the entire year. Thirty percent of the births were to women residing in the 20 community areas with the lowest median household incomes. Similar proportions of births were noted for each corresponding temperature category within each of the 3 lag day periods.

Table 3 presents the average gestational length for each of the 4 temperature categories for each of the 3 lag days (0, 1, and 2 days) by median household income, race/ethnicity, and education. There was no evidence among the 24 categories that increasing maximum apparent temperature was associated with shortened gestation length.

TABLE 1—Number of Days and Average Maximum Apparent Temperature (MAT), by Month and MAT Category: Chicago, Illinois, June–August 1995

	No. of Days (Mean Temperature)			
Month	<90°F	90–99°F	100–109°F	≥110°F
June	19 (. . .)[a]	11 (94.1°)	0 (. . .)	0 (. . .)
July	16 (. . .)[a]	7 (94.0°)	6 (104.4°)	2 (120.7°)
August	10 (85.6°)	15 (94.4°)	5 (105.7°)	1 (110.4°)
Total	45	33	11	3

[a]Not available.

TABLE 2—Characteristics of Births, by Confounding Factors, Lag Time, and Maximum Apparent Temperature (MAT): Chicago Residents, June–August 1995 (n = 11 792)

Characteristic	Sample, %
Race/ethnicity	
Non-Hispanic Black	42.4
Non-Hispanic White	20.4
Hispanic	33.5
Median community area income, $	
Average–high (>20 500)	69.9
Lowest (<20 500)	30.1
Education, y	
≥12	59.3
<12	40.7
Lag time and MAT	
0-day lag	
<90°F (baseline)	47.7
90–99°F	36.6
100–109°F	12.1
≥110°F	3.6
1-day lag	
<90°F (baseline)	48.5
90–99°F	35.6
100–109°F	12.4
≥110°F	3.4
2-day lag	
<90°F (baseline)	47.9
90–99°F	35.9
100–109°F	12.6
≥110°F	3.6

Discussion

This study failed to support our hypothesis of shortened gestation with increased heat stress. Our study is thus inconsistent with the study of Lajinian et al.,[3] which found a trend of increased premature labor rates and delivery rates with increased heat stress, although only the former was statistically significant. However, our findings are consistent with a study conducted in Finland that found that exposure to short-term heat stress did not significantly influence gestation.[8] Although there are other data that suggest that seasonal change affects uterine contractility,[2] we were unable to investigate this possibility because we focused on 3 of the warmest months of the year.

The large sample size and consistency of the data source (vital records) are strengths of this analysis. The fact that some significant differentials in gestation length existed among racial and ethnic groups, income groups, and educational groups suggests that the data can be used to detect variation. That such variation did not exist in the expected direction speaks against our hypothesis.

One limitation of this study is our use of the O'Hare Airport maximum apparent temperature reading as the exposure variable for the entire city of Chicago. This reading may not be representative of the actual tempera-

TABLE 3—Mean Gestational Age of Births, by Sample Characteristics, Maximum Apparent Temperature, and Lag Time Categories: Chicago Residents, June–August 1995

	Mean Gestational Age, wk		
	0-Day Lag	1-Day Lag	2-Day Lag
Overall			
<90°F	38.6	38.7	38.6
90–99°F	38.7	38.7	38.7
100–109°F	38.7	38.8	38.8
≥110°F	38.9	38.7	38.8
Community area with average–high median incomes (>$20 500)			
<90°F	38.8	38.7	38.7
90–99°F	38.8	38.8	38.8
100–109°F	38.8	38.9	38.9
≥110°F	38.9	38.8	38.9
Community area with lowest median incomes (<$20 500)			
<90°F	38.3	38.4	38.4
90–99°F	38.6	38.5	38.5
100–109°F	38.4	38.5	38.6
≥110°F	38.7	38.6	38.6
Non-Hispanic Whites			
<90°F	39.2	39.2	39.2
90–99°F	39.2	39.3	39.2
100–109°F	39.3	39.1	39.2
≥110°F	39.4	39.2	39.0
Non-Hispanic Blacks			
<90°F	38.1	38.2	38.2
90–99°F	38.4	38.2	38.3
100–109°F	38.4	38.5	38.6
≥110°F	38.5	38.7	38.6
All Hispanics			
<90°F	38.9	38.9	38.9
90–99°F	38.8	38.9	38.9
100–109°F	38.9	38.9	38.9
≥110°F	38.9	38.8	38.9
Fewer than 12 years of education			
<90°F	38.6	38.6	38.6
90–99°F	38.6	38.6	38.6
100–109°F	38.6	38.7	38.7
≥110°F	38.6	38.6	38.7
More than 12 years of education			
<90°F	38.7	38.7	38.7
90–99°F	38.8	38.8	38.8
100–109°F	38.8	38.9	38.9
≥110°F	39.1	38.9	38.9

ture in all regions of Chicago. The use of community area income as a marker for individual-level income is another limitation, because household income can vary substantially within community areas, thus adding another potential source of bias. Lack of clinical data restricted our ability to assess delivery rates and determine the stages of pregnancy. Maternal and fetal responses to short-term heat exposure may vary with stage of pregnancy, so there may be subgroups of women who are at higher risk for shortened gestation. In addition, insufficient variability between maximum apparent temperatures that was caused by selecting 3 of the warmest months of the year may have masked the effects of a true relationship between length of gestation and heat stress.

Conclusion

Because little is known about the impact that environmental stressors have on pregnancy and labor, we cannot rule out the possible effects of chronic heat exposure on gestation. Lajinian and colleagues[3(p1206)] noted: "Given the public health importance of preterm delivery and the frequency of exposure to extremes of heat, studies designed to confirm or refute our preliminary observations are warranted." Our study does not suggest any additional risk of shortened gestation for pregnant women exposed to days with extreme or hazardous heat stress of the duration and intensity assessed in this investigation. □

Contributors

K. Porter participated in designing the study, conducted all of the computations and much of the analysis, and was the primary writer of the paper. S. Thomas participated in designing the study, assisted with the analysis, and wrote the Discussion section. S. Whitman conceived the study, participated in designing the study, and assisted with analysis and writing.

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