The link between temperature and child abuse

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Abstract

Objective: Published literature suggests that naturally occurring variations in environmental temperatures can have significant influences on the tendency for violent behaviors. The primary objective of this study was to see whether an association exists between temperature variations and the occurrence of child abuse.

Methods: We conducted a retrospective chart review of patients who presented to our pediatric emergency department with substantiated cases of child abuse from January 1, 2007 – December 31, 2016. Linear regression on 7-day moving average cases of child abuse vs 7-day average temp was calculated. In addition, daily average incidence of child abuse per 10-degree range was calculated by dividing the total cases of abuse in a given temperature range by the total number of days in the same range. Finally, we calculated rates of abuse over summer vs. winter break.

Results: The frequency of child abuse increased with increasing temperatures. Simple linear regression yielded a coefficient of 0.01 for the 7-day moving average cases of child abuse vs 7-day average temp. The Cochran-Armitage test for increasing trend on the daily average incidence of child abuse per 10-degree range was significant (p<0.01). Poisson test on the rate of abuse over summer vs. winter breaks produced a rate ratio of 1.34 with 95% confidence interval [1.01, 1.82] (p=0.03).

Conclusion: Our study reflects the findings of prior literature to support an apparent positive association between temperature and the prevalence of violent behavior, and in the case of this study specifically child abuse.

Introduction

Child abuse is a violent crime that affects one in four children in the United States (US) [1]. More concerning is data from a national estimate in the United States that shows a 3.0% increase in child abuse from 2012 (656,000) to 2016 (676,000) [2]. It is now understood that children who experience abuse in childhood are at an increased risk of adverse health outcomes [3,4]. Thus, it comes as no surprise that identifying and assessing risk factors associated with child abuse is a national research priority [5]. Given the multifactorial nature of child abuse multidisciplinary research is needed to better understand predisposing factors to help identify children at risk and factors that influence rates of child abuse. Since a large number of children seeking care for abuse present to the Emergency Department, this setting provides an ideal environment to identify patterns associated with abuse. Working in a large tertiary Children’s Hospital, we have noted an increase in child abuse patterns during times of increased temperature. Recognizing this as a possible risk factor for child abuse could allow for prospective public service initiatives and educational programs to help protect and care for these children. Additionally, understanding these risk factors potentially could assist social services and healthcare organizations attempting to maximize resource allocation.

The assumption that temperature has an effect on human behavior is one that is deeply rooted in society. Phrases like “hot headed” or “cold hearted” are examples of how we as a culture support the idea that ambient temperatures are somehow intrinsically linked to human behavior. Hippocrates himself is credited with being a champion of humoral medicine in which different “humors” were associated with various qualities of temperatures as well as temperaments [6]. Surprisingly, little scientific inquiry into this idea occurred until the turn of the twentieth century when researchers first began to look at associations between weather and incidents of crime [7]. However, formal evaluation of this age-old assumption did not take off until the 1970s when Baron and Bell performed groundbreaking experiments where they questioned the presumably simple nature of the temperature-aggression relationship [8,9]. Results from these early laboratory experiments sparked an explosion of interest in this field, and soon researchers began comparing the laboratory findings to reports of violent crimes and historical weather data. Over the decades various models have been proposed for the association between temperature and its effects on human behavior, but two dominate the literature. Having their origins in the previously mentioned laboratory experiments are the Negative Affect Escape (NAE) model and its rival the General Affect (GA) model. The specifics of these models are not going to be discussed or investigated here, but a foundational understanding of them seems prudent. The NAE model is one that is curvilinear, and postulates an inflection point above which there

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is a paradoxical reduction in aggression caused by temperature [10]. However, the GA model is linear with direct correlation between temperatures and aggression [11]. While there is still debate on the exact shape of the graph, the overall trend is obvious. However, the studies these models are based on use mostly police reports of violent crimes like assault, rape, and robbery. Measuring the incidence of child maltreatment as the dependent measure and its association with temperature brings about notable differences that can be applied to the NAE and GA models. For example, in regard to the NAE model the Routine Activity Theory (RA) attempts to explain the NAE model by stating that the inflection point is where people are most likely to be outside their homes and thus encounter situations in which violent crimes are more likely [12]. Measuring the correlation between child maltreatment and temperature would provide a previously unmeasured variable since the vast majority of child maltreatment happens not at the hand of strangers but from the child’s caretaker [2].

Furthermore, recent literature shows that climate has significant effects on overall human health [13,14]. This evidence supports the hypothesis that we have previously underestimated the effects of temperature on human behavior. For example, rates of suicide and depressive social media language have been shown to rise with temperature [15]. Even cognitive function has been shown to be negatively impacted by increasing temperatures [16]. The effect of temperature on human behavior is not limited to intrapersonal relationships either. Recent comprehensive synthesis of literature on the effects of climate on human conflict showed that deviations from mild temperature increase the risk of conflict, often substantially [17]. Thus, a growing body of evidence supports the idea that temperature has a significant effect on human behavior; however to date no study has investigated its association with rates of child abuse.

Materials and methods

Design

Institutional review board approval was obtained to perform this retrospective chart review. We chose a time period of 10 years, January 1, 2007 – December 31, 2016, in which to perform our chart review. We requested charts with ICD9 and ICD10 codes for all cases of child abuse that presented to our pediatric emergency department (PED). Medical personnel are mandated reporters of child maltreatment. In our institution, if child abuse is suspected, the medical provider contacts social services, and an internal institutional form of suspected maltreatment (CHO-25) is filed with the chart. Those charts are then reviewed by our Child Protection Team (CPT). In order to include only substantiated cases of child abuse we included only charts that were evaluated by our CPT. Evaluations by the CPT included interviewing the family and/or caregiver at the time of injury, evaluation of laboratory/ radiological studies, and forensic examination and possible interviews of the victims. Each case was discussed individually by the CPT, which is made up of child abuse pediatricians, social services, department of human services (DHS), law enforcement, and a representative from the district attorney’s office. All children evaluated in the PED and found by the CPT to have substantiated claims of physical or sexual abuse with a subsequent DHS referral were included in this study. Patients who were found to have experienced solely neglect were excluded from the analysis as these cases were much less likely to be the product of violence.

We used the National Weather Service (NWS) records for local climatological data as reported by the nearest weather station approximately 8 miles our emergency department. We chose this station due to its central location within the state and greater metropolitan area from which our facility serves. The weather data obtained included maximum and minimum daily temperature as well as average daily temperature for every day during the 10-year period of our study. There were no missing data points for the data collected.

Results

Analysis/results

Between January 1, 2007 – December 31, 2016 we found 1,511 cases of child abuse that met our inclusion criteria. There was a near-even split between female (806) and male (705) cases of child abuse. There were 1,157 cases of physical abuse, 352 cases of sexual abuse, and two cases in which the child was found to have both physical and sexual abuse. The mean age of abused children was 5.54 years old with a standard deviation of 4.76 years.

For our first analysis we calculated a 7-day moving average due to the fact that our data included a large number of days in which no abuse was reported. To do this we started with the first 7-days of our 10-year data set. We then calculated the number of substantiated cases of child abuse over these seven days. Next the average temperature of the seven days in question was calculated. These two data points (cases of abuse and average temperature in the window) were plotted on a scatter plot. The 7-day window in question was then moved forward by one day, and the above process was repeated. In this way a 7-day moving average was calculated. Once the scatter plot was completed, a corresponding linear regression was calculated (Figure 1).

Overall the above analysis showed that the frequency of child abuse increases as temperature increases; however, the regression analysis assumes a constant cause and effect relationship and thus may miss some of the nuances behind the proposed association. To better understand the relationship between temperature and frequency of child abuse, an additional analysis was performed. For our next analysis we analyzed the data with regards to the relative frequency in which each average daily temperature was experienced. This was performed by calculating the total number of days that the average daily temperature fell into a given temperature range. The lowest average daily temperature in our data set was 9.5 degrees (F), and the maximum average daily temperature was 98.5 degrees (F). Thus, our lowest 10-degree range was 10-20 degrees (F) and increased up to a maximum of 90-100 degrees (F). We then calculated the number of abuse cases that occurred within each 10-degree range. By doing this we were able to calculate a daily average incidence of child abuse per 10-degree range by dividing the total cases of abuse in a given range by the total number of days in the same range. This data is shown in the bar graph, Figure 2.

We conducted a Poisson test on the data in Table 1, which produced a rate ratio comparing the rate of abuse in the summer breaks to the rate of abuse in the winter breaks as well as a 95% confidence interval. The estimated rate ratio was 1.34 with 95% confidence interval [1.01, 1.82] and a p=0.03.

Discussion

Data interpretation

Overall, the results of this study are consistent with previously published data on the effects of temperature on human aggression. These data support the idea that child abuse is a violent crime that is likely influenced by the perpetrator’s mental state or arousal. High
Figure 1. Moving 7-day average abuse cases vs 7-day average temperature. Figure 1 simple linear regression yields a coefficient for the 7-day average temperature of .01, meaning that for each 10 degree increase in average temperature, the mean number of child abuse cases that week increases by .01. The coefficient is statistically different from 0 (p<.01), meaning that average temperature is statistically significant in predicting the number of child abuse cases over a week.

Table 1. Comparing rates of abuse during summer and winter break. Table 1 shows the total number of days in both winter and summer break, total cases of abuse during each break, and average temperature during each break.

| Season       | Total Number of Days | Total Abuse Cases | Average Temp (F) |
|--------------|----------------------|-------------------|------------------|
| Summer Break | 840                  | 334               | 81.2             |
| Winter Break | 190                  | 56                | 38.6             |
temperatures have been shown to reduce cognitive function, and lower
cognitive function has been repeatedly shown to be a risk factor for
violence and antisocial behavior [16,18-22]. Also, crying has been
shown to increase frustration and aggression and is thus associated
with increased rates of child abuse [23-27]. The association shown here
between increased temperature and frequency of child abuse likely has
similar and possibly even compounding effects in regards to aggression,
which likely leads to the resulting child abuse. For it was already known
that temperature increases aggression [8,9,28-31]. This study provides
empirical evidence to the theory that these changes in mental status are
risk factors for child abuse.

One obvious compounding variable is the fact that school-age
children are home for the summer and thus around caretakers.
That increased time around the most common perpetrator could be
viewed as an independent variable that leads to child abuse. This
was the motivation behind our analysis comparing rates of abuse
over summer break and winter break. Even when accounting for
the relative number of days in summer break as compared to winter
break, our analysis showed that variations in rates are not due to the
alternative explanations of children being home from school over
breaks as significantly more abuse over summer break as compared to
winter; this is demonstrated by our estimated rate ratio of 1.349 with
95% confidence interval [1.014, 1.824] and p=0.037. This finding is
in agreement with prior studies showing analysis both within years,
as shown by increased crime associated with “hotter” quarters, and
between years with “hotter” years correlating with increased violent
crime [30,31]. Thus, when taking into considerations the findings
presented here and in previous studies, it can be concluded that the
trend for violent behavior is not due to seasonal differences like longer
daylight hours, vacation, or other variables associated with the “hotter”
seasons of the year. Such explanations for seasonal differences cannot
account for previous studies findings of temperatures association with
violent crime in “hotter” years [11,30,31]. In this way triangulation can
be used to rule out alternative explanations for the findings presented.

NAE vs GA model

The purpose of this study was not to refute or substantiate either
the NAE or GA model. However, given the unique perspective of our
study, we feel that it is necessary to comment on how our findings
relate to each model. Overall, our study supports the GA model as no
inflection point was observed. This can be observed best by the data in
Figure 2. It is important to note that by calculating the average
incidence we more closely mimicked the analysis performed by
Anderson who championed the GA model. We chose this analytical
step because we agree with him that in doing so gives the reader a
much more accurate description of how frequent these crimes are at
given temperatures. Due to the fact that more “average” temperature
days than “hot” days, there are relatively more “average” days in
which abuse can occur. Thus, not considering the relative number of
incidences per day gives a skewed model of the relative frequency of
abuse. The NAE model theorizes that the inflection point is where
one seeks to escape the discomfort of extreme temperature. As stated
above the RA theory attempts to explain the NAE model by stating
that the inflection point is where people are most likely to be outside
their homes and thus encounter situations in which violent crimes are
more likely [12]. However, our finding of an overall linear relationship
between temperature and rates of abuse shed a new scrutiny on this
theory since the vast majority of child abuse happens not at the hand of
strangers but from the child’s caretaker [2]. This is not to say that the
NAE model should be abandoned. For as stated previously the model
predicts that increased temperature causes people to seek escape from
discomfort; this desire to escape discomfort could lead caretakers to
shake a crying baby for example. Again, the unique nature of our study
sheds new light on prior models and emphasizes the need for more
work to better understand the nuances behind each.

Implications and limitations

Clinical impact: This study further supports the evidence that
climate change and its resulting increase in temperature will have a
negative impact on children’s health. Literature has already shown
that climate change has resulted in higher risk for mental and physical
diseases [32]. Thus, it is important that clinicians and social workers
involved in the care of children understand risk factors associated with
adverse health outcomes for children. In light of this information we
suggest that those clinicians and social workers counsel caretakers to
be cognizant of the impact of temperature on their behavior, a
strategy previously championed by researchers in the field [30]. One
such strategy to mitigate this effect is to advise caretakers to consume
a “cooling drink” as it has been shown to decrease the aggressive
tendencies brought about by increased temperatures [9]. Though
it should be noted that this drink be non-alcoholic in nature as the
consumption of alcohol has been shown to be a risk factor for aggression
and child abuse [33,34]. Seeking cooler ambient temperatures, via air-
conditioned spaces, may also help to reduce the aggression brought
about by hot temperatures [35,36].

Limitations: Though our total number of cases given the time span
over which they were collected is relatively small compared to previous
work done on temperature and violence, a similar result was found.
Thus, we encourage our readers to consider the findings in this paper as
a part of a much more robust set of data by which it was inspired before
drawing conclusions. We would also like to point out that we did not
account for days of the week in our analysis. This is because it had been
shown previously that when accounted for as an additional predictor
variable a statistically significant association between temperature and
violent behavior was still seen [29].

Finally, we want to acknowledge that this is in all practical sense a
field study and that all data presented in this paper represents an
association, though due to obvious ethical reasons causational studies
are prohibited. However, due to this study design our external validity
is maximized, something previous laboratory studies lacked.

A note on future studies

Previously published literature has shown that violent crimes
are relatively more frequent in hotter regions.31 Though some have
theorized that in the US this discrepancy could be due to a difference
in culture this argument is considerably weakened by the fact that
increased rates of violent crimes have been found in southern France,
Italy, Spain, and England as compared to their respective northern
regions [7,37]. The location of our study proved to be an ideal location
for a pilot study as it is located in a central portion of the US with an
ample amount of temperatures at each end of the spectrum experienced
by most of the country. Future studies should focus on including
multiple nodes for analysis. These studies should account for average
temperature to see whether “relative” hotness affects the rates at which
child abuse occurs. Ideally these future studies should look to control
for as many extrinsic factors as possible in order to stratify the effect
of temperatures on child abuse. This includes additional weather variables
like humidity, precipitation, wind speed, and barometric pressure as
well as socioeconomic factors, demographic data, and perpetrators
relationship to the victim. All of these are all examples of variables that if controlled for would strengthen the effect of temperatures on child abuse. We would also like to acknowledge that this paper is possible thanks to the extraordinary work of those who first modeled the theories of temperature and aggression. Our hope is that this study answers in some small part the call set forth for more field and correlational studies [31].

Conclusion

This study supports the body of literature that shows a positive association between increased temperature and violent behavior, in this case child abuse. Though the association between temperature and child abuse presented here is one that is not surprising, we believe that this study has value because it places empirical evidence on which future forecasting of child abuse can draw.

Disclosures

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