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# Abusive Head Trauma During a Time of Increased Unemployment: A Multicenter Analysis

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## KEY WORDS

child physical abuse, abusive head trauma

## ABBREVIATIONS

AHT—abusive head trauma

TBI—traumatic brain injury

CPT—child protection team

CI—confidence interval

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**WHAT'S KNOWN ON THIS SUBJECT:** Abusive head trauma (AHT) is the leading cause of death from child abuse. Poverty and stress are recognized risk factors for abuse. No studies to date have evaluated whether there is a relationship between the economy and rates of AHT.



**WHAT THIS STUDY ADDS:** Results of this study demonstrate a relationship between an economic recession and the rate of AHT. Given the high morbidity and mortality rates for children with AHT, these results are highly concerning.

## abstract

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**OBJECTIVE:** To evaluate the rate of abusive head trauma (AHT) in 3 regions of the United States before and during an economic recession and assess whether there is a relationship between the rate of AHT and county-level unemployment rates.

**METHODS:** Clinical data were collected for AHT cases diagnosed in children younger than 5 years from January 1, 2004 until June 30, 2009, by hospital-based child protection teams within 3 geographic regions. The recession was defined as December 1, 2007 through June 30, 2009. Quarterly unemployment rates were collected for every county in which an AHT case occurred.

**RESULTS:** During the 5½-year study period, a total of 422 children were diagnosed with AHT in a 74-county region. The overall rate of AHT increased from 8.9 in 100 000 (95% confidence interval [CI]: 7.8–10.0) before the recession to 14.7 in 100 000 (95% CI: 12.5–16.9) during the recession ( $P < .001$ ). There was no difference in the clinical characteristics of subjects in the prerecession versus recession period. There was no relationship between the rate of AHT and county-level unemployment rates.

**CONCLUSIONS:** The rate of AHT increased significantly in 3 distinct geographic regions during the 19 months of an economic recession compared with the 47 months before the recession. This finding is consistent with our understanding of the effect of stress on violence. Given the high morbidity and mortality rates for children with AHT, these results are concerning and suggest that prevention efforts might need to be increased significantly during times of economic hardship. *Pediatrics* 2011;128:637–643

Abusive head trauma (AHT) is the leading cause of death from child abuse and the most common cause of severe traumatic brain injury (TBI) in infants.<sup>1-4</sup> Poverty and stress are risk factors for abuse.<sup>5,6</sup> Studies have revealed increased rates of physical abuse after acute natural disasters.<sup>7,8</sup> Keenan et al<sup>9</sup> demonstrated an increase in both AHT and noninflicted TBI after Hurricane Floyd. Results of a study by Gibbs et al<sup>9</sup> suggested an effect of prolonged stress on child maltreatment in military families.

Numerous studies have evaluated the effect of economic stress on adult health and revealed a strong and positive association between unemployment and numerous adverse health outcomes.<sup>10,11</sup> Evidence relating the effect of economic stress on the well-being of children is less clear. In 1981, Steinberg et al<sup>12</sup> found that increases in child abuse were preceded by periods of high job loss. Krugman et al<sup>13</sup> reported a positive relationship between unemployment and physical abuse. In a 1991 review, Catalano concluded that although the evidence for an effect of economic insecurity on child abuse is weak it could "... move to the strong category with additional aggregate-time series research."<sup>14</sup>

Recent articles in the lay press have reported increases in both physical abuse and AHT and have hypothesized a relationship with the recession.<sup>15-17</sup> These reports were based on physicians' anecdotal reports and are in contrast to the 2008 and 2009 annual national reports on child maltreatment, which reported a decrease in child maltreatment, including a decrease in physical abuse.<sup>18,19</sup> As a result, there has been debate about whether AHT rates have changed during the recent recession.

The objectives of this study, therefore, were to (1) evaluate the AHT rate before and during an economic recession

by using an ecologic time-series analysis, (2) determine if there were differences in demographic and/or clinical characteristics of subjects before the recession compared with during the recession, and (3) assess whether there was a relationship between the AHT rate and local unemployment rates.

## METHODS

Institutional review board approval with a waiver of informed consent was received from all participating hospitals.

Data were collected through medical record review and included year and month of hospitalization, age, gender, mortality, insurance, county of residence, and whether subjects were admitted to a PICU, had evidence of possible previous physical abuse, or had siblings. Subjects were considered to have evidence of possible previous abuse if they had a healing fracture(s), chronic subdural hemorrhage, and/or a nonacute bruise(s).

An encatchment area was defined a priori and included 6 counties in the Seattle, Washington, area, 23 counties in western Pennsylvania, and 45 counties in Ohio and northern Kentucky (total of 74 counties) (Fig 1). Encatchment areas met the following criteria: (1) there was only 1 regional pediatric level I trauma center; (2) there was an established child protection team (CPT) with stable personnel throughout the study period in that trauma center; and (3) the local institutional review board allowed collection of each subject's county of residence. These criteria (1) maximized the possibility that all children in the encatchment region would be evaluated at the participating hospital, (2) minimized the possibility that any change in the rate of AHT was related to a change in the definition of AHT, and (3) allowed

for data analysis, which required county of residence.

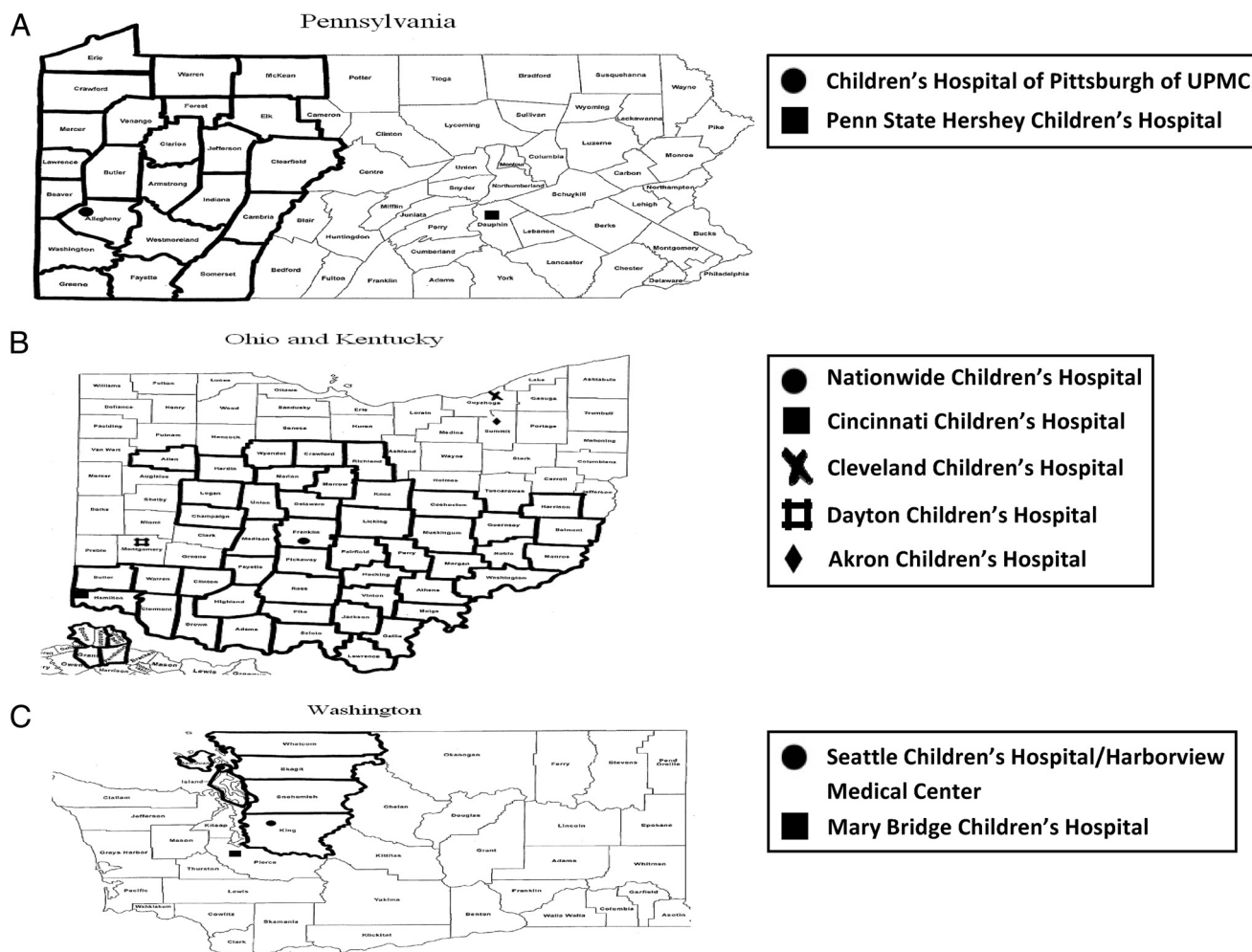
Subjects were eligible if they were younger than 5 years, diagnosed with unequivocal AHT by the hospital CPT between January 1, 2004, and June 30, 2009, and resided in 1 of the 74 participating counties. We also obtained data from the Pennsylvania child abuse registry and from colleagues at 2 nonparticipating children's hospitals (Dayton Children's and Mary Bridge Hospital in Tacoma, WA) to assess the completeness of subject ascertainment and allow for the most accurate calculation of rates.

Cases were aggregated for each county, and AHT rates were calculated by using the population calculated in the US Census for each county. Annual county-specific population data were obtained from the US Census for the <5-year-old age cohort.<sup>20</sup> Annual county-specific data for children aged 0 to 1 year were obtained from the Pennsylvania<sup>21</sup> and Washington<sup>22</sup> Offices of Vital Statistics. Data from Ohio were unavailable for 2009; therefore, the AHT rate for children aged 0 to 1 year in that region was not calculated.

The dates of the recession (December 1, 2007, through June 30, 2009) were defined by the National Bureau of Economic Research, a private group of economists charged with dating the start and end of economic downturns.

Because of the data about the effect of stress on noninflicted TBI in children,<sup>8</sup> 2 participating hospitals (Children's Hospital of Pittsburgh and Nationwide Children's Hospital) determined the number of children younger than 5 years admitted with noninflicted TBI during the same 5½ years. Noninflicted TBI was defined as an intracranial injury for which there was no concern for abuse.

Quarterly unemployment rates were collected for counties within each en-

**FIGURE 1**

Counties included in the encatchment area served by Children's Hospital of Pittsburgh of UPMC (A), Cincinnati Children's Hospital and Nationwide Children's Hospital (B), and Seattle Children's Hospital and Harborview Medical Center (C). Counties outlined in thick black lines are part of the 74-county encatchment area.

catchment area in which there was at least 1 case of AHT during the 5½-year study period. Unemployment rates were obtained from the National Bureau of Labor Statistics<sup>23</sup> and represent the proportion of eligible workers who were unemployed.

Descriptive statistical analyses were performed to assess differences in subjects across regions and over time. Using Poisson regression with a general-estimating-equation approach, AHT rates for children younger than 5 years were calculated per 100 000 person-years with a 95% confidence interval (CI) for each of the 3 regions and in the collective region in the prerecession versus recession pe-

riods. The regression model consisted of 2 levels: month within county. For the Pennsylvania and Washington regions, we used the same approach to calculate the AHT rate for children aged 0 to 1 year. The primary exposure was the recession. To test for the effect of the recession on the AHT rate, we calculated a proxy measure for recession as “no” for prerecession months and “yes” for the months during the recession. Unemployment rates were included in the Poisson regression model as a linear covariate. We specified autoregressive structure for the covariance structure used to model the correlation of the outcome measurements. Because the effects of un-

employment on AHT can take months to develop, we also constructed 3- and 6-month unemployment lag models.

## RESULTS

### Overall Demographics

A total of 422 children were identified with AHT during the 5½-year study period. The mean age of the subjects was 8.9 months (range: 0.3–58 months); 76% of the subjects were younger than 1 year. Fifty-eight percent of the subjects were male. Sixty-seven percent were white, 17% were black, 4% were Hispanic, 3% were biracial, and for 9% race was unknown. Sixty-three percent of the subjects were admitted to a

**TABLE 1** Rates of AHT for Children Younger Than 5 Years

	Prerecession Period Rate, per 100 000 Person-Years (95% CI)	Recession Period Rate, per 100 000 Person- Years (95% CI)	IRR	P
Entire 74-county region	8.9 (7.8–10.0)	14.7 (12.5–16.9)	1.65	<.001
23-county western Pennsylvania region	8.7 (6.6–10.8)	20.8 (15.6–25.9)	2.40	<.001
6-county Seattle region	5.0 (3.4–6.7)	10.4 (6.8–14.0)	2.08	<.001
45-county Ohio region	11.0 (9.2–12.8)	13.7 (10.6–16.7)	1.25	.006

IRR indicates incidence rate ratio.

PICU; the overall mortality rate was 16%. There were no statistical differences in these characteristics among the 3 regions.

Of the 422 subjects, 97% (408 of 422) were evaluated at the participating hospitals. Eight children in the Pennsylvania region, 2 children in the Ohio region, and 4 children in the Seattle region were not evaluated at the participating hospitals over the 5½-year study period.

### Time-Series Analysis: Evaluation of the AHT Rate Before and During the Recession

The Poisson regression analysis revealed that the rate of AHT increased significantly during the recession compared with that during the prerecession period for each region individually and for the 74-county collective region (Table 1). The overall incidence rate ratio for the recession was 1.65 (95% CI: 1.60–1.69). The AHT rate for 0- to 1-year-olds in the Pennsylvania and Washington regions also increased (Table 2).

With a similar Poisson regression analysis, there was no increase in cases of noninflicted TBI during the recession compared with in the prerecession period (mean: 127 [SD: 12.1] annually before the recession versus 127 [SD: 4.0] annually during the recession).

### Evaluation of Subject Characteristics Before and During the Recession

There were no differences in mean age, mortality rate, insurance status, proportion of children without sib-

lings, or proportion of children with evidence of previous abuse during the recession compared with in the prerecession period (Table 3).

### Assessment of the Relationship Between the Rate of AHT and Changes in Unemployment

The unemployment rate increased during the recession in all 3 regions (Table 4), but there was no association between AHT rates and county-level unemployment rates. Lagging the unemployment rates did not change the results.

### DISCUSSION

These data show a significant increase in the rate of AHT in a 74-county region during a recession compared with the

4-year period before it. Although it is not possible to prove a causal relationship between the AHT rate and the economy with our analysis, we believe the data are compelling enough to influence policy and clinical decisions. Specifically, the presence of an association between the economy and the AHT rate should be sufficient to spur a discussion of specific stressors and mediators of these stressors and how they could be modified to decrease the risk of AHT to young children. From a clinical perspective, this association might warrant changes in the threshold for physicians to evaluate for AHT during times of economic stress in the same way that physicians change the threshold to test for and treat pertussis during a pertussis outbreak.

The relationship between the recession and the AHT rate might not be surprising given previous data that supported an association between poverty and all types of physical abuse. However, to our knowledge, this is the first study to focus on a specific exposure, the recession, and a specific outcome measure, county-level AHT rates. We

**TABLE 2** Rate of AHT for Children Aged 0 to 1 Year

	Prerecession Period Rate, per 100 000 Person-Years (95% CI)	Recession Period Rate, per 100 000 Person- Years (95% CI)	IRR	P
23-county western Pennsylvania region	46.0 (33.5–58.6)	61.7 (38.0–85.4)	1.34	<.001
6-county Seattle region	20.1 (11.1–29.1)	34.2 (22.5–45.9)	1.70	=0.04

IRR indicates incidence rate ratio.

**TABLE 3** Demographic and Clinical Variables Before and During the Recession

	Before Recession	During Recession
Age, mean (SD), mo	8.8 (10.1)	9.1 (10.2)
Mortality rate, %	16	17
Public insurance, %	77	83
Children without siblings, %	42	41
Children with evidence of previous abuse, %	45	49

**TABLE 4** Unemployment Rates According to Region

	Prerecession Period Unemployment Rate, %	Recession Period Unemployment Rate, %
23-county western Pennsylvania region	5.6	7.3
6-county Seattle region	5.4	5.6
45-county Ohio region	6.5	7.9



did not assess individual poverty *per se* but evaluated the recession as a societal-level risk factor that can have an effect on the entire population—those above or below the poverty line. The ability of the time-series design to reveal societal-level risk is an important advantage of this approach. Although work in public health is often limited to identifying individual-level risk factors to identify people at high risk, the greatest improvements in a population's health are likely to derive from societal interventions, because the majority of cases of poor public health outcomes arise outside the more easily identified extremes of risk. Therefore, although targeting people at high risk can have a dramatic effect on individual risk, because only a small percentage of people are at high risk, this approach might not have a major effect on population-level rates.

The Pennsylvania data for children aged 0 to 1 year (Table 2) allow for comparison to published studies. In the study by Keenan et al,<sup>2</sup> the incidence of AHT in children aged 0 to 1 year was 29.7 in 100 000 (95% CI: 22.9–36.7). Although this incidence of AHT is lower than the Pennsylvania prerecession incidence, it is likely explained by differences in definitions; only children who were admitted to an ICU or died were included in the Keenan et al study. Using these criteria, 37% of our subjects would have been excluded. Our prerecession rate of 46.0 in 100 000 is similar to the preintervention rate of 41.5 in 100 000 reported by Dias et al<sup>24</sup> before implementation of an AHT primary prevention program. The AHT rate in the Washington region is lower than the rate in the Keenan et al study; this result is likely related to the relatively small number of children, which is reflected in the wide CIs. Our results are in contrast to both the 2008 and 2009 official reports on child maltreatment,<sup>18,19</sup> which documented

decreases in the rate of all types of abuse including physical abuse during the recession. This result has led some to suggest that the recession did not affect child maltreatment.<sup>25</sup> The difference in the findings might be a result of the differences in data sources and definitions and highlights why it is imperative to use multiple data sources when evaluating rates of child maltreatment. The official reports on child maltreatment are based on cases of substantiated abuse by Child Protective Services. Substantiation rates vary greatly between states and depend on multiple factors. The AHT data in our study are based on medical diagnoses. It is also possible that the overall rate of child physical abuse decreased during the recession but that the rate of AHT increased. The annual report on child maltreatment does not address AHT specifically.

The lack of an increase in the number of noninflicted TBI cases is in contrast to results from the study by Keenan et al,<sup>8</sup> in which both the rate of AHT and the rate of non-inflicted TBI increased after a natural disaster. This difference might reflect differences in the risk to children after natural disasters compared with the risk during an economic recession. The increase in the rate of noninflicted TBI after a natural disaster might be related to environment hazards and less parental supervision. There might, in fact, be an increase in the amount of time that parents spend with their young children during a recession because of job loss; this additional time might be a risk factor for AHT.<sup>26</sup> Job loss might also force a caretaker who has previously not provided child care to assume a caretaking role. Because of the different stressors in a recession compared with those in a natural disaster, strategies for decreasing the effect of these stressors on children need to be different.

We do not believe that the increased rate of AHT during the recession is related to increased recognition. One of the strengths of our study is the stringency with which both subjects and sites were selected. Hospitals included in the study had a stable CPT throughout the study period. As a result, there were unlikely to be significant shifts in the evaluation of cases. In addition, we included only patients with unequivocal AHT. These children generally are not the ones whose injuries go unrecognized. Including only unequivocal AHT cases decreased the number of eligible subjects, might have affected the magnitude of the increase observed, and makes it likely that our incidence is an underestimate of true incidence.

We also do not believe that the increase is the result of changes in AHT primary prevention programs. Pennsylvania requires education of all new parents about AHT<sup>27</sup>; compliance with this legislation remained high throughout the study period.<sup>28</sup> Ohio passed a mandate for AHT education in 2008<sup>29</sup>; implementation has been highly variable (unpublished data). Washington did not have an established AHT primary prevention program during the study period.

The lack of a difference in the demographic or clinical characteristics of subjects before compared with during the recession indicates that the recession was a societal-level risk factor that increased risk for all. We incorrectly hypothesized that more children with AHT during the recession would show evidence of previous abuse, because cuts in Child Protective Services budgets might result in episodes of mild abuse not being investigated because of a lack of resources. The fact that half of the subjects showed evidence of previous abuse is consistent with the results of previous studies.<sup>30–32</sup> We also incorrectly hypothe-

sized that a larger proportion of perpetrators during the recession would be male because the recent recession affected jobs traditionally held by men more than jobs traditionally held by women.<sup>33</sup> Finally, our hypothesis that more children would be receiving public insurance during the recession was not supported by the data. The fact that 79% of the subjects had public health insurance before the recession compared with 30% of children nationally<sup>34</sup> is consistent with data suggesting that poverty is a risk factor for physical abuse.<sup>35</sup>

The lack of relationship between unemployment rates and the AHT rates might be the result of recognized limitations in US unemployment data.<sup>23</sup> Unemployment data, for example, do not account for workers who are underemployed, have exhausted unemployment benefits, have stopped looking for work, and/or who receive disability benefits. Although previous studies have revealed a relationship with unemployment, it is possible that the limitations in the unemployment data have become more pronounced over time because of changes in the proportion of underemployed and/or seasonal workers. It is also possible that other macroeconomic indicators (eg, foreclosure rates) might correlate with AHT rates.

This study had several limitations. It is possible that there was a selection bias such that certain hospitals would be more likely to volunteer to participate because they perceived that the

rate of AHT had increased at their site. Although the study was triggered by a perceived increase in AHT in Pittsburgh, the selection of other sites was based only on whether hospitals had met the previously described criteria. Numerous hospitals were eliminated from consideration because of the presence of multiple trauma centers in the region. Dr Berger then contacted >30 other institutions to assess eligibility. The majority of sites were ineligible because of lack of a stable CPT and/or lack of available data about cases of AHT at their respective hospitals.

A second limitation relates to possible site differences in the definition of unequivocal AHT. Although it is possible that different sites defined unequivocal AHT differently, these differences would be expected to be stable across the entire study period, because the members of the CPT were stable during this time. By including only cases of unequivocal AHT, we also sought to minimize differences in interpretation. Finally, it is possible that not every case of AHT that occurred in each catchment region was included. Because of selection criteria for participating hospitals and our additional data collected about children evaluated at nonparticipating hospitals, we are confident that the vast majority of eligible children were included. For the few cases that were not included, we believe that they are nondifferential misclassifications across catchment areas.

## CONCLUSIONS

Our results revealed an increase in the AHT rate during an economic recession in 3 distinct geographic regions encompassing a total of 74 counties. If other regions of the country have seen similar increases, this result would correspond to hundreds, if not thousands, of excess AHT cases. Given both acute and long-term costs of caring for children with AHT,<sup>36–38</sup> this finding may have policy implications for resource allocation for AHT during a recession as well as clinical implications for medical professionals who make decisions about when to evaluate for AHT. Future research should focus on identifying triggers for AHT that might be specific to times of economic hardship and might be amenable to intervention within the economic environment of a recession.

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## Abusive Head Trauma During a Time of Increased Unemployment: A Multicenter Analysis

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