

# Abusive Head Trauma in Children: A Comparison of Male and Female Perpetrators

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## KEY WORDS

child abuse, abusive head trauma, brain injury, retinal hemorrhages, perpetrator confessions

## ABBREVIATIONS

AHT—abusive head trauma

CCH—Steven and Alexandra Cohen Children's Hospital of New York

CPS—Child Protective Services

IP—identified perpetrator

NIP—no identified perpetrator

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**WHAT'S KNOWN ON THIS SUBJECT:** Several studies have examined the relationship between perpetrators of abusive head trauma and their victims. However, no study has evaluated the effect of perpetrator gender on victim presentation, victim clinical outcomes, and perpetrator legal outcomes.



**WHAT THIS STUDY ADDS:** This study reports significant gender differences in perpetrators of abusive head trauma in children. Male perpetrators were younger and more likely to confess and be convicted. Victims of male perpetrators had more serious acute presentations and neurosurgical intervention and suffered worse clinical outcomes.

## abstract

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**OBJECTIVE:** To evaluate the effect of perpetrator gender on victim presentation and outcomes, and perpetrator legal outcomes for abusive head trauma (AHT).

**METHODS:** We performed a retrospective chart review of AHT cases from 1998 to 2008. Patient clinical data and information regarding perpetrator legal outcome was obtained. Relationship of brain injury and retinal hemorrhages (RHs) and differences in categorical variables of perpetrator gender were compared by using Fisher's exact test. Differences in continuous variables between perpetrator gender were compared by using the Mann-Whitney Test.

**RESULTS:** There were 34 cases of AHT with identified perpetrators, 17 of each gender. Mean age of the victims was 9.4 months (SD: 7.8). Thirty-two (94%) had intracranial hemorrhages, 14 (41%) had both primary and secondary brain injury, 28 (82%) had RHs, and 6 (18%) died. The severity of RH was related to the severity of brain injuries ( $P = .01$ ). The median age for female perpetrators (34 years) was higher than that for males (27 years;  $P = .001$ ). Six categorical variables were associated with male perpetrator gender: acute presenting symptoms of cardiopulmonary or respiratory arrest ( $P = .025$ ), worse clinical outcome ( $P = .012$ ), neurosurgical intervention ( $P = .037$ ), death ( $P = .018$ ), perpetrator confession ( $P = .0001$ ), and conviction ( $P = .005$ ).

**CONCLUSIONS:** There were significant perpetrator gender differences of AHT in children. Male perpetrators were younger and more likely to confess and be convicted. Victims of male perpetrators had more serious acute presentations and neurosurgical intervention and suffered worse clinical outcomes. *Pediatrics* 2011;127:649–657

Abusive head trauma (AHT) can lead to permanent neurologic, developmental, and/or behavioral sequelae or death.<sup>1</sup> Estimates of the annual incidence of AHT range from 14.7 to 40.5 per 100 000 children under 1 year of age in various studies.<sup>2–6</sup> Male caregivers are more frequently identified as the perpetrators of AHT.<sup>7–10</sup> However, female perpetrators of AHT may be underestimated, as studies revealed that 2.6% to 5% of mothers report shaking their infants or young children as a means of discipline or in response to crying.<sup>11,12</sup> A recent review of parental self-report data on discipline practices in selected nations worldwide describe a much broader range of reported shaking. For children aged <3 years, 6.6% to 42% of mothers reported using shaking as a form of discipline.<sup>13</sup>

Several studies have examined the relationship between abusers and their victims.<sup>7–10</sup> However, to our knowledge, no study has evaluated the effect of perpetrator gender on victim presentation, victim clinical outcomes, and perpetrator legal outcomes.

## METHODS

The Steven and Alexandra Cohen Children's Hospital of New York (CCH), formerly known as Schneider Children's Hospital, is a tertiary care children's hospital on Long Island, New York, that serves nearly 500 000 children <5 years of age.<sup>14</sup> In 1998, a multidisciplinary child protection consultation team was formed and a protocol for evaluating and creating a database of possible victims of AHT was established by the principal investigator. The initial members of the team remained throughout the study period. This team has diagnosed 48 cases of AHT since 1998. The medical records of the 48 cases of AHT diagnosed at CCH from July 1, 1998, to December 31, 2008, were reviewed. All cases were reported to the State Central Register.

The institutional review board of the North Shore Long Island Jewish Health System approved the project. The criteria used for diagnosis of AHT was: a child aged <5 years with intracranial injury on neuroimaging and no adequate history to explain the injuries with or without retinal hemorrhages or other noncranial injuries considered highly suspicious for abuse.<sup>9</sup> These cases are reviewed monthly with child protection team members and representatives of Child Protective Services (CPS) from Nassau, Suffolk, Queens, and Brooklyn counties at CCH as part of continuing performance improvement. Perpetrators were identified if they were primary suspects in either a child protection service or criminal investigation.

Of these 48 cases, 34 (17 men and 17 women) were identified as a primary suspect in either a child protection service or criminal investigation. Cases in which there was no identified person were used as a comparison group.

Data collected included demographic characteristics, medical history, history of present illness, medical record documentation from CCH or provided by CPS of previous emergency department encounters with physicians for nonspecific clinical signs of AHT, social history, diagnostic tests (eg, serum chemistries, hematology/coagulation tests, cultures, neuroimaging studies, skeletal surveys, bone scans, electroencephalograms), consultations, time taken to seek medical care based on caregiver's accounts of presenting symptoms, length of hospital stay, and medical outcomes. The respective county CPS and/or Special Victims Bureau provided information pertaining to charges filed against perpetrators and legal outcomes. For this study, "confession" was defined as "a direct acknowledgment of guilt made by the accused. An admission is an act or dec-

laration by the accused from which, either alone or with other evidence, guilt may be inferred."<sup>15</sup>

Categorical variables were described using frequencies. Differences between the identified-perpetrator (IP) and no-identified-perpetrator (NIP) groups and between male and female perpetrator groups were compared by using Fisher's exact test.

Brain injuries were classified as primary injuries, secondary injuries, or both. Primary brain injuries were defined as resulting from mechanical forces applied directly to the external head and intracranial tissues, and included associated markers such as skull fracture or deformation, subdural hemorrhage, subarachnoid hemorrhage, and intraparenchymal hemorrhage. Secondary brain injuries were defined as resulting from complications caused by vascular and metabolic changes from the initial trauma and included cerebral edema, hypoxic-ischemic damage, infarctions, and herniations.<sup>16</sup>

All patients had dilated fundus examination by an attending pediatric ophthalmologist using an indirect ophthalmoscope. Detailed retinal drawings were done on all infants. RetCam (Clarity Medical Systems, Pleasanton, CA) photography was performed on infants in the study who were seen after 2004, which was the year a RetCam was obtained at the study institution. Using the detailed retinal drawings, the retinal hemorrhages were classified by the CCH's co-chair of pediatric ophthalmology according to the number of intraretinal hemorrhages, and whether preretinal hemorrhages, subretinal hemorrhages, perimacular folds, traumatic retinoschisis, or vitreous hemorrhage were present. Intraretinal hemorrhages were described as multilayered and extending to the periphery of the retina in all cases with >50 hemorrhages. Two

cases presented with <10 unilateral intraretinal hemorrhages located in the periphery of the retina. The severity of retinal hemorrhages was defined as mild if 1 to 50 intraretinal hemorrhages were present, moderate if >50 intraretinal hemorrhages were present, and severe if in addition to intraretinal hemorrhages, there were preretinal hemorrhages, subretinal hemorrhages, perimacular folds, traumatic retinoschisis, or vitreous hemorrhage. Severity of retinal hemorrhages and the severity of clinical outcomes were compared using Fisher's exact test. Severity of retinal hemorrhages and the type of brain injury were also compared using Fisher's exact test and by logistic regression.  $P < .05$  was considered significant.

Significant variables identified between the male and female perpetrator groups were placed in a multiple logistic regression with a backward elimination method to see if any of these variables, in combination, predicted the gender of the perpetrator. Continuous variables between the IP and NIP groups and between male and female perpetrator groups were compared by using the Mann-Whitney test. The data were analyzed by using SAS 9.2 statistical software (SAS Institute, Inc, Cary, NC).

## RESULTS

A total of 48 cases of AHT were identified using the diagnostic criteria described. Of these cases, 34 had identified perpetrators, 17 men and 17 women. There were no significant differences in the 3 continuous variables: victim's age, delay in seeking medical care, or length of hospitalization between the IP ( $n = 34$ ) and NIP ( $n = 14$ ) groups. For the categorical variables (Table 1), retinal hemorrhages ( $P = .03$ ), acute presentation ( $P = .023$ ), and confession ( $P = .001$ ) were significantly associated with the IP. In the

**TABLE 1** Some of the Categorical Variables According to Perpetrator

	IP		NIP		P
	n	%	n	%	
Gender					
Female	12	35.3	7	50.0	.517
Male	22	64.7	7	50.0	—
Death					
Yes	6	17.6	1	7.1	.656
No	28	82.4	13	92.9	—
Acute presentation					
No	3	2.90	5	35.7	.023 <sup>a</sup>
Yes	31	97.1	9	64.3	—
All symptoms					
CP arrest/RA	13	38.2	4	28.6	.258
Limp (seizure ± unresponsive)	15	44.1	4	28.6	—
Vomiting (± seizure)	3	8.8	1	7.1	—
Enlarged head circumference	3	8.8	5	35.7	—
Retinal hemorrhages					
No	6	17.6	7	50.0	.034 <sup>a</sup>
Yes	28	82.4	7	50.0	—
CNS injury					
Primary	14	41.2	6	42.9	.590
Secondary	2	5.9	2	14.3	—
Both	18	52.9	6	42.9	—
Outcome					
Normal	15	44.1	7	50.0	.644
Rehabilitation	13	38.2	6	42.9	—
Death	6	17.70	1	7.1	—
Confession					
No	16	47.1	14	100.0	.001 <sup>a</sup>
Yes	18	52.9	0	0.0	—

CP indicates cardiopulmonary; RA, respiratory arrest; CNS, central nervous system.

<sup>a</sup> Significant result.

NIP group, all had multiple caregivers at time of presentation. For the NIP group, 8 (57.1%) had family court findings of abuse or neglect.

## Victims of Identified Perpetrators

The demographic information and other characteristics of the 34 children who suffered AHT from identified perpetrators (median age: 7 months; age range: 1.3–34 months; mean: 9.4 months [SD: 7.8]) are summarized in Table 2. Although a majority of victims were male, there was no gender difference in mortality. Time taken to seek medical care ranged from 0 to 48 hours (median: 1 hour; mean: 4.5 [SD: 11.4]) and days hospitalized ranged from 2 to 43 (median: 10; mean: 12.0 [SD: 9.6]). Thirty-one children (91.2%) presented with acute symptoms and 3 (8.8%) presented with enlarged head circumferences that warranted a re-

ferral for neuroimaging. Each of the 34 children had neuroimaging studies. Thirty-two of them (94.1%) had intracranial hemorrhages on imaging studies, and 18 (52.9%) revealed both primary and secondary brain injuries (Table 3). Thirty-one (91.2%) children had skeletal surveys, and 3 (8.8%) had an additional bone scan. Six (17.6%) children had suspicious bruising on physical examination, 3 (8.8%) had other abusive organ injuries, and 1 (2.9%) had a third nerve palsy. Fourteen (41.2%) victims had neurosurgical intervention, and 6 (17.6%) died. All 6 victims who died were autopsied at the Office of the Chief Medical Examiner in New York City, New York. The manner of death for all 6 children was homicide. At autopsy, all 6 showed evidence of rotational acceleration-deceleration injury (eg, subdural hemorrhage, subarachnoid

**TABLE 2** Victims of IPs

Characteristic	n (%) of Children
Gender	
Male	22 (65)
Female	12 (35)
Race	
Black	10 (29)
Asian	7 (21)
White	8 (23)
Hispanic	9 (27)
Presenting symptoms	
Acute	
Limp ± seizures	15 (44.1)
Respiratory arrest	10 (29.4)
Vomiting ± seizures	3 (8.8)
Cardiopulmonary arrest	3 (8.8)
Nonacute	
Enlarged head circumference	3 (8.8)
Neuroimaging studies	
Head CT	33 (97.1)
Head MRI	1
Both Head CT and MRI	28 (82.5)
Skeletal survey	31 (91.2)
Positive Findings	9 (29)
Skull fracture only	2
Skull + posterior rib	1
Skull + radius/ulna	1
CMLs + rib + inferior rami	1
Tibia + rib	1
Posterior rib(s) only	2
Widened coronal sutures	1
Bone scan	3 (8.8)
Additional rib	1
Additional tibia, fibula	1
Normal	1
Pediatric ophthalmology examination	34 (100)
Bilateral retinal hemorrhages	17
Bilateral and asymmetric	6
Unilateral	5
None	6
Neurosurgical intervention	14 (41.2)
SDH evacuations	5
ICP monitor ± ventriculostomy	5
ICP monitor + hemicraniectomy	2
Subdural tap + drains	2
Condition at discharge	
Normal	15 (44)
Impaired (rehabilitation facility)	13 (38)
Died	6 (18)

CT indicates computed tomography; CML, classic metaphyseal lesion; SDH, subdural hemorrhage; ICP, intracranial pressure.

hemorrhage, traumatic axonal injury), and 3 showed additional evidence of impact (Table 4). Of the 28 survivors, 15 (53.6%) had an apparently normal physical examination on discharge. Thirteen of the children (46.4%) were referred for rehabilitation.

**TABLE 3** Neuroradiology Imaging Study Results

CT/MRI Reading	n (%)
Diffuse cerebral edema	2 ( 5.9)
Intracranial hemorrhages	32 (94.1)
SDH ± SAH	14
SDH ± SAH + HIE	6
SDH ± SAH + herniation	4
SDH + SAH + herniation + infarct + edema	2
SDH + infarct	2
SDH + infarct + herniation	1
SDH + SAH + edema + HIE	1
SDH + edema + herniation	1
SDH + edema	1

CT indicates computed tomography; SDH, subdural hemorrhage; SAH, subarachnoid hemorrhage; HIE, hypoxic-ischemic encephalopathy.

Twenty-eight (82.4%) victims exhibited retinal hemorrhages. Retinal hemorrhages were categorized as mild in 5, moderate in 7, and severe in 16. The severity of retinal hemorrhages was associated with more serious clinical outcome ( $P = .023$ ) and the type of brain injuries ( $P = .01$ ). Within the sample, the likelihood of secondary or both primary and secondary central nervous system injury was most frequently associated with the clinical evidence of severe retinal hemorrhage. Victims with no retinal hemorrhages or mild retinal hemorrhages were, respectively, 95% and 94% less likely to have experienced secondary or both types of central nervous system injury compared with victims with severe retinal hemorrhages.

**TABLE 4** Homicide Victims' Findings on Autopsy

- 16-mo-old: facial trauma, scalp contusions, SDH, parenchymal contusions, ischemic brain injury, herniation, bilateral diffuse intraretinal hemorrhages, and preretinal hemorrhages
- 2.1-mo-old: hypoxic-ischemic encephalopathy (no sinus thrombosis), healing rib and tibial metaphyseal fractures, focal peripheral retinal hemorrhages, ischemic changes spinal cord
- 5.5-mo-old: focal areas of subgaleal contusions, SDH, parenchymal hemorrhage, ischemic brain injury, bilateral diffuse retinal hemorrhages, and vitreous hemorrhage
- 10-mo-old: scalp abrasions and contusions, SDH, traumatic axonal injury, bilateral retinal hemorrhages, perimacular folds, traumatic retinoschisis, choroid detachment, optic nerve sheath hemorrhage, traumatic necrosis of spinal cord, liver laceration, mesenteric injuries, and healing rib fracture
- 6-mo-old: SDH, SAH, traumatic axonal injury, diffuse intraretinal hemorrhages, right optic nerve sheath hemorrhage, left optic nerve infarct, epidural hemorrhage lumbar spine, and old abrasions to forehead and ears
- 18-mo-old: SDH, SAH, traumatic axonal injury, ischemic brain injury, bilateral optic nerve sheath hemorrhages, diffuse intraretinal hemorrhages and preretinal hemorrhages, and bruise around left eye

SDH indicates subdural hemorrhage; SAH, subarachnoid hemorrhage.

Eleven (32.4%) victims were evaluated by physicians after an AHT event that was not recognized. These victims were younger (mean age, 5.82 months [SD: 3.67]), and presented most often with vomiting (45%) followed by excessive crying (27%). The mean time to correct diagnosis was 21.3 days (SD: 20.4; median: 14 days). All were reinjured after the missed diagnosis. Six (54.5%) of the reinjured children experienced medical complications that may have been prevented if correctly diagnosed on initial presentation. Two suffered significant developmental delays, 2 had hemiparesis, and 2 died.

### Perpetrators

The perpetrators' ages ranged from 16 to 60 years (median: 30 years). The median age for female perpetrators was 34 years, which was significantly higher than the median age for males (27 years;  $P = .001$ ). Biological parents were the most common perpetrators, followed by the mother's boyfriend defined as biologically unrelated and unmarried to the mother (Table 5).

The most common history offered on presentation was a short fall (<3 feet) in 47% ( $n = 16$ ), followed by no explanation in 26% ( $n = 9$ ), and then "found infant choking" in 9% ( $n = 3$ ). Of the 15 victims who were "normal" on dis-

**TABLE 5** Relationships of Perpetrators to Their Victims

Relationship	<i>n</i>	%
Mother	10	29
Father	9	26
Mother's boyfriend	7	21
Grandmother	4	12
Female babysitter	3	9
Babysitter's husband	1	3

charge, 11 (73.3%) had female perpetrators ( $P = .016$ ).

Six categorical variables were significantly associated with male gender of the perpetrator: acute presenting symptoms of cardiopulmonary or respiratory arrest ( $P = .025$ ), more severe clinical outcome ( $P = .012$ ), neurosurgical intervention ( $P = .037$ ), death ( $P = .018$ ), perpetrator confession ( $P = .0001$ ), and conviction ( $P = .005$ ) (Table 6).

Of the 15 (88.2%) male perpetrators who confessed, 14 described or demonstrated shaking their victims, 1 of whom had evidence of impact on autopsy. One described shaking with impacting the head on a soft surface. Signs of impact were also confirmed at autopsy. In 13 of the confessed cases, acute subdural hemorrhages were noted, and 12 had retinal hemorrhages. None had scalp swelling or skull fractures. Five victims had other injuries, 4 as described in the homicide group (Table 4). One victim had a small adrenal hemorrhage, multiple rib fractures, classic metaphyseal lesions of the proximal and distal femur, and an inferior rami fracture without cutaneous manifestations of abuse or retinal hemorrhages. Of the 3 (17.6%) female perpetrators who confessed, 1 confessed to shaking and slamming the child. The other 2 confessed to shaking their victims. In all 3 victims, acute subdural hemorrhages and retinal hemorrhages were noted. None had scalp swelling or skull fractures. Two had extensive bruising including the face and pattern injuries. Of these, 1 had new and old posterior

**TABLE 6** Categorical Variables According to Perpetrator's Gender

	Male Perpetrator		Female Perpetrator		<i>P</i>
	<i>N</i>	%	<i>n</i>	%	
Gender (victim)					
Female	7	41.2	5	29.4	.720
Male	10	58.8	12	70.6	—
Death					
Yes	6	35.3	0	0	.018 <sup>a</sup>
No	11	64.7	17	100.0	—
Birth					
Term	10	58.8	12	70.6	.721
Preterm	7	41.2	5	29.4	—
Developmental history					
Delayed	1	5.9	0	0	1.000
Normal	16	94.1	17	100.0	—
Medical history					
No	5	29.4	4	23.4	1.000
Yes	12	70.6	13	76.5	—
Emergency department visits					
No	8	47.1	13	76.5	.157
Previous	9	52.9	4	23.5	—
Primary care physician					
No	1	5.9	0	0.0	1.000
Yes	16	94.1	17	100.0	—
Immunizations					
No	1	6.3	1	5.9	1.000
Yes	15	94.1	16	94.1	—
All symptoms					
CP arrest/RA	10	58.8	3	17.6	.053
Limp/seizure ± unresponsive	6	35.3	9	52.9	—
Vomiting ± seizures	0	0.0	3	17.6	—
Enlarging head circumference	1	5.9	2	11.8	—
Acute symptoms ( <i>n</i> = 31)					
CP arrest/RA	10	62.5	3	20.0	.025 <sup>a</sup>
Limp/seizure	6	37.5	9	60.0	—
Vomiting/seizure	0	0.0	3	20.0	—
Acute presentation					
No	1	5.9	2	11.8	1.000
Yes	16	94.1	15	88.2	—
CNS injury					
Both	10	58.8	8	47.1	.186
Primary	5	29.4	9	52.9	—
Secondary	2	11.8	0	0.0	—
Skeletal survey ( <i>n</i> = 31)					
Normal	11	78.6	11	64.7	.397
Findings	3	21.4	6	35.3	—
Bone scan					
Not done	16	94.1	15	88.2	1.000
Other	1	5.9	2	11.8	—
EEG					
Brain dead	5	29.4	0	0.0	.051
Normal	1	5.9	1	5.9	—
Not done	8	47.1	14	82.4	—
Abnormal	3	17.6	2	11.8	—
Retinal hemorrhages					
No	2	11.8	4	23.5	.570
Mild	2	11.8	3	17.6	—
Moderate	3	17.6	4	23.5	—
Severe	10	58.8	6	35.3	—
Confession					
No	2	11.8	14	82.4	.0001 <sup>a</sup>
Yes	15	88.2	3	17.6	—

**TABLE 6** Continued

	Male Perpetrator		Female Perpetrator		<i>P</i>
	<i>N</i>	%	<i>n</i>	%	
Convicted					
Yes	14	82.4	5	29.4	.005 <sup>a</sup>
No	3	17.6	12	70.6	—
Delay in seeking care					
No	1	5.9	2	11.8	1.000
Yes	16	94.1	15	88.2	—
Explanation					
Fall	7	41.2	9	52.9	.732
Other	10	58.8	8	47.1	—
Explanation (4)					
Choking	1	5.9	2	11.8	.779
Fall	7	41.2	9	52.9	—
None	5	29.4	4	23.5	—
Other	4	23.5	2	11.8	—
Neurosurgical intervention					
Yes	10	58.8	4	23.5	.037 <sup>a</sup>
No	7	41.2	13	76.5	—
Race					
Black	5	29.4	5	29.4	.629
Asian	2	11.8	5	29.4	—
White	5	29.4	3	17.6	—
Hispanic	5	29.4	4	23.5	—
Missed AHT					
No	10	58.8	13	76.5	.465
Yes	7	41.2	4	23.5	—
Normal at discharge					
No	13	76.5	6	35.3	.016 <sup>a</sup>
Yes	4	23.5	11	64.7	—
Overall clinical outcome					
Normal	4	23.5	11	64.7	.012 <sup>a</sup>
Rehabilitation	7	41.2	6	35.3	—
Death	6	35.3	0	0.0	—

CP indicates cardiopulmonary; RA, respiratory arrest; EEG, electroencephalogram.

<sup>a</sup> Significant result.

rib fractures, lung contusion and bilateral pleural effusions, a liver laceration, and adrenal hemorrhage. The other had new and older tibia and fibula fractures. All 18 of the confessed perpetrators reported that their victims became immediately symptomatic.

Male perpetrators (Table 7) were convicted of their abuse more frequently than female perpetrators (*P* = .005). Fourteen male perpetrators (82.4%) were convicted, and 2 (11.8%) are awaiting trial. Five female perpetrators (29.4%) were convicted. None is awaiting trial.

## DISCUSSION

The results of this study differ from those of previous studies from which

male suspects were reported as the most likely perpetrators of AHT and fathers and boyfriends accounted for more than half the cases.<sup>7–10</sup> Fifty percent of the children with identified perpetrators were injured by women, and the biological mother was the most common perpetrator. Although perpetrator age has not been previously reported, our female perpetrators were also significantly older than the male perpetrators.

Similar to previous studies,<sup>7–10</sup> both male and female perpetrators in our study were more likely to abuse boys. Male perpetrators are more likely than female perpetrators to fatally injure a child.<sup>7,8</sup> In our study, all 6 fatalities

were committed by male perpetrators: 4 boyfriends and 2 biological fathers. These results are supported by a recent study that found young children who live with unrelated male adults are at a high risk for inflicted-injury death.<sup>17</sup>

In other studies of perpetrators of AHT, the mean age of victims ranged from 3.5 to 6.6 months, with fatalities ranging from 19% to 25%, and were described as “normal” on discharge in 10% to 22% of the cases.<sup>7–9</sup> Victims of AHT who are assessed as normal at discharge may subsequently have neurologic or developmental difficulties.<sup>18–22</sup> In the present study, the victims were older (mean age: 9.4 months), were slightly less likely to die (18%), and, of those who survived, were more likely to be normal at discharge (44%). Furthermore, victims of male perpetrators were significantly more likely to present in cardiopulmonary or respiratory arrest, have neurosurgical intervention, and more severe clinical outcomes.

In a large, heterogenous sample of North American men and women, men had significantly more skeletal muscle compared with women in both absolute terms and in relation to body mass. These gender differences were greater in the upper body.<sup>23</sup> Perpetrators of AHT cause injury by shaking, impact, or a combination of both.<sup>9,24</sup> Clearly, the upper body of the perpetrator is used, regardless of the mechanism. We hypothesize that our victims may have suffered less severe injury by the female perpetrators who physiologically have less muscle mass and are not as inherently strong as men.

This study provides additional support that shaking in the absence of impact can result in serious brain injuries. Of the 18 combined confessed perpetrators, all admitted to some form of shaking, and 4 either described head impact or there was evidence of im-

**TABLE 7** Legal Outcomes for Male and Female Perpetrators

Male perpetrators (15 confessions of 17 cases)
5 individuals with homicide victims confessed
Homicide victim 1, jury trial, convicted manslaughter 1 (18 y)
Homicide victim 2, took plea, manslaughter 2 (7-12 y)
Homicide victim 3, took plea, manslaughter 2 (1-5 y)
Homicide victim 4, took plea, manslaughter 1 (17 y to life)
Homicide victim 5, confessed, no conviction
Homicide victim 6, no confession, indicted by grand jury (trial pending)
10 individuals with survivors who confessed and took pleas
5, reckless assaults of a child: minor (juvenile offender) (1 y, 3 y, 3.5 y, and 4 y) and assault 2 (probation)
4, assault 1 (6 y, 7 y, 10 y, 11 y)
1, awaiting trial
Female perpetrators (3 confessions of 17 cases)
3 jury trials
No conviction, family court ( <i>nolo contendere</i> )
Convicted of first-degree assault (8 y)
Mistrial; pled to reckless endangerment (1 y)
3 individuals with survivors who confessed and took pleas
Reckless assault (1-3 y)
Reckless assault (3 y' probation)
Assault 1 (8 y)
Remaining
1 arrested with adjournment in contemplation of dismissal in 6 mo
1, conditional plea
5, family court findings of child abuse
1, family court ( <i>nolo contendere</i> )
3, family court hearings pending

impact on their victim's autopsy. None of the victims had scalp swelling or skull fractures, and 17 (94.4%) had acute subdural hemorrhages and retinal hemorrhages. A recent study of confessed perpetrators also showed that impact is infrequently seen: only 7 (24.1%) of 29 perpetrators either made statements of impacting their victim's head or their victims had physical evidence of impact.<sup>25</sup> A previous study indicates that 22% of homicides in children younger than 2 years were certified as whiplash shaking "after a thorough and competent postmortem examination did not demonstrate evidence of head impact."<sup>26</sup> In the present study, 3 (50%) of the 6 homicides had autopsy findings consistent with a non-impact shaking mechanism as the cause of death. The discrepancy in the number of shaking deaths between the 2—22% vs 50%—is likely a result of the small number of homicides in our study.

There is no standard classification for retinal hemorrhages seen in AHT. Pre-

vious studies have classified retinal hemorrhages according to a scale similar to ours, and severity of retinal hemorrhages were related to increased number of retinal hemorrhages, presence of preretinal hemorrhages, vitreous hemorrhages, retinoschisis, and perimacular folds. As previously reported,<sup>27,28</sup> the severity of retinal hemorrhages was significantly correlated with more extensive brain injury and more serious clinical outcomes in our victims.

Similar to other studies of children with unrecognized AHT,<sup>29,30</sup> the majority of our missed victims suffered medical complications. This included 2 deaths, which may have been preventable.

Although this study had an equal number of male and female perpetrators, men were significantly more likely to confess. This is consistent with 2 previous reports in which 75.8% of perpetrators who confessed to causing abusive head trauma<sup>25</sup> and 76% of perpetrators who confessed to caus-

ing abusive injuries in children were male.<sup>31</sup> As women are often perceived by society as nurturers and caregivers, they may be more likely to deny abusing children when confronted. When asked anonymously, mothers more readily admit to shaking infants or young children within the context of soothing or disciplining them.<sup>11-13</sup> In our study, 2 of the 3 of the victims of confessed female perpetrators had obvious extensive bruising on presentation, perhaps making abuse less deniable.

Significantly more male perpetrators were prosecuted and convicted of their abuse in our study. Our female perpetrators may not have been prosecuted as aggressively because the majority of their victims were less severely injured. However, other factors may have contributed to our findings, such as preconceived notions about gender and the likelihood of abusing infants, law enforcement approaching female perpetrators less aggressively, prosecutors' unwillingness to prosecute female perpetrators, and, perhaps, jury bias.

Men commit more violent crime than women in the United States.<sup>32</sup> Therefore, according to Wilczynski, society has a tendency to view female perpetrators differently than men. Specifically, women who commit infanticide are perceived by society as having abnormal behavior that must have resulted from either mental illness or a perverse family or social environment.<sup>33</sup>

Although gender bias has not been addressed in the prosecution of perpetrators of AHT, it is prevalent for other crimes. In a study of 1043 sexually abused children, 4% were victimized by women. Of the cases referred for criminal prosecution, the vast majority (70%) had no physical injury. Yet, 57% of male perpetrators had their cases referred for criminal action compared with 40% of women ( $P < .05$ ).<sup>34</sup>

Kingsnorth and MacIntosh<sup>35</sup> also reported gender disparity in the prosecution of heterosexual intimate partner violence. Of the 8461 cases processed through the Domestic Violence Unit (Sacramento County, CA) during the 2.5-year study period, 1027 (12%) were female. Compared with male defendants, women were much less likely to have their case filed ( $P < .001$ ). Although male and female defendants were equally likely to be charged with a felony, women were statistically more likely to have their charge reduced ( $P < .05$ ) or dismissed ( $P < .001$ ). Henning and Feder<sup>36</sup> also demonstrated that gender is a significant determinant of adjudication decisions. Female defendants represented 20.5% of their intimate partner violence cases. Even when controlling for defendant and offense characteristics, women were statistically more likely than men to be released and have their charges dropped ( $P < .001$ ). In addition, when convicted, female defendants received lighter sentences ( $P < .001$ ).

Gender disparity has also been reported in the treatment of female de-

fendants charged with violent felonies. Women were more likely than men to have all charges against them dismissed, and less likely to be incarcerated or sentenced as harshly.<sup>37</sup>

Finally, for similarly matched male drug offenders, female defendants consistently received preferential treatment from prosecutors and judges. Female offenders were statistically more likely to receive a shorter sentence and to get larger sentence discounts if they provided substantial assistance in the prosecution of another criminal case.<sup>38</sup>

There were several limitations of our study. The data were collected from a single institution, and the sample size was small. The cases also represent the institution's population and referral pattern, creating the potential for selection bias. Another limitation is the reliance on perpetrator confessions, which may not be completely accurate.

## CONCLUSIONS

This study found statistically significant differences between male and fe-

male perpetrators of AHT and their victims. Victims of male perpetrators were more likely to present with cardiopulmonary or respiratory arrest, require neurosurgical intervention, and have more severe clinical outcomes. Furthermore, male perpetrators confessed and were convicted more frequently than female perpetrators. Additional research is needed to determine if perpetrator disparities for victim presentations and outcomes are gender dependent or rather attributable to the physical size of their perpetrators. Also, case-matched victim comparison studies may help determine if gender bias truly exists in prosecuting and adjudicating perpetrators of AHT.

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