Infant Abusive Head Trauma in A Military Cohort

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WHAT’S KNOWN ON THIS SUBJECT: Abusive head trauma (AHT) is a type of physical child abuse, with infants at the highest risk. Parental characteristics associated with AHT include stress, young age, and current military service. However, a comprehensive evaluation of AHT among military families is lacking.

WHAT THIS STUDY ADDS: Risk factors and rates of AHT among military families are similar to civilian populations when applying a similar definition. Infants born preterm or with birth defects may have a higher abuse risk.

abstract

OBJECTIVE: Evaluate the rate of, and risk factors for, abusive head trauma (AHT) among infants born to military families and compare with civilian population rates.

METHODS: Electronic International Classification of Diseases data from the US Department of Defense (DoD) Birth and Infant Health Registry were used to identify infants born to military families from 1998 through 2005 (N = 676,827) who met the study definition for AHT. DoD Family Advocacy Program data were used to identify infants with substantiated reports of abuse. Rates within the military were compared with civilian population rates by applying an alternate AHT case definition used in a civilian study.

RESULTS: Applying the study definition, the estimated rate of substantiated military AHT was 34.0 cases in the first year of life per 100,000 live births. Using the alternate case definition, the estimated AHT rate was 25.6 cases per 100,000 live births. Infant risk factors for AHT included male sex, premature birth, and a diagnosed major birth defect. Parental risk factors included young maternal age (<21 years), lower sponsor rank or pay grade, and current maternal military service.

CONCLUSIONS: This is the first large database study of AHT with the ability to link investigative results to cases. Overall rates of AHT were consistent with civilian populations when using the same case definition codes. Infants most at risk, warranting special attention from military family support programs, include infants with parents in lower military pay grades, infants with military mothers, and infants born premature or with birth defects. Pediatrics 2013;132:668–676

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KEY WORDS: military personnel, shaken baby syndrome, child abuse, epidemiology

ABBREVIATIONS

AHT—abusive head trauma
CI—confidence interval
DoD—Department of Defense
FAP—Family Advocacy Program
ICD-9-CM—International Classification of Diseases, Ninth Revision, Clinical Modification
KID—Kids’ Inpatient Database
OR—odds ratio

Ms Gumbs coordinated the study, drafted the initial manuscript, and reviewed and revised the manuscript; Drs Keenan, Runyan, Ryan, and Smith contributed to the design of the study and reviewed and revised the manuscript; Mr Sevick managed study data, performed analyses, and reviewed and revised the manuscript; Dr Conlin guided analyses and reviewed and revised the manuscript; Mr Lloyd was responsible for obtaining investigative data from the Department of Defense Family Advocacy Program and reviewed the final manuscript; and all authors approved the final manuscript as submitted.

(Continued on last page)
Abusive head trauma (AHT) is a form of physical child abuse that occurs most frequently among infants. Victims of AHT may die, and sequelae among survivors may include poor cognitive and developmental outcomes. AHT may be recognized acutely when infants require hospitalization or subacutely in an office setting when an infant’s head circumference is noted to have increased abruptly. Population-level family risk factors for child abuse, including AHT, include parental stress, low social support, maternal depression, young parental age, and poverty.

Children of US military families could be at special risk for AHT. Military families face unusual occupation-related stress from frequent geographical moves and absences due to training and combat deployments. These may decrease social support and are stressful for both the military member and the family. However, military families have attributes and resources that likely protect against child abuse. These include the requirement for the service member to pass an aptitude test, ongoing employment, a high school education/equivalency or higher, and family support programs available to military members. Previous studies of child abuse in military compared with civilian families have shown mixed results. Generally, comparative studies have shown lower rates of neglect in the military population than in the civilian population and similar or higher rates of physical abuse. Two studies that examined AHT in military populations reported an increased risk of AHT in the military compared with the civilian population.

By using available military data sets, we examined the rate of substantiated, probable, and possible AHT in infants within the military population to examine risk factors for AHT and to determine if the rates of AHT in the military population are similar to those in the civilian population. Information gained from this study can be used to help the US Department of Defense (DoD) allocate resources for health and family services.

**METHODS**

**Study Population**

The study population included infants born to military families in the calendar years 1998 through 2005. Same-sex multiples were excluded from analyses because it is difficult to consistently differentiate their initial health care in the data set before each child’s assignment of a unique medical identifier. This research was approved by the Naval Health Research Center institutional review board and conducted in compliance with all applicable federal regulations governing the protection of human subjects in research.

**Data Sources**

**DoD Birth and Infant Health Registry**

The DoD Birth and Infant Health Registry (Registry) captures comprehensive health care utilization data to identify live births and subsequent infant health encounters among infants born to military families whose care is insured by the DoD in both military and civilian medical facilities. The Registry follows infants to 1 year of age or until the infant is no longer receiving DoD-sponsored care. Each inpatient and outpatient encounter is coded by *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes. Infant data are linked to the military parent’s (sponsor’s) demographic data, including age, race/ethnicity, sex, educational level, service branch, rank, and marital status.

**DoD Family Advocacy Program**

Each military service branch has a Family Advocacy Program (FAP) composed of a multidisciplinary team that responds to allegations of child abuse and neglect among military families. The FAP assigns a designation of “substantiated,” “unsubstantiated, unresolved,” or “unsubstantiated, did not occur” to each case and stores this information in conjunction with the military parent’s (sponsor’s) Social Security number.

**Case Ascertainment and Definitions**

Cases were ascertained from the Registry by using ICD-9-CM codes (Table 1). Infants with at least 1 of the defined head injury codes in an inpatient encounter, or the code for shaken infant syndrome in an inpatient or outpatient record, met the study definition for head trauma. The codes chosen were based on the definition for traumatic brain injury developed by the Centers for Disease Control and Prevention but excluded simple skull fractures and penetrating missile injuries. For the 800-series head injury codes, a fifth digit was not required, but any fifth digit present was accepted. Additionally, we recorded all ICD-9-CM codes for child maltreatment and eye injury, as well as external-cause-of-injury codes (E-codes), occurring at any point during an inpatient hospitalization (Table 1).

AHT categories were adapted from a draft Centers for Disease Control and Prevention operational definition for nonfatal AHT that is now formalized. We categorized potential cases of AHT as substantiated, probable, or possible by using both ICD-9-CM code definitions and the investigative findings of the FAP (Table 2). FAP findings were linked to cases by the military sponsor’s Social Security number to examine for temporal matches (ie, cases in which the FAP incident report date occurred 1 week before, or within 60 days of, a head trauma diagnosis). The FAP case determination was recorded for infants with a temporal FAP match.
To be considered substantiated AHT, cases required both an ICD-9-CM code indicating head trauma and a temporal match with a substantiated FAP incident report (Table 2). Probable cases of AHT included infants with an ICD-9-CM code for shaken infant syndrome (995.55) from an inpatient hospitalization, but with no report of abuse in the FAP data, or hospitalized infants with a head injury code with a temporal match in the FAP database indicating a report of abuse that was “unsubstantiated, unresolved.” Infants from the latter category were excluded from analyses if a code indicating birth injury (767.x), motor vehicle crash (E800.0x–E829.x), medical misadventure (E870.0), or adverse effect of a specified surgical operation (E878.8) appeared during the head injury hospitalization. Possible cases of AHT included infants with no FAP report but who were hospitalized with a head injury code in conjunction with either a child maltreatment code or a cause code; those hospitalized with the unspecified head injury code (959.01), a child maltreatment code or cause code, and an eye injury code; or those hospitalized with a head injury code and an eye injury code. The same exclusions were applied as in the probable cases.

To determine if rates of AHT in the military population are consistent with civilian rates, we used an alternate method of case finding. We applied the definitions used by Ellingson et al on the Kids’ Inpatient Database (KID) to inpatient records in the Registry. Ellingson et al’s definition uses a narrower range of ICD-9-CM codes/E-codes for defining AHT among infants (<1 year) in an inpatient population. The KID, an administrative data set, is part of the Healthcare Cost and Utilization Project from the Agency for Healthcare Research and Quality. The KID collects a randomly selected 80% sample of all non–birth-related pediatric discharges from all hospitals in the states that are surveyed in a given year.

In an exploratory analysis of the effect of parental deployment in support of the current operations on the rate of AHT, deployment information was gathered on the military sponsor for all substantiated and probable cases of AHT and a comparison diagnosis of pneumonia among infants born on or after September 11, 2001. Pneumonia was chosen as a comparator because it provided a date relative to deployment for non-AHT cases, and it should not be a deployment-sensitive condition. An infant was considered deployment-exposed if his or her military parent had a deployment of ≥30 days’ duration during 3 specified time frames: (1) deployed at the time of the event, (2) returned from deployment within 3 months before the event date, (3) returned from deployment >3 months before the event but not earlier than 3 months before the infant’s date of birth. Alternatively, the infant was considered unexposed if the military parent was not deployed in any of the specified time frames. If an infant qualified for >1 deployment-exposure category, the specified order above was used as a priority of classification. Infant pneumonia was defined by the following ICD-9-CM codes: 480.xx, 481.xx, 482.xx, 483.xx, 484.xx, 485.xx, 486.xx, and 487.0x.

The comparison group for all analyses consisted of infants born in the same years who did not meet the AHT criteria for inclusion. Sponsor demographic information was obtained for all study infants, and deployment information was captured on sponsors with infants born on or after September 11, 2001.
Statistical Analyses

The rates of substantiated, probable, and possible cases of AHT, with 95% confidence intervals (CIs), were calculated by using the total number of each type of case as the numerator and the number of live births in the cohort as the denominator.

Descriptive analyses examined each case type by military sponsor parent, maternal, and infant demographic characteristics (Table 3). Infant demographic characteristics included sex, prematurity (≤36 weeks’ gestational age), and presence or absence of ICD-9-CM codes indicating a major birth defect, as defined by the National Birth Defects Prevention Network20 and captured in the Registry. Cases of atrial septal defect (745.5x) and patent ductus arteriosus (747.0x) in preterm infants were not included as birth defects in accordance with Metropolitan Atlanta Congenital Defects Program guidelines.21

Odds ratios (ORs) were calculated by logistic regression modeling on the combined group of substantiated and probable cases to reduce the risk of misclassification. A multivariable logistic regression model adjusted for infant sex, birth defect status, and birth term status; maternal age and military/marital status; and sponsor service branch, rank, race/ethnicity, education, and duty status was developed to assess adjusted ORs and 95% CIs. We omitted sponsor age from the multivariable model because of collinearity with maternal age and maternal military/marital status.

Data management and statistical analyses were performed by using SAS software, version 9.2 (SAS Institute, Cary, NC).

RESULTS

There were 676,827 infants who met inclusion criteria. Among these infants, 230 had substantiated AHT, 35 had probable AHT, and 38 had possible AHT. Seventy-three (0.01%) infants were removed from further analysis secondary to unspecified sponsor rank. Infant and sponsor characteristics for each AHT category and the entire Registry are shown in Table 3.

In the adjusted model, infant characteristics associated with substantiated or probable AHT (n = 265) included presence of a birth defect, male sex, and preterm birth. The odds of substantiated or probable AHT nearly doubled in families with young maternal age (<21 years). Infants born to military mothers were more likely to be a substantiated or probable case of AHT. Compared with military families with a nonmilitary mother, infants born to military mothers with a nonmilitary spouse had a 3.6 greater odds, those born to single military mothers had a 3.1 times greater odds, and those born to dual military families had a 2.5 greater odds of being cases. Factors that appeared to be protective were having a military parent who was a National Guard/Reserve member and higher sponsor rank (Table 4).

Cumulative categories for substantiated, probable, and possible AHT were used to determine the rates of AHT by year (Fig 1). AHT rates increased in 2001 (Fig 1), but the increase was only significant for substantiated AHT cases (P = .002). The cumulative estimated rates for AHT per 100,000 Registry infants were as follows: 34.0 (95% CI: 29.6–38.4) for substantiated cases, 39.2 (95% CI: 34.4–43.9) including probable cases, and 44.8 (95% CI: 39.7–49.8) including possible cases (Fig 2). Applying Ellenson et al’s18 definitions decreased calculated rates to 25.6 (95% CI: 21.8–29.4), which is similar to rates found in the civilian population as shown in Fig 2.

There were 147 AHT case infants born after September 11, 2001. Of these, 128 were considered unexposed to...
deployment. Separate exact logistic regression models were performed for maternal and paternal deployment exposure because women are not deployed when known to be pregnant or immediately after delivery. In the paternal model, adjusted for maternal age and paternal rank, deployment was significantly different between the AHT and pneumonia groups \((P = 0.02)\). “Sponsor on deployment” was significantly protective for the AHT group when compared with “not deployed” \((OR: 0.36; 95\% CI: 0.11–0.89)\). Because of the interaction of deployment timing and pregnancy/child birth, the maternal model was limited to comparing “not deployed” with “occurred while sponsor on deployment.” In the maternal model, neither the univariable nor the adjusted models showed a significant effect.

**DISCUSSION**

This study assessed substantiated cases of AHT by linking electronic medical data indicating head trauma

### TABLE 3 Infant, Maternal, and Military Sponsor Demographic Characteristics of Substantiated, Probable, and Possible AHT Cases Among DoD Birth and Infant Health Registry Infants Born 1998–2005

<table>
<thead>
<tr>
<th>AHT Case Category Total Registry Infants</th>
<th>Substantiated</th>
<th>Probable</th>
<th>Possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>Total</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>---------------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>Total</td>
<td>230</td>
<td>100.0</td>
<td>35</td>
</tr>
<tr>
<td>Any birth defect</td>
<td>No</td>
<td>205</td>
<td>89.1</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>25</td>
<td>10.9</td>
</tr>
<tr>
<td>Infant sex</td>
<td>Female</td>
<td>89</td>
<td>38.7</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>141</td>
<td>61.3</td>
</tr>
<tr>
<td>Infant birth status</td>
<td>Full term</td>
<td>187</td>
<td>81.3</td>
</tr>
<tr>
<td></td>
<td>Preterm</td>
<td>43</td>
<td>18.7</td>
</tr>
<tr>
<td>Maternal age</td>
<td>≥21 years</td>
<td>150</td>
<td>65.2</td>
</tr>
<tr>
<td></td>
<td>&lt;21 years</td>
<td>80</td>
<td>34.8</td>
</tr>
<tr>
<td>Maternal military/marital status</td>
<td>Dependent spouse</td>
<td>130</td>
<td>56.5</td>
</tr>
<tr>
<td></td>
<td>Military, single</td>
<td>46</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>Military, married</td>
<td>31</td>
<td>13.5</td>
</tr>
<tr>
<td></td>
<td>Dual military married</td>
<td>23</td>
<td>10.0</td>
</tr>
<tr>
<td>Sponsor age</td>
<td>≥21 years</td>
<td>183</td>
<td>79.6</td>
</tr>
<tr>
<td></td>
<td>&lt;21 years</td>
<td>47</td>
<td>20.4</td>
</tr>
<tr>
<td>Sponsor service branch</td>
<td>Army</td>
<td>87</td>
<td>37.8</td>
</tr>
<tr>
<td></td>
<td>Navy, Coast Guard</td>
<td>63</td>
<td>27.4</td>
</tr>
<tr>
<td></td>
<td>Air Force</td>
<td>57</td>
<td>24.8</td>
</tr>
<tr>
<td></td>
<td>Marine Corps</td>
<td>23</td>
<td>10.0</td>
</tr>
<tr>
<td>Sponsor rank</td>
<td>E01–E03</td>
<td>110</td>
<td>47.8</td>
</tr>
<tr>
<td></td>
<td>E04–E05</td>
<td>103</td>
<td>44.8</td>
</tr>
<tr>
<td></td>
<td>E06–E09</td>
<td>11</td>
<td>4.8</td>
</tr>
<tr>
<td></td>
<td>Officer</td>
<td>6</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>Unspecified enlisted</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Sponsor race/ethnicity</td>
<td>White</td>
<td>138</td>
<td>59.1</td>
</tr>
<tr>
<td></td>
<td>Other/unknown</td>
<td>94</td>
<td>40.9</td>
</tr>
<tr>
<td>Sponsor educational level</td>
<td>No college degree</td>
<td>215</td>
<td>93.5</td>
</tr>
<tr>
<td></td>
<td>College degree</td>
<td>11</td>
<td>4.8</td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
<td>4</td>
<td>1.7</td>
</tr>
<tr>
<td>Sponsor duty status</td>
<td>Regular duty</td>
<td>223</td>
<td>97.0</td>
</tr>
<tr>
<td></td>
<td>National Guard/Reserve</td>
<td>7</td>
<td>3.0</td>
</tr>
</tbody>
</table>

a The infant’s sponsor is the military parent under whom the child is insured.

b Enlisted personnel are denoted as “E”; higher numbers indicate a higher pay grade.
approach used in our study was
investigative data suggests that the
base studies, successful matching to
study decreased. Although our
estimated rate of substantiated AHT in
and probable cases increased the
sound. Including both substantiated
and probable cases increased the
estimated rate of AHT in the military
to 39.2 cases per 100 000 live births
(95% CI: 34.4–43.9), above the confi-
dence limits of the rate found in the
civilian population in 2000 (27.5 per
100 000 infants per year; 95% CI:
22.6–32.3) but within the confidence
limits for civilian rates in 2003 (32.2 per
100 000 infants per year; 95% CI:
26.9–37.4). These increased
rates are explained in part by the fact
that the Registry is neither limited to
pediatric ICU patients nor to hospi-
talized patients. Also, the Registry
allowed us to follow individual infants
longitudinally and to capture all
cases that occurred while the infant
was a military dependent up to 12
months of age.

AHT rates in the military were similar
to those found in the KID database
when we used the same case-finding
methods in our inpatient records
that Ellingson used for KID. This
suggests both that the military population
is not at excess risk of AHT compared
with civilian populations and that
large data set studies in civilian
populations may underestimate the
scope of the problem.

Rates of substantiated AHT among
military infants increased in 2001 (Fig 1). When examined by month
(data not shown), the increase began
in September 2001 and continued for
several months. An increased AHT
risk was previously associated with
stressful events, such as a natural
disaster.22 Similarly, it is feasible that
the events of September 11, or the
strain of impending deployment, could
have acted as stressors that resulted
in the elevated number of cases. How-
ever, this link to potential stressors
following the events of September 11
must be considered speculative be-
cause it is based on very small numbers.

Two previous studies in North Carolina
suggested an excess risk of AHT in
infants born to military sponsors.11,12
Both studies had relatively small
sample sizes and were performed in
the same geographic region. This
study did not find an elevated risk in
military families, suggesting that al-
though there may be a regionally ele-
vated risk of AHT, this may not hold
true for the military population as
a whole.

### TABLE 4 Adjusted ORs and Rates of Substantiated and Probable AHT Among DoD Birth and Infant Health Registry Infants Born 1998–2005

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total number of Infants</th>
<th>Number of AHT Cases</th>
<th>Cases per 100 000</th>
<th>Adjusted OR of Substantiated and Probable AHT (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>676 754</td>
<td>265</td>
<td>29.18</td>
<td></td>
</tr>
<tr>
<td>Any birth defect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>653 373</td>
<td>235</td>
<td>35.97</td>
<td>1.00 (Referent)</td>
</tr>
<tr>
<td>Yes</td>
<td>23 381</td>
<td>30</td>
<td>128.31</td>
<td>3.04 (2.07–4.48)</td>
</tr>
<tr>
<td>Infant sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>329 287</td>
<td>101</td>
<td>30.67</td>
<td>1.00 (Referent)</td>
</tr>
<tr>
<td>Male</td>
<td>347 467</td>
<td>164</td>
<td>47.20</td>
<td>1.50 (1.17–1.92)</td>
</tr>
<tr>
<td>Infant birth status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full term</td>
<td>627 652</td>
<td>219</td>
<td>34.89</td>
<td>1.00 (Referent)</td>
</tr>
<tr>
<td>Preterm</td>
<td>49 102</td>
<td>46</td>
<td>93.68</td>
<td>2.29 (1.65–3.16)</td>
</tr>
<tr>
<td>Maternal age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥21 years</td>
<td>589 844</td>
<td>173</td>
<td>29.33</td>
<td>1.00 (Referent)</td>
</tr>
<tr>
<td>&lt;21 years</td>
<td>86 910</td>
<td>92</td>
<td>105.86</td>
<td>1.71 (1.28–2.28)</td>
</tr>
<tr>
<td>Maternal military/marital status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependents</td>
<td>557 920</td>
<td>144</td>
<td>25.81</td>
<td>1.00 (Referent)</td>
</tr>
<tr>
<td>Military, single</td>
<td>39 545</td>
<td>53</td>
<td>134.02</td>
<td>3.13 (2.24–4.36)</td>
</tr>
<tr>
<td>Military, married</td>
<td>39 493</td>
<td>39</td>
<td>98.75</td>
<td>3.62 (2.52–5.20)</td>
</tr>
<tr>
<td>Dual military married</td>
<td>39 796</td>
<td>29</td>
<td>72.87</td>
<td>2.48 (1.66–3.72)</td>
</tr>
<tr>
<td>Sponsor service branch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Army</td>
<td>250 237</td>
<td>95</td>
<td>37.96</td>
<td>1.00 (Referent)</td>
</tr>
<tr>
<td>Navy, Coast Guard</td>
<td>178 785</td>
<td>81</td>
<td>45.31</td>
<td>1.11 (0.82–1.49)</td>
</tr>
<tr>
<td>Air Force</td>
<td>169 781</td>
<td>60</td>
<td>35.34</td>
<td>0.91 (0.65–1.28)</td>
</tr>
<tr>
<td>Marine Corps</td>
<td>77 951</td>
<td>29</td>
<td>37.20</td>
<td>0.89 (0.59–1.38)</td>
</tr>
<tr>
<td>Sponsor rank</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E01–E03</td>
<td>119 041</td>
<td>128</td>
<td>107.53</td>
<td>1.00 (Referent)</td>
</tr>
<tr>
<td>E04–E05</td>
<td>323 111</td>
<td>118</td>
<td>36.52</td>
<td>0.49 (0.37–0.65)</td>
</tr>
<tr>
<td>E06–E09</td>
<td>110 587</td>
<td>12</td>
<td>10.85</td>
<td>0.20 (0.11–0.37)</td>
</tr>
<tr>
<td>Officer</td>
<td>124 015</td>
<td>7</td>
<td>5.64</td>
<td>0.22 (0.08–0.63)</td>
</tr>
<tr>
<td>Sponsor race/ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>446 056</td>
<td>156</td>
<td>34.67</td>
<td>1.00 (Referent)</td>
</tr>
<tr>
<td>Other/unknown</td>
<td>230 098</td>
<td>109</td>
<td>47.25</td>
<td>0.88 (0.69–1.14)</td>
</tr>
<tr>
<td>Sponsor educational level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No college degree</td>
<td>507 686</td>
<td>249</td>
<td>49.04</td>
<td>1.00 (Referent)</td>
</tr>
<tr>
<td>College degree</td>
<td>155 488</td>
<td>12</td>
<td>7.72</td>
<td>0.53 (0.24–1.14)</td>
</tr>
<tr>
<td>Unknown</td>
<td>13 568</td>
<td>4</td>
<td>29.48</td>
<td>0.90 (0.33–2.44)</td>
</tr>
<tr>
<td>Sponsor duty status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular duty</td>
<td>571 758</td>
<td>256</td>
<td>44.77</td>
<td>1.00 (Referent)</td>
</tr>
<tr>
<td>National Guard/Reserve</td>
<td>104 996</td>
<td>9</td>
<td>8.57</td>
<td>0.43 (0.21–0.87)</td>
</tr>
</tbody>
</table>

* Analyses adjusted for presence of a birth defect, infant sex, preterm birth, maternal age and military status, and sponsor service branch, rank, race/ethnicity, and educational level.

* The infant’s sponsor is the military parent under whom the child is insured.

* Enlisted personnel are denoted as “E”; higher numbers indicate a higher pay grade.
The use of the large and well-validated military data set allowed the exploration of risk factors for AHT with precision. Similar to previous studies, this analysis revealed that male infant sex was associated with substantiated AHT (adjusted OR: 1.5; 95% CI 1.17–1.92).12,18,23 Unique to this data set was the ability to examine premature birth and birth defects, both of which were independently associated with AHT. This finding is important because these 2 groups of infants are more likely to be discharged from the NICU or the regular hospital ward. These higher AHT risk infants may not receive preventive education targeted at the newborn nursery.

Parental risk factors related to AHT included lower pay grade, young maternal age, and the presence of a military mother. Because neither care setting nor perpetrator information were fully available in this data set, further research is necessary to understand the elevated risk associated with military mothers and to develop meaningful programs to decrease this risk.

Finally, we examined deployment as an exposure on the basis of the hypothesis that AHT rates might be elevated during or after parental deployment, secondary to stress in the military parent deploying and then reintegrating into family life and stress to the parent who remained at home.5 However, the majority of AHT cases did not occur in the setting of a recent deployment. In our exploratory analysis, the frequency of AHT cases was similar to the frequency of infant pneumonia cases with regard to deployment in all categories except for “sponsor on deployment” in the paternal model, which was protective. Within civilian populations, male caretakers are most frequently the perpetrators of AHT,24,25 which could explain the protective nature of “sponsor on deployment.” However, the lack of perpetrator information limits our ability to explain these differences. Caution should be applied when considering our deployment findings because only 77 AHT infants were included in the deployment analysis, with 5 of these in the “sponsor on deployment” category.

Limitations of this study include the use of large administrative data sets, which are open to misclassification due to coding errors; however, this type of error is less likely in our data sets because of the ability to follow infants longitudinally and to validate the codes used for specific infants. It
is possible that cases were missed if infants were born before the parent’s enlistment in the military or if the case occurred after the parent left the military but before the child’s first birth date. This situation may be a particular problem for Reserve/Guard individuals who may have been on active duty at the time of an infant’s birth but deactivated at some point during the first year of life. Reassuringly, ~75% of infants in the Registry receive ≥9 months of care, thus any effect from this limitation is likely small. Finally, the data on deployment must be considered as preliminary due to small numbers and the risk of misclassification if members scheduled to deploy did not deploy.

Rates of AHT were similar to those in civilian populations when using the same case definitions. The rate of AHT was higher when applying the more sensitive study definitions, suggesting that civilian data sets relying on discharge coding alone may underestimate the incidence of AHT. Our data identified high-risk groups that warrant special attention. Families with parents in lower military pay grades, those with military mothers, and those with infants who are born premature or with birth defects may need additional support through the military’s family support programs. Similarly, civilian parents of preterm infants or infants with birth defects might benefit from targeted prevention.

**ACKNOWLEDGMENTS**

We gratefully acknowledge the support and/or collaboration of the following professionals: Scott Seggerman and Elsie Ester of the Defense Manpower Data Center and Dr Carol Runyan of the University of North Carolina School of Public Health.

**REFERENCES**

17. Parks SE, Annest JL, Hill HA, Karch DL. *Pediatric Abusive Head Trauma: Recommended Definitions for Public Health Surveillance and Research*. Atlanta, GA: Centers for Disease Control and Prevention; 2012


(Continued from first page)
**Objective**: Evaluate the rate of, and risk factors for, abusive head trauma (AHT) among infants born to military families and compare with civilian population rates.

**METHODS**: Electronic *International Classification of Diseases* data from the US Department of Defense (DoD) Birth and Infant Health Registry were used to identify infants born to military families from 1998 through 2005 (N = 676,827) who met the study definition for AHT. DoD Family Advocacy Program data were used to identify infants with substantiated reports of abuse. Rates within the military were compared with civilian population rates by applying an alternate AHT case definition used in a civilian study.

**Results**: Applying the study definition, the estimated rate of substantiated military AHT was 34.0 cases in the first year of life per 100,000 live births. Using the alternate case definition, the estimated AHT rate was 25.6 cases per 100,000 live births. Infant risk factors for AHT included male sex, premature birth, and a diagnosed major birth defect. Parental risk factors included young maternal age (<21 years), lower sponsor rank or pay grade, and current maternal military service.

**Conclusions**: This is the first large database study of AHT with the ability to link investigative results to cases. Overall rates of AHT were consistent with civilian populations when using the same case definition codes. Infants most at risk, warranting special attention from military family support programs, include infants with parents in lower military pay grades, infants with military mothers, and infants born premature or with birth defects.