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REVIEW ARTICLE

An integrative review on the shadow of abuse in pediatric head trauma

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ABSTRACT

INTRODUCTION

Abusive head trauma (AHT) is a significant public health issue that can lead to severe neurological damage or death in childhood. Often difficult to detect, AHT carries long-term consequences and requires high diagnostic vigilance. This integrative review aims to synthesize the current evidence on abusive head trauma in pediatric patients by identifying distinguishing diagnostic criteria, clinical patterns, and risk factors, in order to support early recognition, accurate diagnosis, and effective intervention strategies by healthcare professionals.

METHODS

This integrative review aimed to systematically include studies published between 2020-2025 and the literature search was conducted in April-June 2025. The databases searched included PubMed and Web of Science. The keywords included in the search were "Abusive head trauma", "child abuse", "non-accidental head injury", "health care professional", "pediatric head trauma". The methodological quality of the included studies was assessed using the Risk of Bias in Non-randomized Studies – of Interventions (ROBINS-I) tool.

RESULTS

The findings were synthesized under four main themes: diagnostic indicators and differentiation, epidemiological risk factors, short-term clinical outcomes, and long-term developmental effects. Elevated glucose levels (>300 mg/dL), the diagnostic "triad" (subdural hematoma, retinal hemorrhage, and encephalopathy), and increased plasma osteopontin levels were identified as critical diagnostic clues. Additionally, household composition and caregiver characteristics emerged as significant risk factors.

CONCLUSION

This integrative review highlights the necessity of identifying high-risk environments and implementing preventive strategies. The evidence presented offers practical, evidence-based insights to support healthcare professionals in accurately diagnosing and managing AHT. It also underscores the need for multidisciplinary prevention efforts and post-trauma monitoring. Ultimately, this study seeks to enhance clinical awareness and improve early identification and intervention strategies for children suffering from abuse-related head trauma.

Keywords: Abusive head trauma, child abuse, non-accidental head injury, health care professional, pediatric head trauma

INTRODUCTION

Pediatric head trauma (HT), caused by falls, collisions, shaking, or blunt force, is a major health concern leading to neurological injury and substantial risks of morbidity and mortality.[1-6] Approximately 200,000 children are hospitalized annually due to HT, and 4,000 die within hours of the trauma. While trauma accounts for 15% of adult deaths, it contributes to nearly 50% of childhood mortality.[7] Despite increased clinical awareness, distinguishing abusive head trauma from accidental injuries remains a major diagnostic challenge for healthcare professionals.[8,9]

Head trauma is the most common cause of morbidity and mortality in children under the age of two.[10,11] According to the lasgow Coma Scale (GCS), HT is classified as mild (GCS 14-15), moderate (GCS 9-13), or severe (GCS 3-8).[12] Common etiologies include sports injuries, falls, and motor vehicle accidents. Falls are especially prevalent in children under two due to immature walking skills, relatively larger head size, shifted center of gravity, and underdeveloped neck musculature.[10]

Though less common, non-accidental trauma (i.e., abuse-related HT) constitutes a serious etiology. The Centers for Disease Control and Prevention (CDC) and the American Academy of Pediatrics (AAP) recommend using the term "Abusive Head Trauma (AHT)" for trauma resulting from abuse.[13] Abusive head trauma most frequently occurs in children under five and results from violent shaking, blunt force, suffocation, or being dropped or thrown—typically by caregivers attempting to silence a crying child.[11]

Abusive head trauma is one of the primary causes of traumatic brain injury in early childhood, often going unrecognized but with lifelong consequences. Caregivers frequently deny any harmful event, offering alternative explanations such as falling from stairs, high chairs, or being pushed by a sibling. This obscures the true etiology and delays diagnosis. Therefore, it is vital for healthcare professionals to recognize the distinguishing signs and symptoms of AHT for timely intervention.[3,10,11,14,15]

Various intracranial and ophthalmologic findings—such as subdural hematoma, retinal hemorrhage, and cerebral edema—have been identified as potential indicators of abuse.[16,17] However, no single finding is pathognomonic, and clinical presentations often overlap with accidental injuries, making misdiagnosis a persistent risk.[18-20] These diagnostic ambiguities are further complicated by inconsistent histories provided by caregivers and limited external signs of trauma.[21-23] This integrative review aimed to conduct a thorough assessment of the available evidence on AHT, focusing on: 1. diagnostic confusion, 2. clinical dilemmas, and 3. missed outcomes.

METHODS

Research type and strategy

This integrative review systematically examined the literature published between 2020 and 2025 to identify key indicators that help differentiate abuse-related injuries in pediatric head trauma cases. The literature search was conducted between April and June 2025. PubMed and Web of Science were used as the databases. The keywords employed included “abusive head trauma,” “non-accidental head injury,” “child abuse,” and “pediatric head trauma. Boolean operators “AND” and “OR” were used to combine and refine search terms. To map the search process, a flow diagram was used PRISMA [24] flow diagram (Figure 1).

Inclusion and exclusion criteria

The inclusion and exclusion criteria were essential for ensuring the methodological integrity of the review and for evaluating the literature comprehensively. These criteria are presented in Table 1.

Selection process

To minimize bias, the selection process was carried out by two independent researchers. Discrepancies and inconsistencies between reviewers were resolved through consultation with a third independent reviewer. The keywords and inclusion/exclusion criteria guided the screening boundaries. Only full-text English-language articles were included for eligibility assessment. The PRISMA flow diagram showing the selection process is presented in Figure 1. The Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) tool was used to assess study quality.[25] According to the ROBINS-I evaluation, seven studies were found to have

moderate risk and four had low risk of bias (Supplementary Table 1).

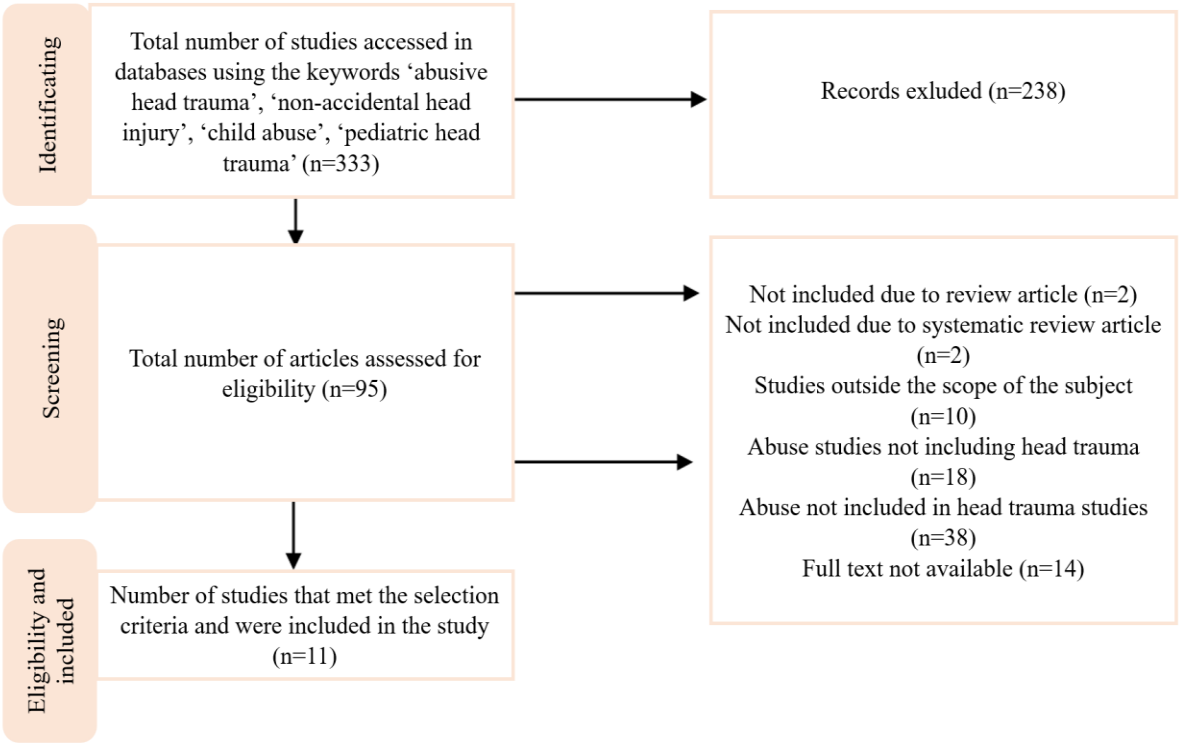

Figure 1. PRISMA flow diagram of the research selection process

Table 1. Inclusion and exclusion criteria of the study

Inclusion criteria	Exclusion criteria
✓ Studies involving head trauma, child abuse, and pediatric age groups	✓ Letters to the editor, abstracts, dissertations, reviews, systematic reviews, and conference proceedings
✓ Studies presenting clinical findings such as physical examination, neuroimaging, or symptoms associated with abuse	✓ Studies not involving children or head trauma
✓ Articles published between 2020 and 2025	✓ Studies not specifically addressing head trauma resulting from abuse
✓ Full-text articles available in English	✓ Non-English studies or those with inaccessible full texts
✓ Quantitative, qualitative, or mixed-method studies (including RCTs, cohort, and cross-sectional designs)	
✓ Studies conducted with children aged 0–18 years	

Data analysis

In this integrative review, data analysis was performed following a systematic and structured approach as recommended by Oermann and Knafl.[26] A standardized data extraction form was used to ensure completeness, transparency, and consistency across all included studies. Extracted data included study design, country, sample characteristics, aims, outcome variables, and key findings.

The analysis proceeded in two main stages. First, a descriptive summary of the included studies was created, detailing their methodological and contextual features. Second, thematic analysis was employed to identify and categorize patterns within the data. The analysis was conducted in a stepwise manner to ensure rigor, and conceptual mapping was used to align thematic findings with clinical practice implications. All analytical steps were planned a priori to reduce bias and enhance methodological transparency.

RESULTS

Study characteristics

This integrative review included 11 studies covering abusive head trauma in children and published between 2020 and 2025 (2020=2; 2022=4; 2023=3; 2025=2). The majority of these studies were conducted in the USA, with one study

in Taiwan,[27] and one study in the Netherlands.[28] It was determined that the sample sizes of the included studies varied widely, with the smallest sample being 47 [29] and the largest sample being 20,540.[30] When the population of the studies was examined, it was determined that all of the studies included children (0-18 years old), and especially children under 3 years old and infants (<12 months) constituted the study populations. Studies have focused on patients diagnosed with craniofacial trauma, traumatic brain injury (TBI), and particularly AHT.

Almost all of the studies were conducted with a retrospective design.[27-35] Only two studies [36,37] were cohort studies. The main focuses of the studies are; focused on clinical/biomarkers/radiological findings helpful in the diagnosis of abuse,[30,32-36] epidemiological features and risk factors of abuse,[30,31] clinical outcomes and prognosis of abuse,[27,34] long-term developmental/behavioral consequences of abuse,[29,37] and classification of abuse-related injuries with mathematical/clinical patterns.[28] The characteristics of the studies included in the research are presented in Table 2.

Thematic synthesis of studies

The findings of the studies were examined under four main themes.

Diagnostic clues and discrimination

Studies have highlighted critical diagnostic clues in distinguishing AHT from accidental trauma. Among these, hyperglycemia,[35] the "triad": subdural hematoma, retinal hemorrhage, encephalopathy [32] intraventricular hemorrhage, widespread axonal injury, hypoxic-ischemic injury, spinal injury [34] and increased osteopontin[36] have been prominent. In the studies of Boos et al.,[28] it has been shown that the mathematical clustering of clinical findings is similar to the distinctive findings of abuse cases.

Epidemiology and risk factors

It has been stated that the risk of AHT increases in infants (<12 months), in the presence of a sibling under the age of 5 and in biological parents. In older children (>12 months) and in those without a sibling, the risk of abuse by the parent's boyfriend/girlfriend has been reported to increase.[31]

Clinical course and short-term outcomes

The association of AHT with poor neurological outcomes and risk of death in the short term has been emphasized. Gomez et al.[30] reported that in-hospital mortality rates were 6.78%; Lee et al.,[27] associated initial findings such as shock, hypothermia, and post-traumatic seizures with poor prognosis. Orman et al.[34] showed a strong association of specific neuroimaging findings (especially hypoxic-ischemic injury) with death and poor neurological outcomes in their studies.

Long-term developmental and behavioral outcomes

Attention has been drawn to the long-term devastating effects of AHT. Children who underwent AHT have been reported to have significant delays and deficiencies in fine motor skills, personal-social development, socio-emotional areas, and cognitive and language development.[29,37] Moderate injuries are more associated with internalizing behavior problems.[29] Rehabilitation services should be provided in this its role in improving negative outcomes has been emphasized.[37] A summary of the thematic synthesis of the studies is presented in Table 3.

Distinguishing findings

Hyperglycemia: Initial glucose levels >300 mg/dL have been described as a very strong indicator of abuse, especially in young children.[35] This finding is a critical “red flag” for clinicians in raising suspicion of abuse.

Classic “triad” finding: The combination of subdural hematoma, retinal hemorrhage, and encephalopathy has been validated as a diagnostic triad with high specificity for AHT.[32] The diagnosis of abuse is highly likely in the presence of this triad.

Specific neuroimaging findings and combinations

Classic findings*:* Subdural hematoma is the most common classical finding.[34]

Non-classic findings: Bridging vein thrombosis is the most common non-classic finding.[34]

Poor prognostic indicators*:* The combination of intraventricular hemorrhage, diffuse axonal injury, hypoxic-ischemic injury, arterial stroke, and spinal ligamentous injury is strongly associated with poor neurological outcome and death.[34]

Table 2. The characteristics of the Studies

Author	N	Sample	Research design	Key findings and conclusion
Gomez et al. [30]	20.540	Children aged 0-17	- A retrospective study evaluating demographic structures, injury characteristics, and trends in injuries related to non-accidental trauma related to early diagnosis, intervention, and prevention studies in pediatric craniofacial trauma. - Patients with craniofacial injuries and diagnosed with non-accidental trauma were identified according to current procedure codes, and demographic and temporal trends were analyzed.	- On average, 39% of all non-accidental trauma cases involved craniofacial injuries, with the most common types of injuries being intracranial, superficial head injuries, and craniofacial fractures. - The mean in-hospital mortality rate was 6.78%, and temporal analysis showed significant reductions in in-hospital mortality and length of stay.
Randall et al. [35]	179	Children treated in the emergency department for traumatic intracranial hemorrhage less than three years ago	- A retrospective study testing the hypothesis that children with AHT are more likely to have hyperglycemia. - Demographic characteristics, laboratory values, and imaging results of the children were analyzed.	- It has been stated that all young children with intracranial hemorrhage and initial glucose levels greater than 300 mg/dL are victims of abuse. - In the presence of a very high initial glucose, health professionals have reported that children should be evaluated for abusive head injuries. - It has been emphasized that in cases of infants with glucose levels greater than 300 mg/dL, consideration of abuse should play an important role in the distinction.
Isaac et al. [33]	476	Children under 3 years of age with acute head injuries and skull fractures	- A retrospective study examining positive findings on radiological skeletal examinations in children with skull fractures who were considered to be at low and high risk for abuse. - The primary aim was to measure and compare positive findings on skeletal imaging in low and high risk children. - Findings considered positive on skeletal examinations were fractures that were moderately or highly specific for abuse. These were; rib fractures, classic metaphyseal lesions, epiphyseal separations, scapula, sternum, finger fractures, and vertebral fractures or dislocations.	- It has been noted that other abuse fractures occur in less than 1% of low-risk children under 3 years of age presenting with simple or complex skull fractures. - It has been stated that the results may inform efforts to reduce unnecessary skeletal research.
Keenan et al. [37]	168	Children under 31 months	- A cohort study examining the developmental process of infants and toddlers over a 3-year period following traumatic brain injury (abusive and non-abusive). - Injury severity was measured using the Abbreviated Injury Scale (Level 1 denotes a minor injury; level 6 denotes an unsurvivable injury). - Abusive head trauma was categorized by reviewing the child abuse team's consultation notes.	- It has been stated that children with AHT are in the worst condition compared to children without AHT and show developmental disabilities in fine motor, personal, social and socio-emotional areas over time. - It has been reported that rehabilitation services can improve these negative outcomes.
Lee et al. [27]	2481	Children aged 1 month to 18 years receiving treatment in intensive care units	- A retrospective study analyzing predictors of clinical outcomes of children who were physically abused. - The main outcome variables of the study were in-hospital mortality and neurological outcomes of survivors. - General functional status at discharge was the secondary outcome variable. - The research data were obtained with the "Pediatric Cerebral Performance Category" scale.	- A large number of children who have been physically abused have had head trauma due to abuse. - Initial symptoms that start with shock, hypothermia during admission to the intensive care unit, and post-traumatic seizures have been associated with poor neurological outcomes and mortality.
Boos et al. [28]	500	<3 years old children	- A retrospective study that performed unsupervised cluster analysis of data sets of children admitted to intensive care due to head trauma.	- The three-cluster algorithm divided the population into 2 clusters without reference to predetermined diagnostic criteria or clinical opinion about the nature of the abusive head injury.

			- Head trauma findings were classified with mathematical algorithms and three cluster algorithms were used.	- Variables significantly more common in cluster 1 were cerebral hypoxemia, ischemia, especially acute encephalopathy lasting >24 hours, respiratory failure, subdural hemorrhage or fluid collection, and retinoschisis. - Variables significantly more common in cluster 2 were linear parietal skull fracture and epidural hematoma. - Clinical differences between clusters were consistent with findings in the literature in abusive versus non-abusive comparisons.
Eismann et al. [31]	200	Children diagnosed with AHT	- A retrospective study evaluating the household structure of children diagnosed with AHT and the relationships between patient, household characteristics, perpetration, and death. - The identified children's electronic medical records, histories, physical examination notes, social worker notes, child abuse pediatrician notes, and child abuse reporting forms from the date of hospitalization were manually reviewed. - Descriptive statistics were used to characterize the sample.	- Children under 12 months of age and those with siblings at home, especially those under the age of 5, were found to be more likely to be injured by their biological parents. - Children 12 months of age and older and children without siblings were found to be more likely to be injured by their parents'/caregiver's boyfriends/girlfriends.
Hymel et al. [32]	58	Children with acute head trauma of less than 3 years duration	- A retrospective study comparing clinical symptoms and injuries in patients with witnessed/accepted AHT and those without witnessed AHT. - The AHT test performance of the trio (subdural hematoma, retinal hemorrhage and encephalopathy) was measured in patients with witnessed/accepted AHT and those without witnessed AHT.	- The differences observed in patients with witnessed/accepted AHT and patients without witnessed AHT supported the literature. - It was stated that the diagnoses regarding abuse were correct in patients presenting with the triad (subdural hematoma, retinal hemorrhage and encephalopathy).
Orman et al. [34]	102	Children diagnosed with AHT	- A retrospective study to describe the prevalence of classical and non-classical brain and spine neuroimaging findings in patients diagnosed with AHT and to evaluate which neuroimaging findings or combinations of findings can be used as prognostic indicators by analyzing the relationship of neuroimaging findings with survival, Glasgow Coma Scale (GCS) score at admission, length of hospital stay, and length of stay in the intensive care unit.	- Subdural hematoma is the most common classical neuroimaging finding. - Bridging vein thrombosis is the most common non-classical neuroimaging finding. - Hypoxic-ischemic injury was found to be significantly higher in children who died from AHT. - In children with AHT, the combination of intraventricular hemorrhage, widespread axonal injury, hypoxic-ischemic injury, arterial stroke and/or spinal ligamentous injury on admission neuroimaging was reported to be poor prognostic indicators.
Blackwell et al. [36]	77	Children <4 years old diagnosed with TBI	- It was aimed to compare plasma osteopontin (OPN) levels, a neuroinflammatory biomarker, in children with AHT with children with other traumatic brain injuries (TBI). - The inclusion criteria for the study were that the children were ≤4 years old, had a diagnosis of TBI, and had a Glasgow Coma Scale (GCS) score of 3-12 or positive neuroimaging findings. - The study data were obtained from the analysis results of the children's blood samples.	- OPN was found to be significantly higher in children with confirmed or suspected AHT compared to children with other types of TBI. - It has been reported that OPN expression may help in the identification of children with suspected AHT, in the provision of appropriate interventions and triage for children at risk of abuse.
Eismann et al. [29]	47	Babies 12 months and younger who underwent AHT	- A retrospective study evaluating early developmental, behavioral, and quality of life outcomes after AHT in infants, and injury severity and early therapeutic intervention as potential predictors. - Infants who suffered AHT were followed at approximately 6-month intervals until they were three years old. - Research data were obtained using the "Mullen Scales of Early Learning," "Child Behavior Checklist," and "Pediatric Quality of Life Inventory TM (PedsQL)."	- Infants' cognitive development, fine motor function, and expressive language decreased significantly by age 3. - Internalizing behaviors were more common in patients with moderate injuries than in those with mild injuries. - Quality of life was reported to be comparable to healthy populations. - Early therapeutic intervention was not significantly associated with developmental, behavioral, or quality of life outcomes.

Table 3. Thematic synthesis of head traumas due to pediatric abuse

Theme	Sub-theme	Key findings	Supporting research
Diagnostic clues and discrimination	Biochemical markers	• Glucose >300 mg/dL (especially in young children with intracranial hemorrhage) is a strong indicator of abuse • Significant increase in plasma osteopontin (OPN) levels	Randall et al. [35] Blackwell et al. [36]
	Radiological finding	• Craniofacial injury in 39.0% of non-accidental traumas	Gomez et al. [30]
	The "Triad" finding	• The combination of subdural hematoma + retinal hemorrhage + encephalopathy confirms the diagnosis of AHT.	Hymel et al. [32]
	Neuroimaging patterns	***Poor prognostic indicators:*** - Intraventricular hemorrhage - Hypoxic-ischemic injury - Spinal ligamentous injury • Non-classic finding: Bridging vein thrombosis	Orman et al. [34]
	Mathematical classification	***Findings showing a significant increase in abuse:*** - Subdural fluid - Retinoschisis - >24 hours encephalopathy - Brain hypoxia/ischemia	Boos et al. [28]
Epidemiology and risk factors	Age-related risk profile	***<12 months old babies:*** - Presence of a sibling under 5 years old↑ - Risk of biological parental abuse↑ ***>12 months old children:*** - Risk of abuse by parent's partner↑	Eismann et al. [31]
Clinical course and short-term results	Mortality	In-hospital mortality rate: 6.78%	Gomez et al. [30]
	Poor prognosis indicators	• Shock, hypothermia, post-traumatic seizure: - Poor neurological outcome - Risk of death ↑ • Hypoxic-ischemic injury → Strong association with death	Lee et al. [27] Orman et al. [34]
Long-term developmental outcomes	Neurodevelopmental effects	***Up to 3 years:*** - Cognitive development ↓ - Fine motor skills ↓ - Language development ↓	Eismann et al. [29]
	Socio-emotional impacts	• ***Internalizing behaviors in moderate injury*** ↑ • Inadequate personal-social development • Disturbances in the socio-emotional sphere	Keenan et al. [37]
	The role of rehabilitation	• Early and continuous rehabilitation → Alleviates the negative effects of developmental disabilities	Keenan et al. [37]

DISCUSSION

Abusive head trauma accounts for 80% of non-accidental trauma deaths and remains a leading cause of death in infants and young children.[38,39] Children with AHT may experience mild, nonspecific symptoms such as vomiting, irritability, lethargy, poor feeding, or trouble sleeping.[40,41] However, many children with AHT do not exhibit external signs of head trauma, such as scalp swelling.[42] Therefore, healthcare professionals should have a high level of knowledge and awareness that injuries in children brought to healthcare institutions affiliated with HT may be due to abuse.[43,44] Accordingly, this integrative review systematically synthesizes the existing literature in the field of child abuse-related head trauma (AHT) by: (i) analyzing the visibility dynamics of AHT in scientific publications over the last five years, (ii) identifying priority research focuses and conceptual trends, (iii) revealing knowledge gaps in diagnostic approaches. The evidence obtained provides practical frameworks to strengthen healthcare professionals' diagnostic awareness.

Following a brain injury, brain tissue releases various chemicals into the cerebrospinal fluid (CSF). The blood–brain barrier temporarily becomes more permeable, which allows these substances to enter the bloodstream. [45] Studies have shown that CSF markers are elevated in young children after inflicted head trauma. [45,46] Orman et al.[34] supported this information and stated that the “Triad Sign” (subdural hematoma + retinal hemorrhage + encephalopathy) continues to be the gold standard in diagnostic specificity.[34]

Similarly, Boos et al.[28] also supported this information in their research. In addition to this information, Hymel et al.[32] stated that non-classical findings such as bridging vein thrombosis can be seen in their research and it has been shown that they can be helpful in diagnosis. Different from these findings, Randall et al.[35] in their research, it was stated that all young children with intracranial hemorrhage and initial glucose levels higher than 300 mg/dL were victims of abuse, and this threshold could be used as a "red code" in emergency services. Blackwell et al.,[36] who evaluated a different finding in their research, showed that the increase in osteopontin (OPN) specific to abuse could be used to develop blood test-basd screening protocols. In light of these findings, in cases where abuse is suspected but a definitive diagnosis cannot be made; in addition to the judicial reporting process, triple findings, and social service consultations, examining glucose and OPN levels with blood tests can help make a definitive diagnosis, and therefore simultaneous evaluations are recommended.

Risk factors for AHT include behaviors involving the child, family, and caregiver. Severe shaking of the crying child by the child's parent/caregiver in order to quiet the child may cause shaken baby syndrome.[47] However, many factors such as having a large number of children in the family, lack of prenatal care, low level of education, low socioeconomic status, single-parent families, stepmother/father, etc. constitute the risk factors for AHT.[48-50]

A detailed diagnostic evaluation is necessary in AHT cases. The first symptoms include decreased interaction in children, lack of social smile, poor feeding, vomiting, lethargy, hypothermia, increased need for sleep, and developmental delay. More severe trauma findings are the emergence of life-threatening signs and symptoms. Gomez et al.[30] reported that the in-hospital mortality rate was 6.78% in their study.[30] Orman et al.[34] stated that the combination of intraventricular hemorrhage, widespread axonal injury, hypoxic-ischemic injury, arterial stroke, and/or spinal ligamentous injury were poor prognostic indicators. Similar to this finding, Lee et al.[27] found that initial symptoms starting with shock were associated with hypothermia and post-traumatic seizure, poor neurological outcomes, and mortality. In addition to these clinical findings, AHT caused neurological damage and negatively affected the later lives of children, Keenan et al.[37] and Eismann et al.[29] studies. However, while Keenan et al.[37] reported that rehabilitation services could improve these negative outcomes, Eismann et al.[29] did not find a significant relationship between early therapeutic interventions and developmental, behavioral or quality of life outcomes. This difference between Keenan et al.[37] and Eismann et al.[29] studies was thought to be due to the characteristics of the sample groups and/or different follow-up periods of the studies, and showed that more research is needed in this area. In addition, these findings have shown how important prevention interventions are. Among the preventive factors; providing awareness training to the community about the short- and long-term outcomes of AHT, parental education on child development and parenting, providing social support, and increasing parental resilience can be recommended.

Implications for health care professionals, research and education

The most important factor in preventing AHT is awareness training for caregivers and training for health professionals to recognize signs and symptoms. All health care professionals should be able to recognize suspected child abuse and neglect, report it, and take appropriate action, such as informing judicial institutions.[10,11] While the diagnosis of abusive head trauma is sometimes easily understood, inexperienced and unsuspecting clinicians may fail to recognize injuries caused by child abuse. In addition, when the diagnosis is unclear, suspicion should continue until the evaluation is completed.

Based on this integrative review, we propose the following recommendations. First, healthcare professionals should pay attention to clinical and biochemical findings at the time of application to detect the possibility of abuse early and initiate the necessary reporting processes. Second, children with suspected AHT should be evaluated holistically with neuroimaging, ophthalmological evaluation and blood biomarkers. And finally, long-term follow-up and rehabilitation services play a critical role in preventing neurodevelopmental problems in children who have AHT.

This integrative review has several strengths. First, it focuses on a highly specific and clinically significant issue—abusive head trauma in pediatric patients—addressing diagnostic confusion, clinical dilemmas, and missed outcomes, which are often underexplored in

existing literature. Second, the review includes studies published between 2020 and 2025, ensuring that the findings reflect the most current evidence. Third, the use of a systematic approach to data extraction and the application of the ROBINS-I tool to assess methodological quality enhanced the rigor and reliability of the synthesis. Additionally, the identification of clear diagnostic indicators and clinically relevant themes offers practical implications for healthcare professionals working in pediatric emergency and forensic contexts. However, the study also has some limitations. Only two databases (PubMed and Web of Science) were used, which may have led to the exclusion of relevant studies indexed elsewhere. Other limitations are also presented below: (i) Study design heterogeneity*:* the majority of included studies (n=9/11) were conducted in a retrospective design. Such studies carry the risk of data recording deficiencies and selection bias. The paucity of prospective or randomized controlled trials limits the interpretation of causal relationships. (ii) Geographic and cultural limitations*:* Nine of the reviewed studies were based in the USA, only 1 was conducted in Taiwan and 1 in the Netherlands. This suggests that the findings may have been influenced by socioeconomic, legal, and cultural factors, questioning the universal generalizability of the results. (iii) Clinical applicability of biomarkers: Promising biomarkers such as osteopontin (OPN) have only been tested in a single study.[22] Multicenter studies are needed to translate these findings into routine clinical use.

CONCLUSIONS

Abusive head trauma (ACT) is a critical condition that can have severe consequences in pediatric patients. This study provides up-to-date data that will guide healthcare professionals in determining diagnostic markers, clinical patterns, and risk factors for ACT. In particular, glucose >300 mg/dL, the “triple sign” (subdural hematoma, retinal hemorrhage, encephalopathy), and high osteopontin levels stand out as important indicators in diagnosis.

Conflict of Interest

The author declares that there is no conflict of interest regarding the publication of this manuscript.

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Declaration of Use of AI in Scientific Writing

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