e-ISSN: 2807-7970
doi: 10.20473/aksona.v5i2.53600

AKSONA
Volume 5 Number 2, July 2025

Analysis of Socioeconomic Status Among Risk Factors of Pediatric Abusive Head Trauma: A Systematic Review

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Article info

Article History:
Received Jan 6, 2024
Revised Oct 31, 2024
Accepted Mar 10, 2025
Published Jul 31, 2025

Keywords:
Child abuse
Head trauma
Pediatrics
Physical abuse
Socioeconomic status

ABSTRACT

Introduction: Previous studies have shown that children from low socioeconomic status (SES) families are more likely to experience abusive head trauma (AHT). However, research on this topic remains limited. Some argue that clinicians may demonstrate diagnostic bias, tending to overidentify AHT in lower-SES children, regardless of actual risk. Is low SES truly a risk factor for AHT? If so, how does it affect AHT occurrence and its relationship with other risk factors? **Objective:** This review was to observe the relationship of SES as one of the risk factors of pediatric AHT. **Methods:** A systematic review was conducted on pediatric AHT using household SES data. Children with AHT were compared to non-abusive head trauma (non-AHT) controls. Articles published between 2002 and 2022 were searched from Scopus, PubMed, and Google Scholar, following PRISMA guidelines. Exlusion criteria included duplicates, inaccessible or non-English/Indonesia articles, and studies not meeting PECO criteria. Data on child age, sex, type of head trauma, and SES were collected. Demographic characterisctics, SES, risk factors, outcome, and preventive measures were analyzed. **Results:** A total of 19,700 articles were found after searching Scopus, PubMed, and Google Scholar. After several screenings, 18 articles were included. Of the 18 articles, 17 included data on patients with AHT, and 6 included data on control patients. In total, there were 21,451 patients with AHT and 411,185 controls. The control group consisted of children with non-AHT and children without trauma. The mean, median , and standard deviation of the percentage of low SES patients with AHT were relatively higher than controls. A higher amount of articles agreed that SES had a significant impact. **Conclusion:** SES may influence pediatric AHT prevalence, but it should not be used as a determinant in diagnostic decision-making.

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Available at https://e-journal.unair.ac.id/index.php/aksona

INTRODUCTION

Hyperglycemia, commonly seen in diabetes, is a Pediatric abusive head trauma (AHT) is one of the causes of death in young children. One in four victims of AHT dies, according to the Center for Disease Control.[1] Out of 1,271,065 children born in 1999-2013 in Washington, 354 children under five was diagnosed with AHT.[2]

Socioeconomic status (SES) reflects an individual's social and economic position.[3] It can be measured objectively or subjectively,[4] and can influence heath outcomes.[5] Previous studies have placed SES alongside other social[6] and psychological[1] factors as a potential risk factor of child abuse, with some reporting that up to one-third of victims come from the lowest income quartile.[7] While AHT has been reviewed several times, no study has specifically focused on SES as a risk factor.

Poverty is a chronic stressor that can provoke mental illness through malnutrition, social exclusion, and increased exposure to violence and substance misuse.[8] Chronic stress negatively impacts the brain and behavior.[9] Lower SES is also associated with early marriage,[10] extramarital relations, divorce,[11] and higher rates of mental illness.[12] From an early age, people with low SES face more stress and higher mental health risk than those with higher SES.[13]

Head trauma accounts for up to 60% of physical child abuse cases[14] and can lead to developmental delays, learning difficulties, motoric deficits, vision loss, and communication deficits.[15] AHT is thought to be associated with crying in infants,[14,16] as it tends to happen during the peak crying period.[17,18] Recognizing its risk and educating parents about the risks of hitting or shaking children is necessary for prevention purposes.[19]

OBJECTIVE

This study aimed to aggregate existing knowledge on SES as a risk factors of pediatric AHT. The specific objectives were to: (1) examine how SES can be a risk factor for pediatric AHT; (2) review other risk factors and analyze how SES may affects them; and (3) review outcomes and known preventative measures. The main research question guiding this study was "What is the relationship between parental socialeconomic status and the incidence of abusive brain trauma (AHT) in children?"

METHODS

A systematic review was done in Surabaya from December 2022 to2023. The study population consisted of parents of children with head trauma, exposure was lower SES, comparison was higher SES, and outcome was incidence of abusive head trauma. The population consisted of journals from Scopus, PubMed, and Google Scholar, that were searched using the Boolean "*(pediatric OR child OR infant) AND ("brain trauma" OR "head trauma" OR "brain traumatic injury" OR "brain injury" OR "shaken baby syndrome") AND (risk factors OR socioeconomic OR income OR poverty OR demographics*). The search results were then filtered using inclusion/exclusion criteria and PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020.

The inclusion criteria for articles were English or Indonesian, published within the last 20 years, involving children aged 0-5 years with head trauma, and containing SES data. SES data was divided into "lower" and "higher" according to the classifications used in each article. When no specific classification was found, the lowest quartile or the lowest two quintiles were used. Exclusion criteria included inaccessible full-text articles, incompatibility with the PECO framework, and studies that were reviews or meta-analyses. The PRISMA 2020 guidelines were used as an instrument to filter journals in a systematic review.[20] Quantitative data were tabulated for comparison and then reviewed narratively.

During the identification stage, duplicate entries and records marked as ineligible by automation tools were excluded. Despite Google Scholar initially returned 20,800 results, only 1,000 were accessible. Similarly, only 2,000 out of 2,086 results from Scopus were exportable. All 2,027 results from PubMed were accessible. During the screening stage, 3,018 articles were excluded for being written in languages other than English or Indonesian, or for having irrelevant titles or abstracts. An amount of 23 inaccessible studies were excluded.

The remaining 944 articles were reviewed. Of these, the following were excluded: articles without SES data (n = 568), with incomplete or non-numerical data format (n = 33), without mechanism of injury (n = 103), that did not distinguish between abusive and non-abusive trauma (n = 43), involving patients over 5 years old (n = 152), reviews (n = 20), using only insurance data available as SES (n = 21), and duplicate studies using the same database as another included study (n = 4). These will be elaborated in the results section. Data were stored and calculated in Microsoft Excel using simple averages and sums. Qualitative data were synthesized by analytical review and narrative synthesis. The variables collected included child age, sex, type of head trauma, and SES classification as defined in each article.

Potential bias in the reviewed studies could be due to conflict of interest, human error, or differing

methods of classifying and interpreting data. Standardized tools, such as critical appraisal checklists, can be used to identify biases in included studies. The reviewed studies were assessed using critical appraisal tools by the Joanna Briggs Institute (JBI).

RESULTS

A total of 19,700 articles were retrieved from Google Scholar, 2,027 from PubMed, and 2,068 from Scopus. However, only 1,000 results were viewable from Google Scholar, and only 2,000 could be downloaded from Scopus. A total of 5,027 articles were taken for initial screening.

During the initial screening stage, 1,024 duplicates were removed. A total of 147 articles were removed due to being published in languages other than English or Indonesian and 2,871 had titles or abstracts which differed from PECO. An additional 23 full-texts articles could not be accessed.

During the second screening stage, 568 articles were removed due to the absence of SES data. An additional 33 articles were removed for having incomplete format, 103 articles did not clearly report the mechanism of injury, 43 articles did not distinguish between abusive and non-abusive head trauma, 152 articles include patients older than 5 years, and 20 were review articles. Four articles were excluded because they used the same database as some of the other included studies. In total, 18 studies were included in the final review. Details of the selection process are presented in Figure 1. The results are summarized in Tables 1 and 2.

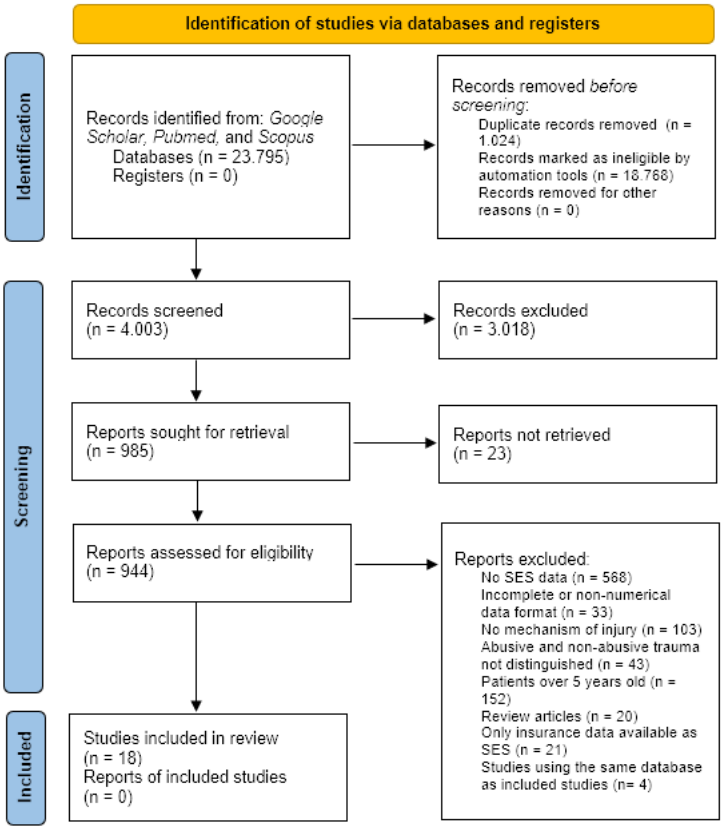

Figure 1. The PRISMA diagram

Table 1. Included studies

No	First author	Year	Journal	Country	Title
1	Conrad A	2021	Injury Epidemiology	United States	Trends in shaken baby syndrome diagnosis codes among young children hospitalized for abuse
2	Niedenkrotenthaler T	2013	Child Abuse & Neglect	United States	Descriptive factors of abusive head trauma in young children—United States, 2000–2009.

Table 1 continued. Included studies

No	First author	Year	Journal	Country	Title
3	Xiang J	2013	Brain Injury	United States	Paediatric patients with abusive head trauma treated in US Emergency Departments, 2006-2009.
4	Rangel EL	2010	The Journal of Trauma	United States	Socioeconomic disparities in infant mortality after nonaccidental trauma: a multicenter study.
5	Kelly P	2017	The Journal of Pediatrics	New Zealand	Perinatal Risk and Protective Factors for Pediatric Abusive Head Trauma: A Multicenter Case-Control Study.
6	Mok JY	2010	Journal of Epidemiology and Community Health	Great Britain	Non-accidental head injury: a consequence of deprivation?
7	Sieswerda-Hoogendoorn T	2013	*Acta Pædiatrica*	The Netherlands	Abusive head trauma in young children in the Netherlands: evidence for multiple incidents of abuse.
8	Ang SC	2021	Child Abuse & Neglect	Malaysia	Outcome of abusive head trauma in children less than 2 years: A single center study from a middle-income country.
9	Beaulieu E	2020	Child Maltreatment	Canada	Inequities in Pediatric Abusive Head Trauma According to Neighborhood Social and Material Deprivation: A Population-Level Study in British Columbia, Canada.
10	Diaz-Olavarrieta C	2011	Child Abuse & Neglect	Mexico	Abusive head trauma at a tertiary care children's hospital in Mexico City. A preliminary study.
11	Yamada F	2014	International Journal of Environmental Research and Public Health	Japan	Prevalence of self-reported shaking and smothering and their associations with co-sleeping among 4-month-old infants in Japan.
12	Tursz A	2014	Pediatric Radiology	France	Epidemiological data on shaken baby syndrome in France using judicial sources.
13	Kaldoja ML	2012	Brain Injury	Estonia	Social-emotional behaviour in infants and toddlers with mild traumatic brain injury.
14	Stipanicic A	2008	Child Abuse & Neglect	Canada	Comparative study of the cognitive sequelae of school-aged victims of Shaken Baby Syndrome.
15	Sidpra J	2021	Archives of Disease in Childhood	Great Britain	Rise in the incidence of abusive head trauma during the COVID-19 pandemic.
16	Demirli CN	2013	Turkish Journal of Trauma & Emergency Surgery	Turkey	Abusive head trauma: Report of 3 cases. *[İstismara bağlı kafa travması: 3 olgu sunumu]*
17	Cohrs G	2022	Child's Nervous System	Germany	Underestimating isolated bilateral hygroma as non-accidental head injury with dramatic consequences: a case presentation.
18	Parrish J	2013	International Journal of Circumpolar Health	United States	Abusive head trauma among children in Alaska: a population-based assessment

Table 2. SES division

First author	SES data type	"Low" SES criteria	Additional information	Control type (if available)
Conrad A	Income quartiles based on postal code	Lowest quartile	-	- (abusive trauma, except on head)
Niedenkrotenthaler T	Median income based on postal code	"*Lower*" category	Split into two according to the 50th percentile	Non-abusive head trauma
Xiang J	Income quartiles based on postal code	Lowest quartile	$1–$38.999 per year	Non-abusive head trauma
Rangel EL	Income quartiles based on postal code	Lowest quartile	<$30.728 per year	-
Kelly P	New Zealand Deprivation Index	Index 8-10	Divided into 1-3, 4-7, and 8-10	-
Mok JY	Scottish Index of Multiple Deprivation (SIMD) 2006	Two lowest quintiles	Calculated from income, occupation, education, health, infrastructure access, criminality, and address	-
Sieswerda-Hoogendoorn T	Maternal education	Highest education was primary school graduate	-	-
Ang SC	Paternal occupation	*"Unemployed, Elementary occupation"* categories	Also divided into *"Manager or professional", "Technician & associate professional", "Clerical support worker", "Craft & related trades worker", "Plant & machine operator & assemblers", "Armed forces occupation",* dan *"Unknown"*	-
Beaulieu E	Material deprivation quintile	Two lowest quintiles	Based on postal code	-
Diaz-Olavarrieta C	Maternal education	Highest education was primary school graduate	-	Accidental head trauma
Parrish J	Maternal education	Education ≥12 years	-	Population subtracted by cases
Yamada F	Income quintiles	Two lowest quintiles	≤ ¥4.000.000 per year	No AHT or smothering
Tursz A	Maternal education	Below university level	-	- (homicide)
Kaldoja ML	Parental education	Highest education was primary school graduate	-	Non-abusive mild head trauma
Stipanicic A	Income	*"Low"* category	Divided into *low*, *medium*, and *high*	- (matched SES)
Sidpra J	Financial problems	Qualitative	*"Four had financial concerns"*	-
Demirli CN	SES	Qualitative	*"The families in these three cases are from low socioeconomic status."*	-
Cohrs G	Maternal occupation	Qualitative	*"The mother had a professional psychosocial background."*	-

Narrative Review

In 10 out of 16 included articles, most of the victims were male. Table 3 shows an age distribution that matches previous studies. During clinical presentation, patients commonly exhibited an unclear or inconsistent trauma history, as well aslesions that were more severe than predicted given the reported history.[21]

Table 3. AHT age distribution

No	First author	Included age range	≤ 6 months	< 1 year	1 year	> 1 year
1	Conrad A	≤ 3 years	-	2.744 (65.2%)	700 (16.6%)	765 (18.2%)
2	Niedenkrotenthaler T	< 2 years	-	6.501 (85.5%)	1.102 (14.5%)	-
3	Xiang J	≤ 4 years	-	1364 (60.6%)	376 (16.6%)	525 (22.7%)
4	Ang SC	< 5 years	56 (77.8%)	69 (95.8%)	3 (4.2%)	
5	Parrish J	< 2 years	-	37 (82%)	8 (18%)	-
6	Tursz A	< 1 year	28 (76%) *	9 (24%) **		
*** < 6 months**			**Age (months)**			
**** ≥ 6 months**			**Mean**	**Median**	**Range**	**SD**
7	Rangel EL	<1 year	25.3	-	-	6.1
8	Mok JY	<2 years	18.5	13	2.4–85	15.9
9	Sieswerda-Hoogendoorn T	<5 years	-	3.5	-	-
10	Beaulieu E	≤2 years	-	4.8	-	-
11	Diaz-Olavarrieta C	<5 years	8	-	1–17	-
12	Yamada F	4 months	4	4	4	-
13	Stipanicic A	≤3 years*	87. 64 **	-	-	25.52**
14	Sidpra J	-	6.4	-	0.5–13	-
15	Demirli Çaylan N	-	6	3	3-12	4.24
16	Cohrs, G.	-	2	2	2	-

Several articles have claimed SES as a risk factor for AHT. Beaulieu *et al.* reported that the frequency of AHT follows a social gradient, increasing proportionally as SES decreases, with a 71% increase per quartile in males and 15% in females.[22] Xiang *et al*. reported a strong association between AHT and income (OR = 1.48; 95% CI: 1.19-1.85), as well as insurance status (OR = 2.76; 95% CI: 2.20-3.45).[23] Mok *et al.* found a significant association with the Scottish Index for Multiple Deprivation (SIMD) and AHT ($p < 0.001$).[24] Diaz-Olavarrieta also reported an association between lower SES and AHT.

However, several articles also claimed that SES was not associated with AHT.[25,26] Several research reported SES-related data, however they did not always analyze it explicitly. Sieswerda-Hoogendorn *et al.* reported 60% of the parents of victims had a highest education level of primary or secondary school,[27] while Diaz-Olavarrieta *et al.* reported that only 50% of the victims' mothers had an education level higher than primary school.[28] During the COVID-19 pandemic, Sidpra *et al*. observed a 1.493% increase of AHT admissions in their health center.[29] SES distribution is presented in Table 4.

Table 4. SES distribution

No.	First Author	Year	Timeframe	AHT			Controls		
				n	% male	% low SES	n	% male	% low SES
1	Conrad, A.	2021	1998-2014	10.083	40	25	-	-	-
2	Niedenkrotenthaler T	2013	2000-2009	7.603	60	29	25.339	57	25
3	Xiang J	2013	2006-2009	2.265	58	33	253.834	57	24
4	Rangel EL	2010	2000-2004	867	-	36	-	-	-
5	Kelly P	2017	1991-2010	142	61	63	-	-	-

Table 4 continued. SES distribution

No.	First Author	Year	Timeframe	AHT			Controls		
				n	% male	% low SES	n	% male	% low SES
6	Mok JY	2010	1988-2008	100	56	77	-	-	-
7	Sieswerda-Hoogendoorn T	2013	2005-2010	89	62	23	-	-	-
8	Ang SC	2021	2011-2018	72	68	7	-	-	-
9	Beaulieu E	2020	2005-2017	66	58	64	-	-	-
10	Diaz-Olavarrieta C	2011	2004-2005	13	38	50	107	62	29
11	Parrish J	2013	2005-2010	45	44	29	130.638	52	14
12	Yamada F	2014	2010-2012	44	48	39	1.232	51	32
13	Tursz A	2014	1996-2000	37	78	54	-	-	-
14	Kaldoja ML	2012	2005-2009	-	-	-	35	63	20
15	Stipanicic A	2008	1988-1999	11	45	18	-	-	-
16	Sidpra J	2021	March-April 2020	10	60	40	-	-	-
17	Demirli Çaylan N	2013	Case study	3	67	100	-	-	-
18	Cohrs G	2022	Case study	1	-	0	-	-	-

Psychosocial stress, a history of abuse or drug misuse, the presence of single or young parents could also be risk factors for AHT.[28,30,31] One article indicated that 81% of victims showed indications of previous abuse.[27] Higher risk was also observed in families with young mothers, multiple pregnancies,[24] or unwanted pregnancies.[28] A lack of family support might also be a contributing factor[32]

According to Kelly *et al.*, although medical and psychiatric history, as well as substance use, were not significantly associated with AHT, younger maternal age, not consuming additional prenatal supplements, and not exclusively breastfeeding 3 days postpartum were associated with AHT.[25]

Seventy-nine percent of perpetrators were male, mostly the victims' fathers or their mothers' partners.[27] In several reports, perpetrators were commonly parents or their partners,[26,33] but, one study in Malaysia reported that AHT usually occurred when children were in the care of unrelated caregivers, such as nannies or daycares.[21]

Previous studies stated that AHT had a worse impact and outcome compared to accidental trauma.[23,34,35] AHT can also lead to economic burdens due to healthcare costs and decreased productivity.[21] Reported morbidity rates vary widely, ranging from 2.9 to 28.9 cases per 100,000,[26,32] with some studies reporting rates as high as 3.4%.[36]

Children with AHT most commonly presented with seizures or decreased consciousness (91%), or nonspecific symptoms (7%).[21] Subdural hematoma (SDH), retinal hemorrhage, and trauma to other body parts were also frequently observed.[26,28] The most common disabilities caused by AHT were motoric (20%), cognitive (18%), and visual (13%).[21] Difficulty with socio-emotional regulation was also reported.[37] Reported mortality rates ranged from 9.1% to 28%.[23,27,34] The overall rate went to 42% when disability was included.[21] SES may influence mortality, as one study found that only 9% of children from the highest income quartile died, compared to 68% from the two lowest quartiles.[38]

DISCUSSION

Demography

The higher number of male victims may be influenced by social norms, as boys are often expected to cry less.[22] Biological factors may also contribute, given that boys are more vulnerable to subdural hematoma (SDH) than girls.[34] The observed age distribution is consistent with previous literature,[17] and may be linked to the impact of infant crying[39] on caregiver stress levels.[34]

Socioeconomic status (SES)

SES has been shown to affect an individual's health since the prenatal stage through factors such as exposure to environmental toxins and infections.[40] Certain health problems could also happen primarily in populations of specific SES.[41] Low SES is particularly associated with physical child abuse.[42]

This connection could be related to higher stress levels in lower SES families, which may lead parents to take it out on their children.[22,23,43] SES-related stressors, such as financial, social, health, and work-related problems are more prevalent among lower-SES population.[13] This may be caused by limited knowledge, stigma, and barriers to accessing mental health services.[44] SES is reported to be associated with

psychological distress and unnatural mortality caused by of violence, accidents, suicide, and alcohol use.[45] Parents with lower SES may also have fewer opportunities to learn emotional management and effective methods to discipline a child[23] Economic recession can also incite an increase in AHT cases.[43,46]

Another factor that may exacerbate these situations is bias among medical professionals. Several articles have shown that such biases may be directed towards parents perceived to have lower SES.[25,38,47] Such biases must be eliminated, since AHT can also happen in households with higher SES.[25] People with higher SES can also experience stress, especially work-related stress associated with high-level positions,[48] and may also have greater access to substances such as alcohol or marijuana, which can contribute to abusive behavior.[49] It is also important to recognize that perpetrators of AHT are not always the parents; in some causes might be an unrelated or paid caregiver.[21]

Other risk factors

According to the ecology theory, children's interactions with their surroundings can affect their growth, health, and life in both positive and negative ways.[50] Psychosocial factors are well-established risk factors for physical abuse in children.[1,51] Abuse is generally cyclical.[51,52] This phenomenon may explain why many children with AHT show signs of previous abuse.

Alcohol consumption[53] and other addictive substances can increase aggressiveness and impulsivity, potentially leading to violence.[54] A negative attitude towards children and misinterpretation of their actions may also contribute to abuse,[55] and these factors are often associated with mental illness and a hisotry of pre- or perinatal neglect.

The predominance of male perpetrators may be explained by the association between testosterone and agression.[56] The larger risk posed by stepfathers, compared to biological fathers,[57] may be linked to the evolutionary tendencies to protect one's biological lineage, or to the relatively higher amount of conflict which may happen in stepfamilies.[58]

Outcome, Morbidity, and Mortality

Outcomes in AHT cases may be linked todue to lower health literacy[59] and difficulty accessing healthcare services.[38,60] Health literacy itself is influenced by the availability of information and healthcare access,[61] and it plays a critical role in shaping health facility usage and outcomes.[62] A child's health is also influenced by parental health, which is, in turn affected by SES and lifestyle factors.[5] In cases of abuse, perpetrators often attempt and conceal their actions,[63] which can delay diagnosis and treatment, leading to worse outcomes.

Preventative measures

Recognizing SES as a risk factor enables the development of focused prevention programs for families with multiple risk factors. Long-term strategies to reduce the incidence of AHT should include increasing education and addressing economic disparities.[22] Social support is important to prevent AHT since it is precipitated by social dysfunction.[64] Equal access to healthcare must be widened, vulnerable communities need to be reached out to,[38] and parents should get social, governmental, or financial support.[21] Educational interventions should also focus on raising awareness about the dangers of shaking babies and promoting emotion regulation among caregivers.[65]

This study has several limitations. First, the collected data were not entirely uniform, which may affect the acuracy of findings when anlyzed side by side. Second, variations in cultural, social, and environment factors limit the relevancy of data from other countries, as they may not accurately reflect the situation in Indonesia.

CONCLUSION

Socioeconomic status (SES) is recognized by some as a risk factors of abusive head trauma (AHT). In this study, more articles supported a positive association between SES and AHT than those that did not. SES is also linked to—and may contribute to—several other risk factors, especially psychosocial ones, and may negatively affect patient outcomes. Other identified risk factors include the child's age and sex, parental age and marital status, and a history of abuse or drug misuse. Regardless, SES should not serve as a basis for diagnosis. It is necessary to educate parents and caregivers of children about normal crying, appropriate responses to crying, and the dangers of shaking a baby. It is also important to enact policies in support of families, especially high-risk families.

More detailed patient data should be collected to facilitate further research. This would help determine prevalence, identify local risk factors, and allow for comparison with data from other countries.

Acknowledgement

Special thanks to all the supervisors for their tutelage and the corrections given, as well as all the doctors, lecturers, and staff at Universitas Airlangga for their training and cooperation.

Conflict of Interest

Authors have no conflict of interest to declare.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Author Contributions

MAP concieved the research design, guided the course of research, and suggested revisions. PIG and WS guided the course of research and suggested revisions. CF contributed to the data collected and wrote the manuscript.

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