

## ORIGINAL ARTICLE

## Are there patterns of bruising in childhood which are diagnostic or suggestive of abuse? A systematic review

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**Aims:** To investigate what patterns of bruising are diagnostic or suggestive of child abuse by means of a systematic review.

**Methods:** All language literature search 1951–2004. Included: studies that defined patterns of bruising in non-abused or abused children <18 years. Excluded: personal practice, review articles, single case reports, inadequate confirmation of abuse. Two independent full text reviews using standardised data extraction and critical appraisal forms. Studies ranked by study design and definition of abuse used.

**Results:** Twenty three studies included: seven non-abusive bruising, 14 abusive bruising, and two both. *Non-abusive:* The prevalence, number, and location of bruises is related to increased motor development. Bruising in non-independently mobile babies is very uncommon (<1%). Seventeen per cent of infants who are starting to mobilise, 53% of walkers, and the majority of schoolchildren have bruises. These are small, sustained over bony prominences, and found on the front of the body. *Abuse:* Bruising is common in children who are abused. Any part of the body is vulnerable. Bruises are away from bony prominences; the commonest site is head and neck (particularly face) followed by the buttocks, trunk, and arms. Bruises are large, commonly multiple, and occur in clusters. They are often associated with other injury types that may be older. Some bruises carry the imprint of the implement used.

**Conclusion:** When abuse is suspected, bruising must be assessed in the context of medical, social, and developmental history, the explanation given, and the patterns of non-abusive bruising. Bruises in non-mobile infants, over soft tissue areas, that carry the imprint of an implement and multiple bruises of uniform shape are suggestive of abuse. Quality research across the whole spectrum of children is urgently needed.

Bruising is the commonest presenting feature of physical abuse in children.<sup>1,2</sup> However, it is not easy to distinguish intentional patterns of bruising from the bruises that children sustain from everyday play activities and accidents. Differentiating “normal”, non-abusive bruising patterns from abuse is crucial. Most clinicians offer an opinion as to the probability of abuse based on their own clinical experience and textbooks. It is often difficult to give the level of certainty that the child protection agencies or the Court would like. The evidence base to inform this process has not been defined. We have therefore conducted the first systematic review to identify the evidence base and answer the question “What patterns of bruising in childhood are diagnostic or suggestive of abuse?”.

## METHODS

### Inclusion criteria

All papers which defined patterns of bruising in non-abused or abused children less than 18 years of age were included. Bites were excluded and will be the subject of a future systematic review. We excluded review articles, expert opinion, single case reports, papers where abuse was not defined, and papers that addressed medical conditions that predispose to bruising. Where appropriate, original data was sought.

### Grading the evidence

Early scanning of studies identified a variety of definitions of abuse and international variation between diagnostic criteria used. The nature of the cases included in abused groups and the level of confidence that abuse was excluded in non-abuse

cases has a direct effect on the quality of the study. We have allocated a score to rank the definitions of abuse used (1, abuse confirmed at case conference, civil or criminal court proceedings, or admitted by the perpetrator; 2, abuse confirmed by stated criteria including a multidisciplinary assessment; 3, abuse defined by stated criteria; 4, abuse stated but no supporting detail or evidence given; 5, suspected abuse). In non-abuse papers we have recorded whether factors that influence bruising were excluded, namely abuse, neurodisability, and medical conditions predisposing to bruising.

The diagnostic nature of the question determines that the best possible research studies will be observational and we have ranked papers on study type. We have provided a detailed qualitative summary of the critical appraisal of each paper. The methodological quality of included papers is presented on the *ADC* website where papers are listed informally according to their importance.

### Data sources

We have conducted an all language literature search of original articles, textbooks, conference abstracts, and references from these and review articles for the period up to October 2004. We used the ASSIA (Applied Social Sciences Index and Abstracts) 1987–2004, Caredata (1980–2004), Medline (1951–2004), Child Data (1958–2004), CINAHL (1982–2004), Embase (1980–2004), ISI Proceedings (1990–2004), PsycInfo (1987–2004), Science Citation Index (1981–2004), SIGLE (1980–2004), Social Science Citation Index (1981–2004), and TRIP databases. The search strategy is described on the *ADC* website.

### Data extraction/validity assessment

A panel of 15 reviewers, all with child protection expertise, conducted two independent full text reviews of each paper. All used standardised criteria for defining the study type and worked to specially devised data extraction, critical appraisal, and evidence forms that were based on criteria defined by the NHS Centre for Reviews and Dissemination.<sup>3</sup> If there was disagreement between two reviewers the paper was brought to the panel to discuss, and if agreement could not be reached, a third independent review was carried out.

### RESULTS

We sourced 6984 citations; excluding papers for duplicates and irrelevancy there were 1345. Browsing the titles and abstracts we found 161 potentially relevant texts. Six additional papers were identified from references. Twelve papers required translation. After full text review, 23 papers met the inclusion criteria: seven papers addressed patterns of bruising in non-abused children, 14 discussed bruising due to abuse, and two papers compared both. Data from studies was not sufficiently homogeneous to enable a statistical analysis.

#### Bruising in non-abused children

Seven of the nine studies<sup>4-12</sup> addressed the general pattern of bruising in non-abused children, and two<sup>9, 12</sup> addressed bruises associated with specific injuries, namely fractures and falls from hospital beds. Six of the papers were written primarily about bruises and three contained limited bruising data as part of a wider context.<sup>9, 10, 12</sup> There were two case control, four cross sectional, and three case series studies. All had random recruitment, and child abuse; known diseases that predispose to bruising and neurodisability were excluded to a varying degree. Most information applied to children under 10 years of age.

Socioeconomic status was noted in seven papers. There was no difference in bruising in children of different socio-economic groups. Although ethnicity was recorded in many studies, data were only given in two. Tush<sup>6</sup> found no significant differences between white and black children,

while Sugar and colleagues<sup>4</sup> found bruising to be significantly more common in white children. However, the ethnic minority population was under-represented in both papers where a mixed ethnic population accounted for under one third of each sample. Tush<sup>6</sup> found more bruising in boys ( $p < 0.05$ ). However, combining the data from studies where sex was reported,<sup>4-6</sup> there were no significant differences in gender. Increased accidental bruising was noted in summer<sup>10</sup> (all ages above 8 months), and with increased family size ( $p > 0.05$ ).<sup>5</sup>

Bruises were characteristically small; Carpenter<sup>5</sup> and Mortimer and Freeman<sup>8</sup> reported that all bruises were less than 10 and 15 mm in size respectively. Wedgwood<sup>7</sup> quotes the mean size of bruises to the head as  $12.8 \pm 1$  mm, and 5.6–6.8 mm at other sites. Parents were able to give explanations for 23 of 32 bruises in the Carpenter study,<sup>5</sup> and Mortimer and Freeman<sup>8</sup> quote explanations in three of six cases that they describe.

The prevalence and mean number of bruising increases with age (table 1). Sugar and colleagues<sup>4</sup> looked at different developmental stages within 3-month age bands and showed that bruising was directly correlated with motor developmental stage. Carpenter<sup>5</sup> and Wedgwood<sup>7</sup> confirm this strong correlation between bruising and mobility in the younger child. Bruising in a baby who has no independent mobility is very uncommon. Wedgwood<sup>7</sup> found no bruising in 11 children whose motor development was no better than crawling, and Sugar and colleagues<sup>4</sup> identified only two babies (under 6 months old) with scalp bruising. These babies were under 10 days of age and the bruising was almost certainly related to their birth. In contrast bruising is present in the majority of independently mobile preschool and school children.

Studies divided the body into anatomical sites in different ways to report on the distribution of bruising (table 2). As the mobility of the child develops the prevalence of lower leg bruises increases. The commonest sites of bruising in non-abused children who are walking are the knees and shins.<sup>4, 6, 7</sup> Sugar and colleagues<sup>4</sup> and Carpenter<sup>5</sup> noted that bruises were

**Table 1** Prevalence of bruising according to age and development when stated

Studies defining prevalence according to age	Infants	Preschool	School age	
Carpenter	6–12 months = 12.4% (n = 177) Mean number of bruises per child 1.45, range 1–4			
Mortimer	0–12 months = 1% (n = 620) Mean number of bruises per child = 2, range 1–6			
Tush		36–48 months = 90% (n = 30) mean no. bruises per child = 5.6 range 1–27		
Sugar	0–6 months = 0.5% (n = 366) 6–12 months = 10.6% (n = 226)	12–24 months = 42% (n = 223) 24–35 months = 61% (n = 115)		
Labbe	0–8 months = 1.2% n = 246	9 months–4 years = 60.3% (n = 1012)	5–9 years = 80.3% n = 579 10–17 years = 52.7% n = 203	
Studies defining prevalence according to developmental stage	Pre-crawling	Crawling	Cruising	Walking
Carpenter	3.9% (4/101)	17.3% (9/52)	Not defined in study	37.5% (9/24)
Sugar	Pre-cruisers 2.2% (11/511) Mean no bruises per child 1.3 Range 1–2		17.8% (18/101) Range 1–5	51.9% (165/318) Mean no. bruises 5.6 Range 1–27

**Table 2** Distribution of bruises with respect to age and development when stated

Distribution of bruises described according to age					
Author	Outcome measure	No. bruises/no. children	Age group	Distribution	
Carpenter	No. bruises at each site	32/22	6–12 months	Face and head	25
				Shins	7
Tush	No. bruises at each site	169/30	3–4 years	Legs	149
				Arms	10
				Left trunk	7
				Forehead	1
				Buttocks	2
Mortimer	No. bruises at each site	12/6	Under 1 year	Face and head	4
				Shins	7
				Arm	1
Distribution of bruises described according to development					
Author	Outcome measure	No. children	Development	Distribution	
Sugar	No. children with bruises at each site	511	Pre-cruisers	Ant tibia/knee	3
				Forehead	3
				Scalp	3
		101	Cruisers	Upper leg	1
				Ant tibia/knee	12
				Forehead	3
				Scalp	5
				Upper leg	1
				Ant tibia/knee	142
		318	Walkers	Forehead	18
				Scalp	2
				Upper leg	13
Wedgwood	% of total bruising at each site	11	No better than crawling	0	
				8	Cruisers
		16	Walk on flat/crawl upstairs		
				Knees/shins	68%
				Head	11%
				Arms	13%
		37	Walking/walk upstairs both feet on stair	Lower back	0
				Knees/shins	62%
		13	Walkers	Head	5%
				Arms	25%
				Lower back	5%
				Knees/shins	49%
4	Crawlers and pre-crawlers	Head and face	3		
		Arm	1		
2	Walkers	Shins	2		
		Fore head	1		

over bony prominences in 93.1–100% of cases respectively. Bruises were most commonly seen on the front of the body, those to the head usually occurring on the forehead.<sup>5</sup>

There were areas of the body where bruising was uncommon. These sites include the back, buttocks, forearm, face, abdomen or hip, upper arm, posterior leg, or foot where Sugar and colleagues<sup>4</sup> recorded bruising in less than 2% of children, at any developmental stage. These uncommon sites for bruising were broadly confirmed in the remaining studies;<sup>5–7</sup> heterogeneity of anatomical description obviated direct comparisons. Wedgwood<sup>7</sup> noted bruising to the lower back in the very mobile child, but he saw none in early walkers, cruisers, or pre-cruisers. Forearm bruising was not seen in the cruising and pre-cruising group.<sup>4 5 7</sup> There was no bruising to the hands in children less than 4 years old recorded in any study. Dunstan and colleagues<sup>11</sup> found no bruising to the ears.

Worlock and colleagues<sup>12</sup> describe 116 children under 5 years of age with accidental fractures, but only one had significant bruising. Lyons and Oates<sup>9</sup> studied 207 children

under 6 years who fell from hospital beds onto an uncarpeted floor from a height range of 25–54 inches; less than 1% had contusions.

### Bruising in abused children

Sixteen papers dealt with abused children (see *ADC* website). Two were case control studies where the definition of abuse ranked highly. Thirteen were case series and one was a cross sectional study. These papers were frequently methodologically weak, either because they were highly selected cases or because the definition of abuse had a low ranking. The age ranges and demography of cases included varied. Only three studies focused primarily on bruising;<sup>11 13 14</sup> the majority described soft tissue injuries with some reference to bruising and others looked at injuries to specific parts of the body.

Bruising in child abuse is common; prevalence figures varied widely according to study inclusion criteria<sup>1 2 12 13 15–17</sup> (table 3). The mean number of bruises each child sustained varied from 5.7 (controls 1.5)<sup>11</sup> to 10 (range 0–44) in the populations studied.<sup>13</sup> Demographic variants noted by

Johnson and Showers<sup>15</sup> were that white children are more likely to be bruised than black ( $p < 0.025$ ); he found no sex difference. Black children were more likely to be hit by a cord or belt than white children ( $p < 0.001$ ). In contrast white children were more likely to be hit with the open hand or a paddle. Girls were more likely to be struck by the open hand than boys ( $p < 0.0001$ ).

Bruises can occur among other types of soft tissue injuries. These may be recent or older injuries (for example, scars and healed abrasions).<sup>18 19</sup> The measured lengths of bruises were greater in abused children than controls.<sup>11</sup>

Five studies addressed the distribution of bruises in abuse; all confirmed that the head was the commonest site.<sup>11 12 13 20</sup> De Silva and Oates<sup>20</sup> noted multiple bruising to face and head in 53% (9/17) of fatal child abuse cases and multiple bruising to the trunk and limbs in 41%; only one child had no bruising. Dunstan and colleagues<sup>11</sup> state that bruising to ear, face, head and neck, trunk and buttocks, and arms is seen significantly more in abuse than controls. Atwal and colleagues<sup>13</sup> confirmed this distribution of bruises associated with fatal non-accidental head injury (face 19%, forehead 10.9%, back 8.4%, buttocks 11.7%), and Worlock noted that 72% of bruises in children with non-accidental fractures were on the head and neck. Homicide,<sup>12</sup> fatal non-accidental head injury,<sup>13</sup> and non-accidental fractures can occur, however, without external bruising.<sup>12</sup> In contrast to non-abused children, bruises were seen on soft parts of the body.<sup>21</sup>

A common feature in abused children was clustering of bruises.<sup>18 19</sup> These were often defensive injuries: on the upper arm, outside of the thigh, or bruises on the trunk and adjacent extremity.<sup>18</sup> Bruises often carry the imprint of the implement used. These include linear or tramline bruising due to being struck with a rod like instrument,<sup>15 18 19 22</sup> banding where the hand has been tied,<sup>22 23</sup> and an imprint or a negative image of the implement such as an electrical cord or studded belt<sup>22</sup> or dog collar.<sup>18</sup> The presence of areas of bruising interspersed with small abrasions was consistent with being hit with a rope.<sup>19</sup> Vertical gluteal cleft bruising<sup>14</sup> is described, and bruising to the pinna<sup>14 24</sup> of the ear, where the profile of the bruise assumes the line of anatomical stress rather than the shape of the injuring object.<sup>14</sup>

## DISCUSSION

We have systematically reviewed the literature and identified the extent of the evidence base that underpins our original question. The nature of the question determines that the studies included were observational in nature. There was only one case control study that compared the general distribution of bruises in abused and non-abused children.

The evidence for bruising patterns in non-abused children primarily addresses children under 10 years of age. The majority of studies were prospective and focused specifically on bruising. The level of published evidence about patterns of bruising in abused children was poorer; the studies that were included dealt with wider issues than bruising. Many papers

looked at bruising patterns in specific anatomical areas, in fatal cases, or in narrow age groups of children. Most studies were retrospective and based on the analysis of existing records. The qualitative nature of included studies, variability in study type, methods, and the wide discrepancy in definitions of abuse used prevented us from being able to use a meaningful composite score to directly compare or calculate a hierarchy of studies. The papers that use lower ranking for defining abuse run the risk of reverse causality in defining the abused population.

Studies focused on young able children and predominantly white populations. We included papers with small case series of photographic records. These formed the basis of early influential papers where there were clear descriptions of the abuse that ranked highly and photographs of the injuries that resulted. In this context we felt that their evidential value was still relevant.

Some frequently quoted papers were unsuitable for inclusion. Keen wrote a short letter<sup>25</sup> detailing bruising patterns in six 3–4 year old children who were repeatedly examined. The study was not methodologically suitable for analysis as there was no detail on ascertainment, exclusion of illness or abuse, methods, or detailed results. Robertson and colleagues<sup>26</sup> compared recent injury in abused and normal children. They commented that bruising was uncommon in non-abused children 3–9 months of age and increased in prevalence with age. They stated that the hands and lower legs were the most common site of bruising in these children, but no quantitative data were presented. No bruise specific data were given for the abused children. This paper, like many others, described the distribution of soft tissue injury in abused children that was broadly similar to the pattern of bruising.<sup>15–18 27</sup> Despite the fact that bruising accounted for the majority of these injuries, 56–62%,<sup>16 17 27</sup> figures specific to bruising could not be extracted.

From the literature we were able to identify clear differences between bruises sustained after accidents and those that are seen in physical abuse.

Bruising in babies who are not independently mobile is very uncommon (<1%). Around 17% of infants who are crawling or cruising have bruises, whereas the majority of preschool and school children have accidental bruises. These bruises are characteristically small and sustained over bony prominences on the front of the body where they are likely to correspond to falls, the most common cause of childhood injury.<sup>27</sup> The prevalence, number, and location of bruises are directly linked to motor developmental ability. Children with significant motor development delay would not be expected to have the same bruising pattern as their peer group. This evolving pattern needs to be taken into consideration when assessing bruising in children. Data on explanations for bruises was limited; one paper discussed bruises after falls from hospital beds, and a second, the association of bruises with fractures. Both conclude that even in these specific situations associated bruising is rare.

**Table 3** Prevalence figures for bruising in abused children

Author	Prevalence
Lynch	28% of school age children with child abuse who have an injury had bruising
Galleno	32% of children with confirmed physical child abuse have bruises
Johnson-Showers	56% of children under 17 years with suspected child abuse have bruises
Smith-Hanson	82% of 134 "battered" children under 5 years old, admitted to hospital had bruises
Mcmahon	92% of 371 children (0–18 years) with suspected child abuse had soft tissue injuries, 62% of these injuries were bruises
	98% of 44 infants with suspected child abuse had bruises
Worlock	72% of children under 5 years with non-accidental fracture had bruising
Atwel	71% of children with fatal non-accidental head injury have bruises

## Implications for practice

A bruise must never be interpreted in isolation and must always be assessed in the context of medical and social history, developmental stage, explanation given, full clinical examination, and relevant investigations.

### Patterns of bruising that are suggestive of physical child abuse

- Bruising in children who are not independently mobile
- Bruising in babies
- Bruises that are seen away from bony prominences
- Bruises to the face, back, abdomen, arms, buttocks, ears, and hands
- Multiple bruises in clusters
- Multiple bruises of uniform shape
- Bruises that carry the imprint of implement used or a ligature

In contrast, any part of the body was vulnerable to bruising from abuse. Bruises are located away from bony prominences. They are most commonly seen on the head and neck, particularly the face. The buttocks and back, trunk, and arms are also common sites of injury. Although papers gave relatively little information of mechanism of injury, the histories and photographs of multiple uniform injuries suggested repeated injury to areas of the body that are not commonly bruised accidentally. Abusive bruises are often larger, they are commonly multiple, and occur in clusters. They are often associated with other injury types that may be older. Some bruises carry the imprint of the weapon used.

The one case control study that looked at bruising recognised the significant differences in location and size of bruises between abuse and non-abuse. The authors were able to combine this data mathematically to develop a tool to calculate the probability of abuse. This is a welcome attempt to apply a scientific estimate of probability of abuse, although to apply it in practice would require you to know the prior probability of abuse in your population. Large case control studies encompassing developmental stage in populations representative of ethnic and cultural diversity and children with disability would greatly strengthen the evidence. Further studies exploring the relation of explanations of injury to the pattern of bruising sustained would be valuable.

With the exception of a bruise that carries the clear imprint of the implement used or multiple bruises of uniform shape, there are few bruising patterns that reach diagnostic significance. However, some patterns and locations of bruising are very suggestive of abuse and warrant further exploration. When interpreting the significance of any bruising, it is essential to evaluate the full clinical and social picture and note the developmental level of the child. All bruising must be interpreted in the context of the explanation given. In the court setting, opinion must be solidly based on the evidence available. The expert witness must have an up to date knowledge of the current evidence, its strengths, and limitations.

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