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Child-related risk factors and injuries in cases of physical child abuse

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Abstract

Background: When evaluating child welfare risk, recognition of abuse-related injuries and knowledge of risk factors for child abuse are important aspects. The purpose of this study was to evaluate child-related risk factors and particularities of injuries in cases of physical child abuse, to use the results for preventive child protection.

Methods: This retrospective case control study evaluated case files of 368 physically abused children (age range 0–14 years) referred to forensic medicine in 2004–2015. Death cases and cases that could not be separated from sexual abuse and neglect were excluded and 363 controls without suspicion of abuse were recruited from a pediatric clinic. Demographic data, state of care and previous illnesses were compared in both groups by determining χ^2-test and Fisher's exact test. Concerning injuries, specified mechanism of origin, type of violence, localization on the body and frequency of life-threatening and repeated abuse were evaluated.

Results: Male gender and age group of infants/toddlers were identified as significant child-related risk factors. In over 90%, injuries resulted from blunt trauma, with the skin (86%) and skeletal system (22%) most commonly involved. Injuries were located in almost 60% on obvious parts of the body. Reported causes for trauma were mostly accident mechanisms. Repeated abuse was found in over half and life-threatening injuries in nearly 20% of the cases.

Conclusion: As part of the daily work pediatricians and other child protection workers are able to identify suspected cases early. Therefore, good understanding of typical risk factors and injuries including plausibility check of the reported origin are important aspects. Periodic reassessment of child well-being and mandatory visit to pediatricians could avoid repeated and severe child maltreatment with life-threatening consequences.

Keywords
Child maltreatment · Risk factors · Prevention · Intervention · Trauma · Clinical forensic medicine · Violence

Data availability statement
The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Introduction

Violence in general is a widespread public health, human rights and social problem, but violence against children and women contributes disproportionately to the health burden [1]. According to estimates nearly a quarter of adults worldwide suffered from physical abuse as a child [2]. Findings from population-based surveys showed, that globally one billion children, or one out of two children, suffer some form of violence each year [3]. Child physical abuse affects children of all ages, ethnicities and socioeconomic groups. Previous studies estimated annual trauma follow-up costs between 11 and 30 billion Euros for Germany and up to 124 billion

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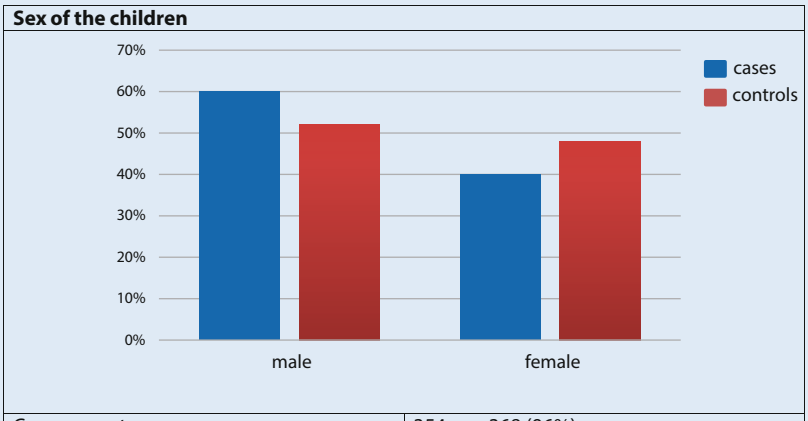


Coverage rate cases		354 von 368 (96%)	
Coverage rate controls		350 von 363 (96%)	
Sex	**cases + controls**	**cases**	**controls**
Total	n = 704 (100%)	n = 354 (100%)	n = 350 (100%)
Male	n = 394 (56%)	n = 211 (60%)	n = 183 (52%)
Female	n = 310 (44%)	n = 143 (40%)	n = 167 (48%)
Asymptotic significance in the χ2-Test		0.05	

Fig. 1 ▲ Sex distribution in the case and the control group

US Dollars per year in the USA [4, 5]. The United Nations has launched "The 2030 Agenda for Sustainable Development" to end all forms of violence against children. For this agenda to progress, it will be essential to document the magnitude of violence against children and to find out factors that increase a child's vulnerability to maltreatment [6].

Physicians and other child protection workers are important actors in child protection. When evaluating child welfare risk, recognition of abuse-related injuries and knowledge of risk factors for child abuse are significant aspects. Risk factors can be categorized as child-related, related to the perpetrator and related to family structure and society. The World Health Organization defines for example young and premature infants, twins and children with a disability to be at increased risk for physical abuse and neglect [7]. If there are indications of child abuse, the initiation of further steps can prevent continuing abuse. Official risk screening is not currently enshrined in guidelines, as studies have shown high false positive rates of abuse, neglect and the need for assistance [8–11]. The specificity and sensitivity of such screening procedures are considered to be low [12]. Nevertheless, early detection of child abuse can help to decrease mortality and morbidity [8]. Risk factors should be considered as broadly defined markers rather than strong individual determinants of abuse [13].

The aim of the present study was to explore child-related risk factors and specifics of abuse-related injuries in cases of physical abuse. The results of this study are useful for child protection work and will help physicians and other child protection workers to incorporate child abuse prevention into their daily practice.

Methods

In total, 368 cases of abused children aged 0–14 years, examined by forensic medicine between 1 January 2004 and 31 December 2015, were retrospectively screened using forensic case files. Physical examinations and assessments based on files on behalf of investigative authorities as well as cases without criminal complaints were included. Death cases, cases that could not be separated from sexual abuse and neglect, and in which suspicion of physical abuse could not be confirmed by forensic experts were excluded. The evaluation was made in comparison to controls ($n = 363$) of the same age group without suspicion of abuse, recruited in a pediatric clinic from the same catchment area. In addition to age and sex, information on the state of care, previous illnesses and the migration background of the child was recorded in both groups. The injuries in the case group were evaluated with respect to the type of violence, the affected body regions and organs, the reported mechanism of origin, repeated abuse and life-threatening consequences.

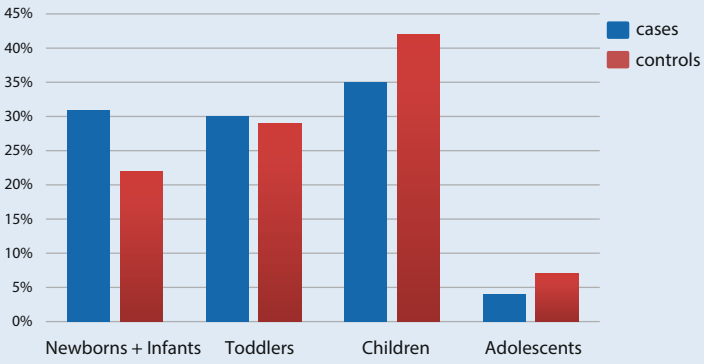
Data were evaluated using the IBM® SPSS® Statistics software package (version 23, IBM Deutschland GmbH, Ehningen, Germany). Frequencies, mean values and medians were determined for descriptive analyses. For all variables that were collected in the case group and the control group, exploratory analysis was carried out by determining Pearson's χ^2-testand Fisher's exact test if necessary. A p-value of 0.05 was considered as statistically significant.

Results

The sex ratio in the control group was almost balanced, in the case group there were significantly more male (60%) than female (40%) children (**Fig. 1**). The age of the children was divided into newborns and infants (<1 year), toddlers (1–3 years), children (4–12 years) and adolescents (13–14 years). The evaluation showed that younger children (newborns, infants and toddlers) were more often represented in the case group, older children (children and adolescents) more often in the control group. The median age of the children in the case group was 2 years, in the control group 3 years (**Fig. 2**).

The care status of the affected children was only recorded in the case group. Poor care means visibly poor personal hygiene, poor hygiene of clothing and/or poor dental status. Information on the state of care was not given uniformly in the files. An inadequate care status was recorded, while a good care status was rarely documented. For this evaluation, cases with a good care status and cases in which information on the care status were missing, were compared to cases with poor care status. A poor state of care resulted in at least 13% of the cases.

Chronic illnesses, disabilities, developmental disorders, a so-called crying child and premature birth were recorded un-



Coverage rate cases Coverage rate controls		363 von 368 (99%) 360 von 363 (99%)	
Ages	**cases+ controls**	**cases**	**controls**
Total	n = 721 (100%)	n = 361 (100%)	n = 360 (100%)
Newborns and Infants (0 years)	n = 193 (27%)	n = 113 (31%)	n = 80 (22%)
Toddlers (1-3 years)	n = 211 (29%)	n = 108 (30%)	n = 103 (29%)
Children (4-12 years)	n = 277 (38%)	n = 126 (35%)	n = 151 (42%)
Adolescents (13-14 years)	n = 40 (6%)	n = 14 (4%)	n = 26 (7%)
Average for invoice without categorization	4.14 years	3.58 years	4.72 years
Median for invoice without categorization	3 years	2 years	3 years
Asymptotic significance in the $\chi 2$-Test		0.009	

Fig. 2 ▲ Age distribution in the case and the control group

der previous illnesses. A migration background was assumed if the child was born outside Germany. Information on previous illnesses and migration background of the child were also not uniformly documented. Cases without previous illnesses and/or migration background and cases in which information on these aspects were missing, were compared to cases with documented previous illnesses and/or migration background. The frequency of previous illnesses was approximately the same in both groups (28–29%). Migration background was documented in 5% of the cases and in 3% of the controls, without a significant difference ($p = 0.160$).

The evaluation of the type of violence (multiple answers per case were possible) revealed that the physical injuries resulted in 94% from blunt force trauma, only 2% of the injuries were caused by sharp force trauma and 6–7% of the injuries resulted from thermal action or compressive force against the neck or chest.

Regarding the affected organ systems and body regions (multiple answers per case were possible), the injuries were manifested in 86% of the cases on the skin, in 22% on the skeletal system and in 13% on the brain. Internal organs (2%) and other parts of the body (4%) were rarely affected (◘ **Fig. 3**). The face (including the ears) was injured in almost half of the cases, followed by the upper and lower extremities and the back (◘ **Fig. 4**). On average more than two regions of the body were injured. In almost 60% of the cases the injuries were located on obvious parts of the body and not covered under long clothing.

Considering wound morphology, 38% ($n = 139$) of the injuries were shaped. In at least 29% ($n = 105$) an implement was used, although the coverage rate in this respect was incomplete due to lack of information in the files.

Most common notified causes for the trauma were accident mechanisms (41%) or maltreatment (39%). In 20% of the injuries no information about the mechanism of origin was reported, in 5% a pathological process was named.

The present study revealed repeated abuse (57%) in over half of the cases, almost 20% of the cases were classified as life-threatening.

Discussion

In the present study, relevant factors that increase the risk of physical child abuse and aspects of abuse related injuries were identified by evaluating a collective of 368 abused children (0–14 years) and a control group without suspected abuse.

Although there is no single factor that causes an individual to maltreat a child, a wide range of factors interact to increase or reduce the risk [14]. In this study, young childhood (newborns, infants and toddlers) and the male sex were identified as significant child-related risk factors for physical abuse. The sex distribution in the control group (52% male, 48% female) is comparable to the values of the general population in 2004–2015 of the state in which the study was conducted (live births: 51% male, 49% female) [15]. In contrast, the evaluation of the case group showed 60% male children. With respect to physical abuse, no significant sex differences have been found in individual studies [16, 17], in other studies boys were more often affected by physical abuse than girls [18, 19]. Girls, on the other hand, were more frequently affected by sexual abuse than boys [16, 18]. There is only little research on sex differences in the consequences of child abuse. Thompson et al. investigated the effects of physical abuse in childhood on health problems in adulthood with particular reference to sex differences (data from 8000 men and 8000 women who were interviewed in the National Violence Against Women Survey). They also found that physical abuse in childhood was more prevalent among men than women. Physical child abuse was related to health problems in adulthood of the whole sample and adversely affected the mental health and

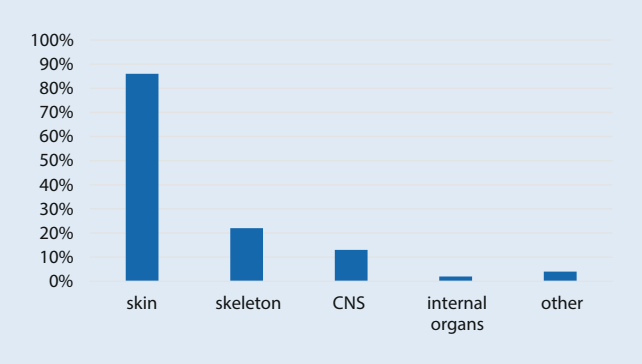


Fig. 3 ▲ Affected organ systems (*CNS* central nervous system, $n = 368$, multiple answers possible)

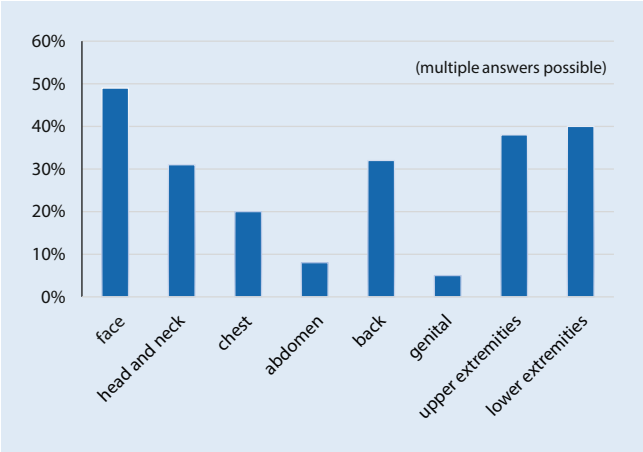


Fig. 4 ▲ Affected body regions ($n = 368$, multiple answers possible)

general perceptions of health of women more than men [20]. Although male children seem to be affected more, the consequences are detrimental for both males and females, which highlights the need for early detection and prevention in our society.

The median age of children in the case group was 1 year younger than in the control group. Even without considering the control group, it can be seen that over half of the abused children (61%) were 3 years old or younger. More in detail, the children were under 1 year old in 31% of the cases and in 30% 1–3 years old. Given the low infant mortality rate in Germany and the constant birth rate since 2004, it can be assumed that the absolute number of children in the 0–15 years age group has remained the same in the current survey period [15, 21]. The results confirm the previously known assumption that younger children are at greater risk of physical abuse [22, 23]. Moreover, it has been shown that children under 1 year of age have a higher risk of becoming victims of serious and, in the worst case, fatal abuse [24].

In the present study, a poor care status was noticed in 13% of the cases. The assessment of the care status is extremely subjective and subject to interobserver variability, which makes classification difficult. In the absence of comparative values, a poor care status could neither be confirmed as a risk indicator nor rejected. The results indicate that a poor care status (for example lack of body care, dirty clothing) can be observed not only in cases of neglect, but also as a co-factor in physical child abuse.

In the case and control groups there were no significant differences with respect to previous illnesses (case group 28% versus control group 29%) and a migration background (case group 5% versus control group 3%) of the child. The evaluation was difficult due to the inconsistent recording in the files. In the yearbook of the State Statistical Office in Rhineland-Palatinate, the share of under 20-year-old foreigners with their own migration experience in 2016 was 6.3%, the share of under 20-year-old Germans with their own migration experience was 1.2% [25]. The frequencies in the investigated collective are therefore not higher than the values in the general population. There are only a few studies in the literature that investigated risk factors for child abuse in population-based samples. In these studies, a migration background of the families was associated with an overrepresentation of various risk factors and an increased risk for maltreatment as compared to children from native families [26–28]. The rate of pre-existing illness among abused children was not increased compared to the control group, but to the general population: in a study on the health of children and adolescents aged 0–17 years in Germany (KiGGS study), the prevalence of chronic physical diseases was approximately 16% and approximately 1/5 of the children and adolescents could be assigned to a risk group for psychological abnormalities [29, 30]. As expected, in this study the control group is not sufficiently representative of the pre-existing conditions item, as pre-sick children are presented more often in hospitals than healthy children (pre-selection). In the literature there are at best weak connections between previous illnesses in general and the occurrence of child abuse [17]. Yet especially children with disabilities are at high risk for physical, sexual and emotional abuse [31]. Considering data from the general population, the inconsistent recording in the files and the insufficient significance, a migration background and the existence of previous illnesses could neither be confirmed nor rejected as risk factors. In this study, disabilities were also evaluated as pre-existing conditions, which could be the reason for the higher rate of previous illnesses in contrast to the general population in the case group and emphasizes the need for special attention to this population for early detection and intervention of child maltreatment.

Knowledge of aspects of abuse-related injuries is of great importance in practice in order to objectify a child's well-being. With respect to the evaluation of physical injuries, the findings were comprehensively documented in all case files, so that the examined study group provides very meaningful data.

Findings were most often due to blunt trauma (94%), compressive violence against the neck/chest and thermal action but sharp violence was rare. The injuries were manifested most frequently on the skin (86%), followed by the skeletal system (22%) and the brain (13%) but rarely on the internal organs (2%) and other parts

of the body (4%). The skin is in direct contact to the environment of a child. Blunt trauma including compressive violence against the neck/chest, thermal action and sharp violence are suitable to leave injuries on this part of the body. The frequencies described in the literature are roughly comparable, most of the abused children had injuries due to blunt trauma and sharp or penetrating trauma is seldom [32].

It is also worth mentioning that in about 60% of the cases the injuries were located on obvious parts of the body that were not covered by long clothing. The face was affected in about half of the cases and the head/neck region in about 30%. In addition, more than two regions of the body were injured on average. Comparatively, Pierce et al. found a strong correlation for the existence of abuse-related injuries (sensitivity 97%, specificity 84%) for hematomas on the trunk, ears and neck in children under 4 years of age, but in principle every region of the body can be affected [33]. A systematic review also indicated that the head, including the face, is most commonly affected in cases of abuse [34]. The head including the face and neck region is within easy reach for blows or other violence, such as pulling on the ears.

In the present evaluation 38% of the injuries were shaped, with an implement being used in at least 29% of the cases. Shaped injuries are pathognomonic for the presence of physical abuse. Not every tool necessarily leaves a shaped injury and even without using a tool, shaped injuries can occur, for example by a slap with the open hand. The findings considering the literature demonstrate that injuries are often not only visible to doctors, nurses and other healthcare providers. Injured skin can be the first and most objective finding that leads to the suspicion of abuse.

Bruises due to accidents are observed more frequently with increasing age of the children. They are common on crawling and walking children (approximately 18–52%), which illustrates the difficulty of differentiating them from non-accidental injuries, especially in older children [35]. The absence of bruising does not preclude the presence of severe trauma resulting in organ injuries and fractures. In up to 80% of cases with abdominal injury no bruising is present [36]. The challenge for physicians is to recognize that such a trauma has occurred. Intentional scalds often appear in a symmetrical, sharply demarcated stocking or glove pattern on the extremities (immersion injuries). Burns due to child abuse are mostly contact burns and have sharply demarcated edges, which could be matched to a specific implement.

In addition to stating an abuse, the caregivers in the present collective often specified accident mechanisms as the cause of the injury. In practice, injuries should be assessed considering the age, developmental status and mobility of the child, whereby a plausibility check of the stated mechanism of origin is mandatory.

In about 20% of the cases the injuries were classified as at least potentially life-threatening and 60% of the children were repeatedly abused. In the literature there are frequencies for repeated abuse up to 50% [18, 37]. Sheets et al. found previous injuries (sentinel injuries) in infants with severe physical abuse, in contrast to infants who were not abused, with doctors only being aware in about 40% of cases that injuries had already occurred in the past [38]. Knowledge of suspected injuries in the past, a regularly re-evaluation of the child's well-being and (if necessary, mandatory) visit to a pediatrician could be a viable path to avoid repeated and severe abuse with life-threatening consequences.

In summary we identified the male sex and the infancy/toddler age as significant child-related risk factors for physical abuse. Consequences of physical abuse are often obvious and therefore not only recognizable for doctors. The plausibility check of the specified mechanism of origin is an important criterion for the injury assessment. The high rates of repeated child abuse and life-threatening injuries in the studied collective suggest that early diagnosis of child maltreatment can prevent severe injuries and long courses. The results should encourage anyone working with children to keep their eyes open to prevent severe cases.

Conclusion

As part of their daily work, pediatricians and other child protection workers are able to screen for risk factors of child maltreatment and recognize suspected cases early, with the goal to refer families to effective community-based prevention programs. Although general screening procedures and compulsory examinations are not currently recommended, a good understanding of child-related risk factors for physical abuse and typical aspects of nonaccidental injuries are important for guiding the development of prevention and intervention strategies.

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Declarations

Conflict of interest. C. Walz, U. Kullmer, J. Lecht, T. Riepert and T. Germerott declare that they have no competing interests.

For this article no studies with human participants or animals were performed by any of the authors. All studies mentioned were in accordance with the ethical standards indicated in each case. A positive ethics vote has been received from the Ethics Committee Mayence (837.057.16 810376).

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Zusammenfassung

Kinderbezogene Risikofaktoren und Verletzungen bei körperlicher Kindesmisshandlung

Hintergrund: Das Erkennen misshandlungsbedingter Verletzungen und die Kenntnis von Risikofaktoren für Misshandlung sind wichtige Kriterien bei der Einschätzung einer Kindeswohlgefährdung. Ziel der Studie ist die Auswertung von kindbezogenen Risikofaktoren sowie Besonderheiten misshandlungsbedingter Verletzungen, um die Ergebnisse für den präventiven Kinderschutz heranzuziehen.
Methoden: In der retrospektiven Fall-Kontroll-Studie wurden Fallakten von 368 körperlich misshandelten Kindern (0–14 Jahre) ausgewertet, die in den Jahren 2004 bis 2015 am Institut für Rechtsmedizin untersucht wurden. Todesfälle und Fälle, die nicht von sexuellem Missbrauch und Vernachlässigung abzugrenzen waren, wurden ausgeschlossen. Als Kontrollgruppe wurden 363 Kinder ohne Misshandlungsverdacht in einer Kinderklinik rekrutiert. Demografische Daten, Pflegezustand und Vorerkrankungen wurden mittels Chi-Quadrat-Test und exaktem Fisher-Test zwischen den Gruppen verglichen. Hinsichtlich der Verletzungen wurden der angegebene Entstehungsmechanismus, die Art der Gewalteinwirkung, die Lokalisation am Körper und die Häufigkeit von lebensbedrohlichen und wiederholten Misshandlungen ausgewertet.
Ergebnisse: Das männliche Geschlecht und das Säuglings-/Kleinkindalter wurden als signifikante kindliche Risikofaktoren identifiziert. Die Verletzungen waren in über 90 % der Fälle Folgen stumpfer Gewalt, wobei die Haut (86 %) und das Skelettsystem (22 %) am häufigsten betroffen waren. In nahezu 60 % der Fälle waren die Verletzungen an offensichtlichen Körperstellen gelegen. Am häufigsten wurden Unfallmechanismen als Ursachen für die Verletzungen angegeben. Wiederholte Misshandlungen wurden in über der Hälfte und lebensbedrohliche Verletzungen in nahezu 20 % der Fälle festgestellt.
Schlussfolgerung: Kinderärzt:innen und andere Akteur:innen im Kinderschutz können Verdachtsfälle frühzeitig in ihrer täglichen Arbeit identifizieren. Die Kenntnis von typischen Risikofaktoren und Verletzungen, einschließlich einer Plausibilitätsprüfung des angegebenen Entstehungsmechanismus, sind dabei wichtige Aspekte. Regelmäßige Einschätzungen des Kindeswohls und obligatorische Besuche bei Kinderärzt:innen könnten wiederholte und schwere Kindesmisshandlungen mit lebensbedrohlichen Folgen vermeiden.

Schlüsselwörter
Kindesmisshandlung · Risikofaktoren · Prävention · Intervention · Trauma · Klinische Rechtsmedizin · Gewalt

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