

## The Perception and the Prevalence of Pediatric Concussion and Related Knowledge among Parents and Pediatric Emergency Physicians: A Systematic Review

Hidayah J Almasoud<sup>1</sup>, Jaafer A Alsultan<sup>2</sup>, Mahdi Alsuwailem<sup>3\*</sup>, Mohammad A Alzain<sup>4</sup>, Saeed B Almuhanha<sup>5</sup> and Ahmed Alghadeer<sup>6</sup>

<sup>1</sup>Pediatric Emergency Medicine, MCH Ahsaa KSA, Ahsaa, Saudi Arabia

<sup>2</sup>Pediatric Emergency Medicine, Moh, Dammam, Saudi Arabia

<sup>3</sup>Pediatric, Ministry of Health, Alhofuf, Saudi Arabia

<sup>4</sup>Pediatrics, Almoosa Specialist Hospital, Al-Ahsa, Saudi Arabia

<sup>5</sup>Pediatric Emergency Medicine, MCH-alahsa/KAUH, HOFUF, Saudi Arabia

<sup>6</sup>Pediatric Emergency Medicine, Maternity and Children Hospital Al hofuf, Alhofuf, Saudi Arabia

\*Corresponding Author: Mahdi Alsuwailem, Pediatric, Ministry of Health, Alhofuf, Saudi Arabia.

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### Abstract

**Background:** Concussions are one of the most prevalent types of head injuries among children. Children's concussions represent a significant proportion of emergency department visits. Most children's concussions resolve within a month without secondary complications. However, early management should be performed to avoid further complications and consequences. Therefore, parents should have sufficient knowledge regarding children's concussions when caring for children, and pediatric emergency physicians should adequately understand the diagnosis and management of children's concussions to ensure better outcomes.

**Aim:** This study aimed to assess the prevalence of children's concussions, as well as the knowledge among parents and pediatric emergency physicians of children's concussions, by reviewing previous original studies on this subject.

**Methods:** For this systematic review, we searched PubMed, Elsevier, Science Direct, and Google Scholar databases for studies related to the current subject. The keywords used in this search process included "pediatric", "physicians", "emergency", "prevalence", "knowledge", "parents", "prevalence", and "awareness." The study's inclusion criteria were original, English-language articles that focused on the examined topic whose full text was available.

**Results:** In total, 11 articles were eligible for inclusion, and they involved a total of 26,046 participants. The majority of these studies were focused on parents' knowledge, followed by the prevalence of children's concussions and then pediatric emergency physicians' knowledge.

**Conclusion:** The prevalence of children's concussions in the reviewed studies was similar to that found in previous reports, and parents' knowledge was good; however, pediatric emergency physicians' knowledge contained many gaps that can be improved by the establishment of educational programs.

**Keywords:** Brain Concussion; Concussion; Parents; Pediatric Emergency Physicians; Pediatrics; Knowledge; Prevalence

## Introduction and Background

A concussion is a mild type of traumatic brain injury [1] and one of the most prevalent types of head injuries among children [2]. A concussion is often defined by four primary characteristics: a direct blow to the body or head, the rapid onset of short-lived neurological impairments, functional deficits (rather than structural impairments), and graded clinical symptoms that resolve sequentially [3].

Diagnosis of concussion increased by 71% in children aged 10-19 years by 71%, from 2010 till 2015 to reach 15.2 diagnoses per 1000 child. The incidence among children was much higher compared to adults aged 20 - 64 years, for whom concussions' incidence increased by 26% during the same period, reaching 2.4 diagnosis per 1,000 individuals [4].

Concussion symptoms can be cognitive, symptomatic, or emotional. Approximately 60%-80% of children who experience concussions recover within a month without enduring secondary complications. However, a concussion that is not managed appropriately can lead to long-term complications, prolonged recovery, and in rare cases-death [5].

For pediatric emergency physicians, diagnosis and management of concussion is challenging as they are dealing with different age groups and there are no well established or concise guidelines for management as in adult health care [6,7].

In the United States, approximately 25,000 emergency department (ED) visits are related to pediatric concussions [7]. A report stated that, in the United States, almost 750,000 children are diagnosed with concussions by EDs [8,9].

The best management tool for any disease is prevention. For concussion this step is started from home and emphasizes the role of parents or the care giver for children [10]. Therefore, parents must have sufficient knowledge of children's concussions to perform early management. Since concussions are common ED presentations, emergency physicians' concussion knowledge and management must be assessed. This assessment is necessary because emergency physicians represent the first line of concussions' clinical management [11]. Accordingly, the current systematic review was performed to identify perception of pediatric concussions and level of knowledge among parents' and pediatric emergency physicians.

## Review

### Method and search strategy

This systematic review was written in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist for systematic reviews and meta-analyses [12]. Literature Search: PubMed, Elsevier, Science Direct, and Google Scholar databases were used to find studies. The study only considered articles that were published in the English language between April 2010 and April 2023. Keywords used were "pediatric", "physicians", "concussion", "emergency", "prevalence", "knowledge", "parents", "prevalence", and "awareness" in different combinations on all databases.

### Eligibility criteria

The titles of all articles identified during the primary search were revised, and all duplicate articles were excluded. Then, articles with irrelevant titles were also excluded. All articles' abstracts were scanned, and only original articles written in the English language were included. Articles written in other languages and unoriginal articles such as systematic reviews, review articles, meta-analyses, reports, and letters to editors were excluded. Any article that reported on concussions' prevalence among children, parents' knowledge regarding concussions, and pediatric emergency physicians' or providers' knowledge were included.

The second step of our data collection entailed determining which articles would be included in our final review. The articles' abstracts were reviewed closely; then, the full articles were scanned. Articles whose full text was unavailable were excluded; also, any articles that

reported incomplete or overlapping data were excluded. Articles that used any study design or did not report their study design but reported full data were eligible. The full description of the search strategy is shown in figure 1 following PRISMA chart.

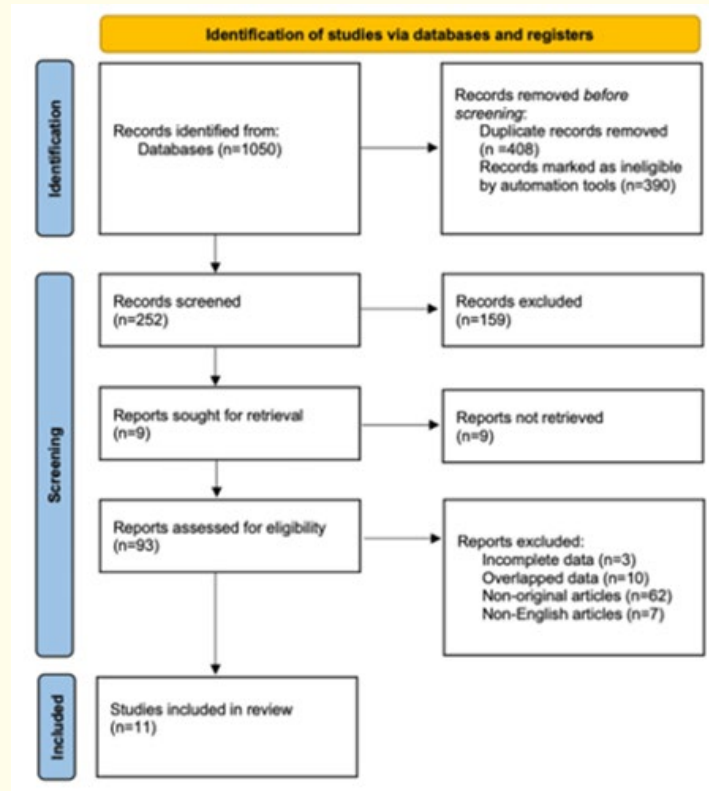


Figure 1: Planning of eligible criteria.

\*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

\*\*If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

### Data review and analysis

A preliminary review of each included article was performed to identify data of interest for extraction. These data included authors and publication years, study designs, study populations and sample sizes, and studies' results and findings. The selected data were extracted into an Excel sheet and reviewed. Then, they were transferred to a pre-designed table so that the collected data could be summarized.

### Results

In total, 11 articles [13-23] that met our eligibility criteria were included in the current systematic review (Table 1). Three articles did not report their study designs [17,19,20], while the remaining eight articles reported their study designs. These designs included survey-based [13,22], cross-sectional [14,15,21,23], prospective [16], and retrospective [18] approaches. Six studies were conducted on parents to assess their knowledge regarding concussions, and these studies involved 1,490 parents in total [13-15,19-21]. Three

studies were conducted on children to determine concussions' prevalence among them, and these studies involved 24,296 participants in total [16-18]. Finally, two studies were conducted on pediatric emergency physicians to assess their knowledge regarding children's concussion, and these studies involved 260 physicians in total [22,23]. Thus, the studies' parents, children, and physicians amounted to 26,046 participants. The majority of studies (six) focused on parents' knowledge, followed by studies that investigated concussions' prevalence among children (three studies), and only two studies focused on pediatric emergency physicians' knowledge regarding children's concussions.

Concussions' prevalence among children was reported in three studies [16-18]. Two of these studies reported a prevalence of 1.1% [16] and 4% [17], respectively, while the third study reported concussions' prevalence associated with different activities and settings. The highest prevalence was associated with organized sports (53.3%), followed by injuries at school (15.6%), other injuries (11.3%), recreation (6.7%), motor vehicle collisions (6.6%), and homes (5.5%). Additionally, among sports, football was the main cause of concussions among children (12.9%), followed by schools' physical education classes (10.6%) [18]. The factors associated with concussions included the male gender, higher family incomes, more somatic symptoms after correction for false discovery rates [17], and the female gender ( $P < 0.001$ ) [18]. One study associated attention deficit hyperactivity disorder (ADHD), accident proneness, and prior concussions with concussions' prevalence using univariate analysis, but its multivariate analysis showed that only prior concussions were a significant risk factor for such prevalence at almost fivefold odds ( $OR = 5.49$ ) [16]. Only one study's authors recommended increasing awareness of concussions [18].

Of the studies that focused on parents' knowledge, three reported good or high knowledge regarding concussion among parents [13,14,20], whereas the other three studies reported average or moderate knowledge levels [15,19,21]. One of the studies that reported a moderate knowledge level measured this level before parents' intervention [19].

The factors associated with parents' high knowledge levels included a medical occupation ( $P = 0.04$ ), an older age ( $P = 0.03$ ) [13], a higher paternal age ( $aOR = 1.59$ ), increased sports competitiveness ( $aOR = 1.25$ ), a female gender ( $aOR = 3.9$ ), a White or non-Hispanic ethnicity ( $aOR = 1.79$ ), a personal concussion history ( $aOR = 1.79$ ) [14], a low social risk status score ( $P = 0.003$ ) [15], and income and education levels [21].

Also, other factors were reported to affect knowledge levels, including social risk status, age upon first participating in a sport, and sports contact [15], while previous sports experience showed no significant impact on knowledge [21]. Additionally, two studies did not report on the factors affecting knowledge levels [19,20]. One study reported that intervention is important for increasing knowledge levels and that concussion-related education is required for parents, especially parents with low incomes and educational levels [19-21].

The final two studies focused on pediatric emergency physicians, showing that the large majority have cared for children with concussions and adequately diagnosed concussions. In one study, most of the physicians reported using guidelines frequently or always to guide their clinical diagnoses, and they diagnosed concussions to professional standards. However, only 64% correctly applied graduated return-to-play guidelines, the physicians exhibited wide variation in recommending a graduated return to play, and limited recommendations concerned cognitive rest following concussions [22]. The other study revealed that pediatric emergency physicians regularly care for children with concussions; however, these physicians lacked adequate training to asymptotically diagnose and manage such patients for many reasons, including inadequate training to educate patients (16%), inadequate time to educate patients (15%), and such education falling outside physicians' roles (1%) [23].

Author and Publication year	Study design	Population and Sample size	Results and main findings
Beidler., <i>et al.</i> 2022 [13]	Survey-based study	- Parents, N = 466	It found that a mean concussion knowledge score of $39.3 \pm 4.6$ out of a possible 47 points. Having a medical occupation ( $P = 0.04$ ) and being older ( $P = 0.03$ ) were associated with higher concussion knowledge scores among parents.
Haarbauer-Krupa., <i>et al.</i> 2021 [14]	Cross-sectional	Parents, N = 400	The median score of parents' knowledge regarding concussion symptoms was 39 out of 50 (a high level). The odds of a higher knowledge level were higher with increased parental age (10-year increase, aOR = 1.59), increased competitiveness (10% scale increase, aOR = 1.25), a female versus male gender for parents (aOR = 3.90), a White or non-Hispanic ethnicity for parents (aOR = 1.79), and a personal concussion history among parents (aOR = 2.34).
Roberts., <i>et al.</i> 2021 [15]	Cross-sectional	Parents -N = 90	Parents scored an average of 76% accuracy in factual concussion knowledge, with 74% confidence in responses. A low social risk status score was associated with higher perceived accuracy of knowledge than a medium or high score ( $P = 0.003$ ). SRS influenced overestimations and underestimations of factual knowledge ( $P = 0.04$ ). Age during one's first sport participant and sports contact levels influenced factual and perceived concussion knowledge.
Cock and Iverson 2021 [16]	Prospective cohort	Children -N = 11013 children (9 - 10 years old)	During the one-year follow-up period between ages 10 and 11, one in 100 children (1.1%) sustained a concussion. In univariate models, three baseline predictors (ADHD, prior concussion, and accident proneness) were significantly associated with sustaining a concussion. In a multivariate model controlling for all other predictors, only prior concussion remained significantly associated with the occurrence of a concussion during the observation period (OR = 5.49, 95[.1]).
Dufour., <i>et al.</i> 2020 [17]	Retrospective	Children -N = 11875 children (9 - 10 years)	The prevalence of concussion was 4%. The prevalence of concussion was significantly associated with the male gender, an increased family income, and more somatic symptoms after the correction of a false discovery rate.
Yaramothu., <i>et al.</i> 2019 [18]	Retrospective	Children -N = 1408 children	Concussions were most prevalent in organized sports (53.3%), followed by injuries in the following settings: schools (16.5%), recreation (6.7%), motor vehicle collisions (6.6%), homes (5.5%), and other (11.3%). Specifically, the soccer (12.9%), school physical education (PE) classes (10.6%), and football (9.8%) subcategories recorded the most concussion incidences. In school PE classes, female children were diagnosed with concussion significantly compared to males ( $P < 0.001$ ) Awareness of concussions and methods to reduce the risk of concussion were suggested.

Rice and Curtis 2019 [19]	Survey-based	Parents -N = 140	Participating parents displayed a moderate level of pre-intervention knowledge, but critical gaps in knowledge were identified. Knowledge of concussion improved slightly post-intervention, regardless of intervention type. Gaps are present in the knowledge of concussions among parents whose children play club sports.
Rieger, <i>et al.</i> 2018 [20]	Survey-based	Parents/ guardians -N = 180	The vast majority of respondents (86%) were confident in their ability to recognize concussions. Parents' general knowledge regarding concussions was somewhat positive; however, variability and misconceptions were noted. Therefore, concussion education is required for parents.
Lin, <i>et al.</i> 2015 [21]	Cross-sectional	Parents -N = 214	Participants scored an average of 18.4 (possible: 0–25) on the Concussion Knowledge Index. The level of knowledge increased with income and education levels, but previous sports experience did not affect this knowledge. Parents who reported experiencing undiagnosed concussions had significantly better concussion knowledge than parents who did not. Parents with low income and education levels may benefit from additional concussion-related education.
Zemek, <i>et al.</i> 2015 [22]	Survey-based study	Pediatric emergency physicians -N = 115	While 90% of respondents adequately diagnosed concussions, only 64% correctly applied graduated return-to-play guidelines. Cognitive rest recommendations were also frequently limited; 40% of respondents did not recommend school absence, 30% did not recommend a schoolwork reduction, and 35% did not recommend limiting screen time. Eighty percent of respondents reported having used guidelines frequently or always to guide clinical decisions regarding concussions. Despite proficiency in diagnosing concussions, pediatric emergency physicians exhibit wide variation in recommending the graduated return to play and cognitive rest following a concussion.
Zonfrillo, <i>et al.</i> 2012 [23]	Cross-sectional	Pediatric primary care and emergency medicine providers -N = 145	Ninety-one percent of participants had cared for at least one concussion patient in the previous three months. Providers reported significant barriers to adequate training to educate patients (16%), inadequate time to educate patients (15%), and their roles' excluding such education (1%). Although pediatric primary care and emergency medicine providers regularly care for concussion patients, they may not have adequate training or infrastructure to systematically diagnose and manage these patients.

**Table 1:** Summary of the included studies.

*P:* p-value; *aOR:* Adjusted Odds Ratio; *OR:* Odds Ratio.

## Discussion

In the current systematic review, we focused on three main points: the prevalence of pediatric concussions, parents' related knowledge, and pediatric emergency physicians' related knowledge. The prevalence of children's concussions ranged from 1.1% to 4%. However,

only two of the three prevalence-related studies reported on the prevalence of children's concussions since the third study reported on concussions' prevalence by activity. Additionally, the lack of studies reporting on the prevalence of children's concussions was due to reporting on the prevalence of children's concussions while including adolescents and children as one group. However, in the current review, we examined studies that included children whose ages did not exceed 11 years.

According to studies that used national data, concussions' prevalence could differ based on questions' wording and surveys' methodologies [24]. This suggestion explains the variation in prevalence rates between the studies that reported on children's concussions in the current review. This variation may reflect the need for a unified tool to assess concussions' prevalence among children in emergency and daily life settings.

Overall, 3.9% of children were reported to have received a diagnosis of concussion or brain injury by a healthcare professional in their lifetime, and such diagnoses increased with age. Children aged 12 - 17 years had more such diagnoses than children of five years or younger [25]. This finding reflects age's impact on concussions' prevalence; no study that we reviewed reported on this impact.

Concussions' risk factors were stated to include histories of concussions, the female gender, and age [26]. Female patients were reported to have a higher incidence of sports-related concussions than male patients [2]. In our review, previous concussions were associated with the prevalence of children's concussions, but gender showed a different impact since one study reported an association between this prevalence and the male gender [17], while another study reported an association between this prevalence and the female gender [18].

Parents' knowledge of children's concussions reached a good level overall. This knowledge level was high or good in three studies and moderate or average in three other studies.

In a study of parents, the parents stated that they could recognize a potential concussive injury among their teenagers, and almost all of these parents were aware of the consequences of playing with a concussion [27]. A study conducted on 495 parents revealed that parents often did not suspect concussions that were ultimately diagnosed by pediatric emergency physicians. Parental education was supported to increase parents' knowledge [28].

We found that many factors affect parents' knowledge level, such as age, medical occupation, gender, ethnicity, income and education levels, and personal concussion histories. One study reported that the personal experiences of parents with concussion-related symptoms slightly influenced parental knowledge [29]. However, in our review, personal concussion histories were associated with a more than onefold increase in parents' knowledge.

One study included in our review reported a moderate level of knowledge among parents before intervention, and this study reported that parents' intervention is important for increasing their knowledge levels [19]. Educating parents can increase their knowledge regarding concussions [5]. One study found that concussion education for parents was associated with small overall variations in knowledge regarding concussions [5]. A systematic review showed a limited number of studies on concussion education programs' effectiveness for the parents and coaches of youth athletes [30].

Pediatric concussions can represent diagnostic challenges to emergency providers since their symptoms are often vague, are subject to the development of reporting differences, and may change over time [31]. The cornerstone of all concussion management by emergency physicians depends on the diagnosis of concussions versus minor head injuries [32]. However, few studies have assessed pediatric emergency physicians' knowledge regarding children's concussions, and fewer were eligible for our review.

Only two studies in our review met our eligible criteria, and we found that the vast majority had cared for children with concussions and adequately diagnosed concussions among children. However, gaps were found in the use of guidelines, recommendations, and adequate training.

One study found that pediatric emergency physicians diagnosed concussions less often than international consensus-based guidelines and used a limited number of parameters to make such diagnoses compared to the current recommendations [7].

Good knowledge among emergency physicians was reported in one study; of 152 emergency physicians, 64% were aware of return-to-play guidelines. Additionally, most concussion-knowledge questions were answered correctly by a high proportion of physicians [33].

In Singapore, concussions were common ED presentations. Most emergency physicians (73.1%) regularly assessed concussions; however, only 46.2% knew the most common concussion symptoms. The training regarding concussions among emergency physicians was insufficient and establishing relevant education programs for medical clinicians to increase their knowledge and, hence, improve patient management was recommended [11].

One study revealed that only 12% of emergency physicians were aware of the Sports Concussion Assessment Tool, Version 2, and more than one-half (59%) were unaware of available guidelines for clinical management [34].

Applying the recommendations for concussion diagnosis to children in acute care settings in order to differentiate between concussions and isolated minor head injuries was reported to be possibly challenging [7]. This report was similar to our findings since many gaps in physicians' recommendations were found.

### Conclusion

In the current study, prevalence of childhood concussions was similar to previous reports; however, a discrepancy was noted between different studies regarding the associated factors. Parents' knowledge was good; although previous studies did not focus on the factors affecting parents' knowledge levels, we could identify such factors in our analysis. Pediatric emergency physicians' knowledge included many gaps that can be improved by establishing educational programs. Further studies dedicated to exploring the knowledge levels of both parents and pediatric emergency physicians regarding pediatric concussions are essential. Such research will provide valuable insights into emergency care for children and support the development of effective educational campaigns to improve concussion awareness and management.

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