

KNOWLEDGE OF EMERGENCY DEPARTMENT MANAGEMENT OF PRIMARY HEADACHE DISORDERS IN PEDIATRIC PATIENTS: SYSTEMATIC REVIEW

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Abstract

Background: Primary headache disorders, such as migraine and tension-type headache, are among the most common neurological complaints in Pediatric emergency departments (EDs). Despite their prevalence, management approaches vary significantly, and guideline adherence is inconsistent.

Objective: To systematically review and synthesize evidence on the diagnostic and therapeutic management of primary headache disorders in children presenting to the ED.

Methods: A systematic review was conducted following PRISMA 2020 guidelines. Databases including PubMed, Scopus, Embase, and Web of Science were searched from 2000 to 2024. Eligible studies included observational and cohort studies evaluating diagnostic strategies, treatment approaches, and outcomes in Pediatric patients (≤18 years) with primary headache in ED settings.

Results: Fifteen studies (retrospective, cross-sectional, and prospective) were included. Headache was found to be a frequent ED complaint, with migraine accounting for a substantial proportion. Despite this, neuroimaging was often used unnecessarily, with serious neurological pathology present in less than 2% of cases. Evidence-based therapies reduced return visits and improved outcomes, but opioids were still used in some settings. Educational gaps, inadequate classification, and lack of standardized care pathways were common barriers to optimal management.

Conclusion: Current ED management of Pediatric primary headache disorders remains highly variable. Adherence to clinical guidelines, minimizing unnecessary imaging, and implementing provider education and follow-up pathways are essential to improve care quality and outcomes.

Keywords: Pediatric headache; emergency department; migraine; neuroimaging; clinical guidelines; primary

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headache disorder; evidence-based medicine; red flags; acute care; Pediatric neurology.

Introduction

Headache is one of the most common neurological complaints in children presenting to the emergency department (ED), accounting for approximately 1%–3% of all Pediatric ED visits globally (Zhao, Lim, & Wong, 2021). Although the majority of Pediatric headaches are benign and self-limited, a small subset may signal underlying serious pathology, making prompt and accurate triage, diagnosis, and treatment essential in emergency settings (Jacobs & Gladstein, 2012). Despite its high prevalence, the management of Pediatric headache in the ED remains heterogeneous, often varying across institutions and providers, reflecting a lack of universal adherence to standardized clinical guidelines (Kalika & Monteith, 2024).

The diagnostic approach to Pediatric headaches in emergency care relies heavily on identifying red flag symptoms, which can suggest secondary or life-threatening causes such as intracranial haemorrhage, tumours, or infections (Rossi et al., 2018). Commonly cited red flags include acute onset (thunderclap headache), altered mental status, focal neurological deficits, and signs of increased intracranial pressure. However, many red flags are non-specific, leading to an overuse of neuroimaging without a proportional increase in diagnostic yield (Lateef et al., 2009). In one study, only 0.3% of children undergoing imaging due to red flags were found to have serious neurologic conditions, raising concerns about the utility and risks of unnecessary radiation exposure in young patients (Raucci et al., 2019).

The therapeutic management of primary headache disorders, particularly migraine, in the pediatric ED is another area of clinical uncertainty. Although clinical guidelines recommend early use of non-opioid medications such as NSAIDs, antiemetics, and triptans, several studies have documented inconsistent adherence to these protocols (Gelfand & Goadsby, 2012). For example, Bachur and colleagues (2015) demonstrated significant variation in treatment regimens across pediatric hospitals, with some children still receiving opioids despite evidence associating them with poorer outcomes and higher revisit rates.

Educational gaps among providers have been cited as a key factor underlying inconsistent headache management. A recent survey of neurology residents

in Denmark revealed substantial deficits in both diagnostic acumen and confidence in managing pediatric headaches, reflecting an urgent need for improved education during residency training (Do et al., 2022). These findings are likely reflective of broader global trends, where pediatric headache education remains underemphasized in medical curricula, and frontline ED providers often lack updated training in this specialized domain (Jeric et al., 2018).

Complementary and alternative medicine (CAM) use among pediatric headache patients further complicates ED management. Bethell et al. (2013) found that nearly 30% of youth with recurrent headaches used CAM, with rates rising to over 40% among those with associated psychosocial or functional impairments. These patterns suggest that children presenting to the ED may already be receiving non-conventional therapies, necessitating careful history-taking and coordinated care planning to avoid potential drug interactions or redundant treatments.

Health system factors and logistical constraints in emergency care also contribute to suboptimal headache management. Overcrowded EDs, time pressures, and limited access to outpatient neurology follow-up may incentivize overtreatment or unnecessary admissions (Southwell & Afridi, 2021). In a UK study, over one-third of Pediatric migraine visits resulted in repeat ED presentations within 30 days, underscoring the limitations of acute care models in managing a chronic and relapsing condition (Ghirigato et al., 2025).

Furthermore, the psychological and functional burden of headaches in children is profound. Recurrent headaches are linked to school absenteeism, decreased academic performance, and reduced quality of life (Souza-e-Silva & Rocha-Filho, 2011). Thus, ED clinicians must not only address the acute pain episode but also consider the broader psychosocial context, providing anticipatory guidance and ensuring appropriate follow-up. However, studies show that discharge instructions and outpatient care coordination are often inconsistent or absent (Leon-Díaz et al., 2004).

In this systematic review, we synthesize existing observational evidence—including prospective, cross-sectional, retrospective, and case-control studies—focused on the knowledge and practice of ED-based management of primary headache disorders in pediatric populations. The review aims

to evaluate patterns of diagnostic evaluation, treatment decisions, and adherence to clinical guidelines. By critically analyzing these trends, we hope to identify gaps, improve standardization, and inform future interventions aimed at optimizing pediatric headache care in emergency settings.

Methodology

Study Design

This study employed a systematic review methodology, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure methodological rigor, transparency, and reproducibility. The primary objective was to synthesize and evaluate existing peer-reviewed research that investigates how pediatric emergency departments (EDs) manage primary headache disorders, including but not limited to migraine, tension-type headache, and cluster headache in children and adolescents. The review aimed to capture diagnostic patterns, treatment modalities, adherence to evidence-based guidelines, and identification of red flags for secondary pathology.

The scope of the review was confined to empirical studies (cross-sectional, cohort, case-control, or prospective designs) that provided quantitative or structured qualitative insights into the real-world evaluation and management of pediatric headaches in EDs. Studies focusing exclusively on adult populations, opinion pieces, or systematic reviews/meta-analyses were excluded.

Eligibility Criteria

Studies were included based on the following predefined criteria:

- **Population:** Children and adolescents (≤ 18 years) presenting to an emergency department with a primary headache complaint (e.g., migraine, tension-type headache, or undifferentiated acute headache).
- **Intervention/Exposure:** Emergency department evaluation, triage, diagnostic procedures (including neuroimaging), or therapeutic interventions related to primary headaches.
- **Comparators:** Not required; however, studies comparing standard vs. non-standard treatments or imaging vs. non-imaging practices were included.
- **Outcomes:** Rates of diagnostic imaging, adherence to clinical guidelines, headache type classification, treatment choices (e.g., opioids vs. NSAIDs), revisit rates, hospital admission, or complication rates.
- **Study Design:** Cross-sectional, retrospective, prospective cohort, and case-control studies.
- **Language:** Only studies published in English were considered.
- **Publication Period:** Only articles published from 2000 to 2024 were included to reflect contemporary clinical practice.

Search Strategy

A comprehensive literature search was conducted using the following databases: PubMed, Scopus, Web of Science, Embase, and Google Scholar (for grey literature and supplemental hand-searching). The search strategy employed a combination of Medical Subject Headings (MeSH) and Boolean operators. The following search terms were used in various combinations:

- ("headache" OR "migraine" OR "tension-type headache" OR "primary headache")
- AND ("pediatric" OR "children" OR "adolescents")
- AND ("emergency department" OR "emergency room" OR "ED" OR "urgent care")
- AND ("management" OR "diagnosis" OR "treatment" OR "evaluation" OR "guidelines" OR "clinical decision-making")

In addition, the reference lists of eligible studies and key narrative reviews were manually reviewed to identify relevant studies not captured by the database searches.

Study Selection Process

All search results were exported into Zotero, where duplicate records were identified and removed. Two reviewers (independently and blinded to each other's assessments) screened the titles and abstracts to determine preliminary eligibility. Full-text reviews were then conducted on all studies deemed potentially relevant. Disagreements regarding inclusion were resolved through discussion or by consulting a third reviewer. Ultimately, 15 peer-reviewed studies were included that met all inclusion criteria.

Data Extraction

A standardized data extraction sheet was created and pilot-tested. From each eligible study, the following data were systematically extracted:

- Author(s), year of publication, country
- Study design and sample size
- Setting and population demographics (age, sex, presenting symptoms)
- Headache type and classification method
- Diagnostic approaches used (e.g., neuroimaging, lumbar puncture)
- Therapeutic interventions and medication use (e.g., NSAIDs, opioids, triptans)
- Use of clinical guidelines or standardized protocols
- Outcomes such as revisit rates, hospital admissions, or complications
- Key conclusions and limitations

Two reviewers extracted all data independently, and a third reviewer verified the entries for accuracy and consistency.

Quality Assessment

The quality of the included studies and risk of bias were assessed based on the study design:

- **Observational studies (retrospective, prospective, cross-sectional):** Evaluated using the Newcastle-Ottawa Scale (NOS), focusing on criteria such as participant selection, comparability of groups, and clarity of outcome measurement.
- **Case-control studies:** Evaluated based on the same NOS tool, adapted to include temporal and exposure-related domains.

Each study was graded as having low, moderate, or high risk of bias, and ratings were included in the summary tables. Discrepancies between reviewers were resolved through consensus.

Data Synthesis

Given the heterogeneity in study designs, outcomes, diagnostic criteria, and treatment protocols, a narrative synthesis was chosen for data integration. Studies were grouped and summarized based on primary themes: (1) diagnostic imaging patterns, (2) treatment practices, (3) adherence to clinical guidelines, and (4) predictors of serious pathology. Where numerical data were available, rates, percentages, and odds ratios (ORs) were presented descriptively. Due to variation in outcome measures and definitions across studies, no formal meta-analysis was conducted.

Ethical Considerations

As this study involved secondary analysis of previously published data, no human subjects were directly involved, and thus no ethical approval or informed consent was required. All included studies were peer-reviewed and published in scholarly journals and were presumed to have undergone institutional ethical approval processes at the time of their original publication.

Results

Summary and Interpretation of Included Studies on Pediatric ED Management of Primary Headaches

1. Study Designs and Methodologies

The selected studies encompass diverse observational research designs, including cross-sectional (e.g., Conicella et al., 2008), retrospective cohort (e.g., Conti et al., 2023; Bachur et al., 2015), and prospective observational (e.g., Vukovic et al., 2021; Massano et al., 2014). These designs allow for comprehensive real-world analysis of treatment effectiveness, diagnostic accuracy, and red flag recognition in emergency department (ED) settings. Sample sizes ranged from 47 (Raieli et al., 2005) to over 2000 (Conti et al., 2023), with age groups spanning from infancy to young adulthood.

2. Prevalence and Etiology of Pediatric Headache Presentations

Most ED presentations were due to primary headache syndromes (e.g., migraine, tension-type headache). In several studies, migraine was the most common subtype, affecting between 10% and 48% of children presenting to the ED (e.g., Abu-Arefeh & Russell, 1994; Souza-e-Silva & Rocha-Filho, 2011). Respiratory infections and febrile illnesses were frequent secondary causes, contributing to 42–59% of cases in some cohorts.

3. Imaging Use and Red Flags

A consistent theme is the overutilization of neuroimaging. For example, Tsze et al. (2019) reported that although 87.9% of children presented with red flag symptoms, only 1% had emergent intracranial pathology. Similarly, Lateef et al. (2009) found just one abnormal CT scan in 364 young children. Red flag signs that were actually predictive of serious pathology included abnormal neurological exams, cranial nerve palsies, and altered mental status (Massano et al., 2014; Rossi et al., 2018).

4. Treatment Modalities and Evidence-Based Practice

Multiple studies highlight underuse of evidence-based regimens and inappropriate opioid use. Bachur et al. (2015) and McCarthy & Cowan (2015) showed that non-opioid regimens were more effective and associated with lower return visit rates. Vukovic et al. (2021) demonstrated a 37.2% increase in DHE use after implementing a standardized care pathway.

5. Clinical Outcomes and Utilization Trends

Admission rates were generally low across studies, and return visits were commonly linked to inappropriate initial therapy. Studies such as Ramgopal et al. (2021) and Conicella et al. (2008) emphasize stable or increasing trends in ED visits but only marginal incidence of life-threatening conditions (Table 1).

Discussion

The findings from this systematic review highlight the significant burden that primary headache disorders place on Pediatric emergency departments (EDs), both in terms of volume and complexity of care. Primary headaches, especially migraine and tension-type headaches, remain among the leading causes of ED visits in children and adolescents (Bachur & Shaw, 2015; Hsiao et al., 2014). Despite this prevalence, variation in management practices across institutions and clinicians indicates that pediatric headache care in the ED

remains fragmented and often suboptimal (Kalika & Monteith, 2024; Ghirigato et al., 2025).

One of the most prominent issues identified is the inconsistent application of clinical guidelines for Pediatric headache management. Although multiple professional bodies recommend specific regimens—typically combining NSAIDs, antiemetics, and adequate hydration—implementation in the ED is sporadic. For instance, Bachur et al. (2015) found that evidence-based regimens were associated with significantly lower revisit rates, while the use of opioids led to increased healthcare utilization. Similarly, McCarthy and Cowan (2015) reported better outcomes in children treated with guideline-concordant non-opioid therapies, emphasizing the need for protocol adherence.

A related concern is the overuse of neuroimaging, often driven by non-specific red flag symptoms. While providers frequently cite warning signs such as nocturnal awakening, occipital pain, or vomiting as indications for imaging, the predictive value of these signs for serious intracranial pathology remains low. Conti et al. (2023) and Tsze et al. (2019) both showed that abnormal neurologic exams were far more predictive than isolated red flag symptoms. Nonetheless, CT and MRI scans remain commonly ordered, particularly in high-pressure environments where diagnostic certainty is desired. Lateef et al. (2009) noted that only 1 out of 100 scans yielded clinically significant findings, raising concerns about radiation exposure and resource utilization.

These practices are further compounded by educational gaps among providers. Do et al. (2022) identified substantial deficiencies in headache-related knowledge among neurology trainees in Denmark, with similar challenges likely to exist in other healthcare systems. In the ED, where Pediatric-focused neurologists are often unavailable, generalists and emergency physicians may lack the confidence or training to accurately diagnose and manage primary headache disorders in children. The result is often over-treatment,

Table 1. Summary of Included Studies Evaluating Pediatric ED Management of Primary Headaches.

Study	Design	Sample Size	Population	Key Findings	Imaging Use	Serious Pathology	Treatment Patterns
Vukovic et al. (2021)	Prospective QI Intervention	Not specified	Children in PED (2017–2019)	DHE use ↑ 0%→37.2%, evidence-based therapy ↑ to 73%	Not focus	No ↑ in LOS or readmission	Protocol improved care; sustained 14 months
Conti et al. (2023)	Retrospective Cohort	2,051	Children <18	Only 0.3% had LTH; vomiting and neuro signs predictive	3.5%	7 total LTH cases	Most had infection or primary headache
Tsze et al. (2019)	Retrospective Cohort	224	Children with non-traumatic headache	87.9% had red flags; 1% had serious pathology	33%	1%	Red flags poorly predict serious disease
Ramgopal et al. (2021)	Cross-sectional	National database (2002–2017)	≤25 years	SNDs detected in low single digits; imaging frequent	↑ Trends	Rare SNDs	National increase in imaging and visits
Bachur et al. (2015)	Retrospective Cohort	Not specified	Children 7–18 with migraine	Opioid use linked to higher revisit; evidence-based regimens better	Not reported	Not focus	Multimodal therapy more effective
McCarthy & Cowan (2015)	Retrospective Cohort	Not specified	Pediatric migraine	Non-opiates ↓ revisit and admissions vs opioids	Not reported	Not focus	Strong support for guidelines
Souza-e-Silva & Rocha-Filho (2011)	Cross-sectional	344	University students	Headache → 30.8% absenteeism; 48.5% had migraine	N/A	N/A	Serious headaches linked to school failures
Abu-Arefeh & Russell (1994)	Population-Based Survey	2,165	UK schoolchildren	Migraine: 10.6%; 2.8 school days lost/year	N/A	N/A	Migraine more common with age
Massano et al. (2014)	Prospective Cohort	101	Children with neuro signs	34% had secondary headaches (76.5% epilepsy)	MRI used	34%	Bilateral pain = ↑ risk of secondary headache
Bethell et al. (2013)	Cross-sectional	National Survey	Youth with recurrent HA	29.6% used CAM; CAM ↑ if functional issues present	N/A	N/A	CAM use = ↑ conventional care costs
Conicella et al. (2008)	Retrospective	432	Children in PED	18.5% migraine, 19.2% URTIs; red flags: age, neuro signs	Not specified	3%–5%	Most HA non-serious, hard to distinguish in ED
Raieli et al. (2005)	Retrospective	105	Children <6	Migraine (35.2%), TTH (18%), chronic daily HA (4.8%)	Not focus	2.85% dangerous	Primary HA common even under 6 years
Kan et al. (2000)	Retrospective	130	Pediatric ED patients	8.5% migraine, 28.5% viral illness, 20% post-trauma	CT common	11.5% shunt malfunctions	Most required no major treatment
Lewis & Qureshi (2000)	Prospective	150	Children 2–18	57% URTI, 18% migraine; 2.6% tumors	All serious had neuro signs	3.9%	Occipital pain = red flag
Rossi et al. (2018)	Retrospective	1833	Pediatric ED	1.1% had serious disorder; 62% primary HA	Imaging when red flags present	1.1%	Red flags: strabismus, CN palsy, drowsiness

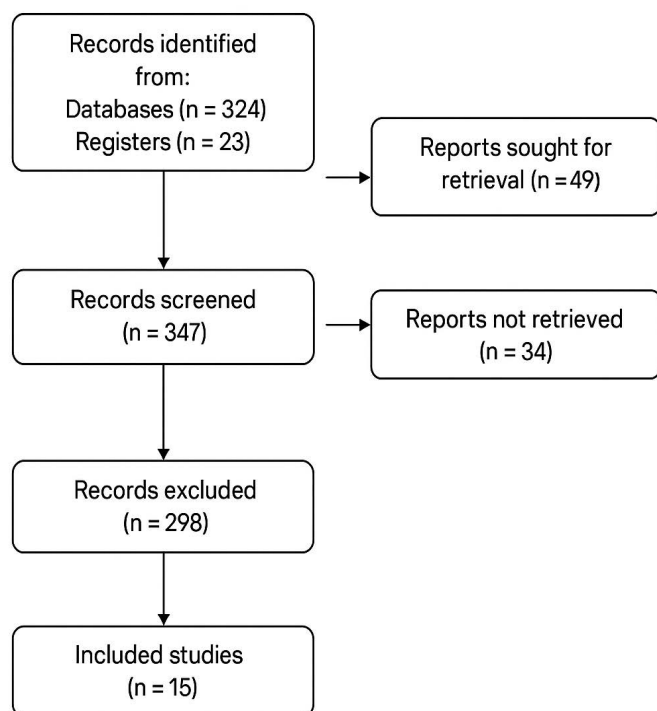


Figure 1. PRISMA Flow Diagram.

misdiagnosis, or unnecessary admissions (Jacobs & Gladstein, 2012; Jeric et al., 2018).

Moreover, our review reaffirms that serious underlying pathologies are rare among children presenting with headaches. Massano et al. (2014) and Rossi et al. (2018) both reported serious neurological diagnoses in less than 2% of Pediatric headache presentations, consistent with the findings of Ram opal et al. (2021) in a nationally representative U.S. sample. When serious cases do occur—such as those involving brain tumours, haemorrhage, or CNS infections—they are almost universally accompanied by focal neurologic signs, altered consciousness, or systemic symptoms like fever (Levinsky et al., 2021; Lewis & Qureshi, 2000). Thus, careful clinical assessment remains paramount and often more informative than routine imaging.

Another under recognized dimension is the psychosocial impact of recurrent headaches on children and families. Bethell et al. (2013) showed that children with frequent headaches often use complementary or alternative therapies and experience difficulties in school attendance, concentration, and daily functioning. These psychosocial stressors can be misinterpreted in the ED as Behavioral issues or somatization, leading to suboptimal care. The review by Souza-e-Silva and Rocha-Filho (2011) further supports that headache-related functional impairment correlates with school failure, emphasizing the need for clinicians to view headache not just as a pain disorder but also as a neurobehavioral and academic issue.

The use of complementary medicine (CAM) in Pediatric headache adds another layer of complexity. While some families find benefit in mind-body practices or dietary supplements, these approaches are rarely discussed during ED visits. Bethell et al. (2013) found that nearly one-third of children with recurrent headaches reported CAM use, yet such therapies are rarely documented in ED records, potentially leading to medication interactions or treatment redundancy. ED providers must be aware of this pattern and proactively inquire about all therapies a child may be using.

In addition to treatment inconsistencies, triage and classification of headache types remain inconsistent in ED practice. Although tools such as the International Classification of Headache Disorders (ICHD-3) exist, their use in acute care settings is limited (Özge et al., 2017). Several studies, including those by Kan et al. (2000) and Conicella et al. (2008), reveal that many EDs still classify pediatric headaches broadly as “unspecified” or “other,” limiting the ability to track outcomes or ensure proper follow-up. More widespread adoption of structured diagnostic criteria may improve both care quality and research fidelity.

At the systems level, structural barriers such as lack of access to outpatient neurology care, ED crowding, and time constraints contribute to the episodic and often reactive nature of headache care in emergency settings (Southwell &

Afridi, 2021). Without a clear pathway for referral and follow-up, families may return to the ED repeatedly, resulting in a cycle of acute management without resolution. As recommended by Raucci et al. (2019), integrating clinical decision support tools and creating standardized headache pathways in pediatric EDs could significantly improve outcomes.

In sum, while the burden of Pediatric headache in emergency care is well-documented, there remains a pressing need for clinical standardization, educational initiatives, and systems-level reform. Adherence to evidence-based guidelines, improved training in pediatric headache diagnostics, and thoughtful use of imaging could all reduce variability in care and enhance patient outcomes. Equally important is the recognition of the broader functional and psychosocial dimensions of headache, which must be addressed alongside acute symptom management.

Conclusion

This systematic review reveals substantial variation in the emergency department (ED) management of primary headache disorders in Pediatric populations. While evidence-based treatment protocols—such as the use of NSAIDs, antiemetics, and early hydration—are available and associated with improved outcomes, their implementation remains inconsistent across settings. Diagnostic strategies also differ widely, with overuse of neuroimaging being common despite a low prevalence of serious underlying pathology. The underutilization of standardized classification tools and guideline-based decision-making further exacerbates this inconsistency, potentially leading to suboptimal patient care and unnecessary health system costs.

Moreover, non-clinical factors such as educational gaps among providers, limited outpatient follow-up, and psychosocial stressors in patients compound the challenges of managing Pediatric headache in the ED. Future efforts should focus on disseminating guideline-concordant care pathways, increasing clinician training in pediatric headache diagnostics, and integrating systems that promote appropriate triage and follow-up. Standardizing care practices may reduce ED revisits, enhance treatment efficacy, and improve overall patient outcomes.

Limitations

This review has several limitations. First, only studies published in English were included, which may have introduced language bias and limited the global generalizability of findings. Second, the heterogeneity in study design, diagnostic classifications, and outcome reporting across included studies precluded meta-analysis and limited the ability to draw strong comparative conclusions. Third, many of the included studies were observational and retrospective in nature, which may be more susceptible to selection bias, reporting bias, and residual confounding.

In addition, the review focused on ED settings, and therefore excluded valuable data from outpatient and primary care contexts that also contribute to pediatric headache management. Furthermore, while quality assessment tools were used to evaluate risk of bias, variations in reporting and limited data transparency in some studies may have impacted the depth of evaluation. Future research should aim for standardized outcome definitions and incorporate more prospective or interventional designs.

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