

# Non-Invasive Modalities in the Management of Kidney Stones in Children: A Systematic Review

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**Keyword:**

Pediatric,  
urolithiasis,  
kidney stones,  
extracorporeal shock  
wave lithotripsy,  
ESWL

**Abstract**

**Background:** The incidence of pediatric nephrolithiasis is increasing worldwide. The disease is predominantly associated with metabolic etiologies and carries a high risk of recurrence. Non-invasive approaches are therefore prioritized to ensure long-term safety and preservation of renal function. The aim of the study was to evaluate the effectiveness and safety of non-invasive modalities in the management of pediatric kidney stones.

**Methods:** A systematic literature search was conducted in PubMed, Scopus, Web of Science, and Cochrane Library for studies published between January 2015-December 2025. PRISMA 2020 guideline was followed. Studies involving patients <18 years with kidney stones managed using non-invasive approaches, including observation, conservative therapy, pharmacotherapy, and extracorporeal shock wave lithotripsy (ESWL), were included. Data were extracted and analyzed narratively.

**Results:** Eight studies were included. Ultrasonography was recommended as the first-line diagnostic modality. Active surveillance and adequate hydration were effective for small stones (<4–5 mm), with high rates of spontaneous resolution. Pharmacotherapy, including potassium citrate and thiazides, were effective for selected metabolic abnormalities and reduced recurrence. ESWL achieved high stone-free rates with up to approximately 86% after multiple sessions, associated with generally mild and transient complications. Treatment success was influenced by stone size and location, patient age, and metabolic factors.

**Conclusion:** Non-invasive modalities are effective and safe as first-line management for pediatric urolithiasis. Individualized management based on comprehensive clinical and metabolic evaluation is essential to optimize outcomes and prevent recurrence.

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## INTRODUCTION

**K**idney stones or urolithiasis is not solely affecting adults, their incidence increases over the past few decades in pediatric. Pediatric urolithiasis is the formation of calculi in the kidneys or urinary tract as a result of precipitation and crystallization of solutes in the urine. It was more common associated with metabolic abnormalities compared to infection in pediatric population.<sup>1</sup> Global Burden of Disease (GBD) 2021 reported approximately 106 million new cases of urolithiasis globally in 2021.<sup>2,3</sup> The prevalence of this condition varies across regions, ranging from 1–5% in Asia to 13–15% in North America.<sup>3,4</sup> Although kidney stones in children are relatively uncommon, accounting for approximately 2–3% of all cases, the trend showed a consistent increase.<sup>5</sup>

In Indonesia, the burden of urolithiasis is also substantial. The GBD 2021 estimated approximately 3.19 million new cases in 2021, with an age-standardized incidence rate of around 1,890 per 100,000 population. A local data from study conducted in Aceh revealed that the prevalence of pediatric with kidney stones increased significantly from 1.2% in 2013 to 4.5% in early 2016.<sup>6,7</sup> These global and local findings underscored the importance of early and comprehensive management of kidney stones in the pediatric population.

Clinical manifestations of kidney stones in children are often non-specific, necessitating a higher degree of clinical suspicion. Infants and toddlers may present with nonspecific symptoms such as excessive crying, irritability, or vomiting without an obvious cause. Older children may experience renal colic, hematuria (microscopic or macroscopic), or recurrent urinary tract infections. Consequently, non-invasive imaging modalities are strongly recommended for diagnosis. Abdominal ultrasonography (kidney–ureter–bladder ultrasound) is the primary imaging modality in children because it does not involve ionizing radiation and generally does not require anesthesia. As a first-line investigation, ultrasonography should evaluate both kidneys, a distended urinary bladder, and adjacent segments of the ureters. Low-dose plain

abdominal radiography (KUB) or non-contrast computed tomography (CT) may be considered when ultrasonography provides insufficient diagnostic information.<sup>4</sup>

The management of kidney stones in children is determined by stone size, stone location, and the clinical condition of the patients. In the pediatric population, non-invasive approaches are preferred as they aim to reduce the risk of complications and preserve long-term renal function. These approaches generally include conservative management and extracorporeal shock wave lithotripsy (ESWL).<sup>8</sup> Conservative therapy consists of adequate hydration, dietary modifications such as oxalate restriction, and regular follow-up, particularly for small stones. Active observation is recommended for asymptomatic children with small stones, especially in the absence of urinary tract anatomical abnormalities. In addition, pharmacological therapy in the form of medical expulsive therapy, including the use of alpha-blockers, has been reported to facilitate the passage of small ureteral stones and improve stone-free rates, particularly for distal ureteral stones.<sup>4,9</sup>

ESWL is a widely used non-invasive modality and is often considered a first-line option for small to moderate-sized renal and ureteral stones in children. This technique fragments stones into smaller pieces without the need for surgical intervention. Numerous studies have demonstrated favorable outcomes of ESWL in the pediatric population, with high stone-free rates, particularly for smaller stones. Although some patients may require additional sessions or subsequent interventions due to residual stone fragments, ESWL is generally regarded as safe and associated with a low rate of complications.<sup>10,11</sup>

Invasive approaches such as ureteroscopy and percutaneous nephrolithotomy are not addressed in this review, as they fall outside the scope of non-invasive modalities. Given the increasing use of conservative therapy and ESWL in pediatric patients, a comprehensive evaluation of their effectiveness and safety is warranted. Therefore, this systematic review aims to synthesize the available scientific evidence regarding the effectiveness and safety of

non-invasive modalities in the management of kidney stones in children. The primary focus of this review was to assess the role of non-invasive approaches in both diagnostic and therapeutic aspects of pediatric urolithiasis, as well as to identify factors influencing the success of these interventions.

The research question of this systematic review was formulated using the PICO framework, encompassing pediatric patients with kidney stones, non-invasive management modalities, and comparisons between different non-invasive approaches or standard observation. Clinical outcomes of interest include stone-free rates, symptom improvement, complication rates, and the need for additional interventions. Through this approach, the systematic review is expected to provide a robust scientific basis to support clinical decision-making in the non-invasive management of pediatric kidney stones.

## METHODS

A systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to evaluate non-invasive modalities in the management of pediatric kidney stones. A systematic literature search was performed across the PubMed, Scopus, Web of Science, and Cochrane Library databases for articles published between January 2015 and December 2025. The search strategy employed a combination of relevant keywords and Boolean operators encompassing terms related to the pediatric population, kidney stones, and non-invasive diagnostic and therapeutic approaches.

Eligible studies included children and adolescents aged <18 years diagnosed with kidney stones who underwent non-invasive modalities such as ultrasonography, conservative management, pharmacotherapy, or ESWL. Randomized controlled trials, cohort studies, case-control studies, and systematic reviews were included in this study. Only studies published in English or Indonesian with full-text availability were included. Studies involving adult populations, single case reports, small case series, editorials, and investigations focusing on

invasive procedures were excluded. Study selection was conducted through title and abstract screening followed by full-text assessment by two independent reviewers. Any disagreements were resolved through discussion.

Data extraction was performed systematically and included study characteristics, patient demographics, types of non-invasive modalities, primary clinical outcomes (stone-free rates, symptom resolution, and need for additional interventions), as well as reported adverse events or complications. Methodological quality and risk of bias were assessed according to study design using the Cochrane Risk of Bias 2 tool for randomized controlled trials, the Newcastle–Ottawa Scale for observational studies, and AMSTAR 2 for systematic reviews.

Data were analyzed using narrative synthesis with grouping based on the type of non-invasive modality. Meta-analysis was performed when data were sufficiently homogeneous and adequate. In addition, subgroup analyses based on patient age, stone size, and stone location were conducted to evaluate variations in the effectiveness and safety of the interventions.

RESULTS

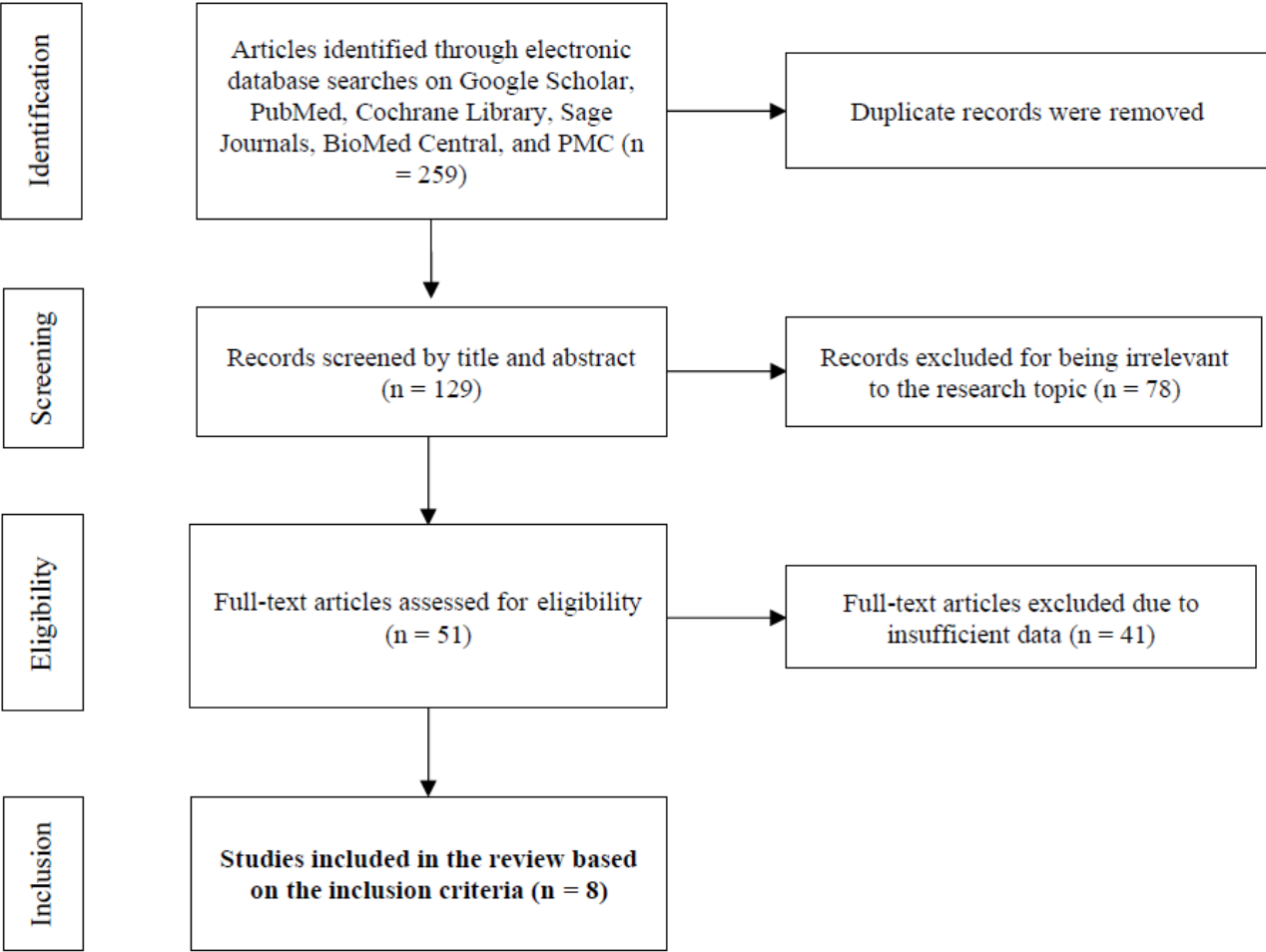


Figure 1. PRISMA flow diagram for study selection

**Table 1. Summary of Included Studies**

| No. | Author(s)<br>(Year)            | Country          | Study Design                                                                                | Sample<br>Size (n)                | Age<br>(range)                                             | Age<br>(years)  | Location<br>of Stone                                           | Non-Invasive<br>/ Conservative<br>Modalities                                                                                                                                                                       | Main Clinical<br>Outcomes                                                                                                                                                                                                                        | Complications/<br>Adverse<br>Outcomes                                                                                            | Follow-up<br>Period                                                                                                          |
|-----|--------------------------------|------------------|---------------------------------------------------------------------------------------------|-----------------------------------|------------------------------------------------------------|-----------------|----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| 1   | Salevitz et<br>al. (2023)      | United<br>States | Retrospective<br>comparative<br>study (pre-post<br>implementation<br>of the ED<br>protocol) | 259 (Pre;<br>139; Post:<br>120)   | Children<br>and<br>adolescents<br>(pediatric<br>age group) | 14 years<br>old | Ureteral<br>stones<br>(predom-<br>inantly<br>distal<br>ureter) | Observa-<br>tion, MET,<br>analgesics,<br>CT reduction;<br>selective<br>ESWL                                                                                                                                        | Increased rates<br>of spontaneous<br>stone passage<br>and MET use,<br>accompanied<br>by reduced use<br>of CT scans,<br>decreased need<br>for surgical<br>intervention, and<br>lower opioid<br>prescribing                                        | Not reported                                                                                                                     | Follow-up<br>continued<br>until<br>urology/<br>nephrology<br>outpatient<br>care<br>(specific<br>duration<br>not<br>reported) |
| 2   | Smeulders,<br>et al.<br>(2022) | England          | Narrative<br>review                                                                         | Not<br>reported                   | Children–<br>adolescents                                   | Not<br>reported | Kidney,<br>ureter,<br>bladder                                  | Ultrasonogra-<br>phy, low-dose<br>non-contrast<br>CT, MRI,<br>DMSA<br>scintigraphy,<br>ESWL, and<br>conserva-<br>tive therapy<br>(hydration,<br>urinary<br>alkalinization,<br>and medical<br>expulsive<br>therapy) | Ultrasound is<br>the first-line<br>diagnostic<br>modality; ESWL<br>is effective<br>and safe as the<br>primary non-<br>invasive therapy<br>for pediatric<br>kidney stones;<br>multidisciplinary<br>approaches<br>reduce the risk of<br>recurrence | ESWL side<br>effects are<br>generally mild<br>(hematuria,<br>pain); serious<br>complications<br>are rare (hema-<br>toma, sepsis) | Not<br>reported                                                                                                              |
| 3   | Lu et al.<br>(2015)            | China            | Systematic<br>review & meta-<br>analysis                                                    | 14 studies<br>(1,842<br>patients) | Children                                                   | Not<br>reported | Kidney<br>& ureter                                             | ESWL                                                                                                                                                                                                               | Higher stone-<br>free rates were<br>observed in<br>stones measuring<br><10 mm and in<br>stones located<br>in the proximal<br>ureter.                                                                                                             | Steinstrasse and<br>mild abdominal<br>colic                                                                                      | Variable                                                                                                                     |

| No. | Author(s)<br>(Year)     | Country           | Study Design                 | Sample<br>Size (n)                      | Age<br>(range)       | Age<br>(years)  | Location<br>of Stone           | Non-Invasive<br>/ Conservative<br>Modalities                                                       | Main Clinical<br>Outcomes                                                                       | Complications/<br>Adverse<br>Outcomes       | Follow-up<br>Period    |
|-----|-------------------------|-------------------|------------------------------|-----------------------------------------|----------------------|-----------------|--------------------------------|----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------|------------------------|
| 4   | Öncel et al.<br>(2022)  | Türkiye           | Cohort<br>retrospective      | 433<br>patients                         | 1–16<br>years<br>old | 12 years<br>old | Kidney &<br>proximal<br>ureter | ESWL                                                                                               | High stone-<br>free rates<br>were achieved<br>following<br>one or more<br>treatment<br>sessions | Mild hematuria<br>and transient<br>colic    | 1 months               |
| 5   | Sarıca et al.<br>(2016) | Türkiye           | Comparative<br>retrospective | 189<br>patients                         | Children             | Not<br>reported | Kidney                         | ESWL (low-<br>energy protocol)                                                                     | High<br>effectiveness<br>with good<br>safety                                                    | Minor and<br>transient<br>complications     | 3–6 months             |
| 6   | Tekgöl et<br>al. (2015) | Multina-<br>tions | Guideline-based<br>review    | N/A                                     | Children             | Not<br>reported | Kidney &<br>ureter             | Observation,<br>dietary<br>management,<br>pharmacotherapy,<br>and ESWL                             | Non-invasive<br>approaches are<br>the first-line<br>option for<br>small stones                  | Not reported                                | N/A                    |
| 7   | Hodhod et<br>al. (2021) | Saudi<br>Arabia   | Cohort<br>retrospective      | 106<br>patients                         | Children             | Not<br>reported | Kidney                         | Active<br>surveillance                                                                             | Stone stability<br>or spontaneous<br>resolution in<br>most patients                             | Urinary tract<br>infection and<br>mild pain | 24 months              |
| 8   | Teoh et al.<br>(2023)   | Multina-<br>tions | Systematic<br>review         | Children<br>with<br>hypocitra-<br>turia | Children             | Not<br>reported | Kidney                         | Dietary<br>intervention<br>(potassium citrate<br>supplementation<br>and increased<br>fluid intake) | Prevention<br>of stone<br>recurrence                                                            | No serious<br>adverse effects               | Long-term<br>follow-up |

CT, Computed tomography; DMSA, Dimercaptosuccinic Acid; ESWL, Extracorporeal shock wave lithotripsy; MET, Medical expulsive therapy; MRI, Magnetic resonance imaging

## DISCUSSION

Urinary tract stone disease in children is relatively uncommon compared to adults. However, the incidence has been reported to be increasing and it exhibited different clinical characteristics, etiology, and management. In children, urinary tract stones are more frequently associated with metabolic factors, anatomical abnormalities, or genetic disorders rather than lifestyle-related factors commonly seen in adults. Moreover, the condition carries a high risk of recurrence, reaching up to 50% within three years.<sup>11,12</sup>

Diagnostic modalities for pediatric urolithiasis prioritize non-invasive methods with minimal radiation exposure. Ultrasonography (USG) is the first-line examination because it is safe, widely accessible, and capable of detecting renal stones with a sensitivity of approximately 80%. In addition, USG can assess obstruction and anatomical abnormalities of the urinary tract. The use of color Doppler with identification of the twinkle artifact can improve the accuracy of stone detection.<sup>12,14</sup>

If USG results are inconclusive, non-contrast CT with a pediatric low-dose protocol may be used as a follow-up examination. CT provided high accuracy and allows assessment of stone density to estimate composition and predict response to therapy. Meanwhile, magnetic resonance imaging (MRI) is rarely used due to its low sensitivity for detecting stones. However, MRI is beneficial for evaluating hydronephrosis and anatomical abnormalities without radiation exposure. In addition, nuclear medicine imaging, particularly DMSA scanning, plays a role in assessing renal function in cases of complex stones or abnormal renal anatomy.<sup>13,14</sup>

### Comparison of Modalities

#### Observation

Observation is the primary non-invasive modality in pediatric urolithiasis due to the high potential for spontaneous stone passage, particularly in patients with specific clinical characteristics. This approach is recommended for children who are hemodynamically stable, without signs of severe urinary tract infection, sepsis, or impaired renal function, and who do

not exhibit threatening obstruction. Furthermore, observation is most appropriate for small to medium-sized stones, especially those with a diameter of <5 mm and located in the distal ureter, which naturally have a higher likelihood of passing spontaneously. Other characteristics that support observation include pain that can be controlled with non-opioid analgesics, good tolerance of oral intake, and the absence of persistent vomiting or severe dehydration. In these patients, observation is conducted in a structured manner with regular clinical monitoring, family education regarding warning signs, and a clear outpatient follow-up plan. This management is often combined with adequate hydration and, when indicated, medical expulsive therapy to increase the success of stone passage.<sup>12</sup>

Implementation of urolithiasis protocols in emergency departments strengthens appropriate patient selection for observation and reduces variations in clinical practice. With proper patient selection, observation has been shown to be safe and effective, contributing to reduced radiation exposure, opioid use, and the need for surgical intervention, without increasing complication rates. Therefore, standardized observation is an essential component of evidence-based conservative management of pediatric urolithiasis.<sup>15,16</sup>

#### Hydration and Diet

A study by Hodhod et al. showed that conservative management focusing on adequate hydration is a safe and effective approach in prepubertal children with small renal stones. The children population in the study were directed to maintain sufficient fluid intake and were monitored periodically with ultrasonography, without initial surgical intervention. Hydration plays a key role in reducing the concentration of stone-forming substances in the urine, thereby increasing the likelihood of stone reduction or spontaneous passage. During follow-up, approximately one-quarter of cases experienced stone resolution without intervention, particularly for small stones. Although specific dietary interventions were not described in detail, the dietary principles in conservative

management aim to support the effect of hydration by preventing increased urinary supersaturation. The best outcomes were observed in the infant group, which had higher rates of spontaneous resolution and fewer complications, possibly due to better control of fluid intake. Overall, these findings reinforced that optimization of hydration, as part of a conservative diet and lifestyle approach, can reduce symptoms, lower the risk of complications, and decrease the need for surgical intervention in children with small renal stones.<sup>17</sup>

### **Pharmacotherapy**

Pharmacological interventions for pediatric urinary tract stones are tailored to the type of underlying metabolic disorder causing stone formation. In idiopathic calcium stones with hypercalciuria, the initial therapy remains adequate hydration and dietary modification of low sodium, and protein and calcium intake according to recommendations. However, since dietary adherence in children is often challenging, pharmacotherapy is initiated when dietary measures fail, with potassium citrate as the first-line treatment. Potassium citrate has been shown to reduce stone recurrence, increase urinary pH and citrate levels, and improve bone mineral density. Thiazide diuretics may be added, especially in symptomatic patients or those with reduced bone density, as they reduce urinary calcium excretion. In hypocitraturia, potassium citrate is preferred over sodium-based preparations because sodium can increase urinary calcium excretion. Pediatric dosing is weight-adjusted with urinary pH monitoring to avoid exceeding 6.5, while also monitoring for gastrointestinal side effects.<sup>18,19</sup>

In hyperoxaluria, particularly the primary genetic form, therapy focuses on high fluid intake, use of citrate, thiazides, magnesium, and in selected cases, vitamin B6 (pyridoxine) to reduce oxalate production. Dietary oxalate restriction has a limited role in primary hyperoxaluria but is important in absorptive hyperoxaluria. Adjunctive approaches such as probiotics (e.g., *Oxalobacter formigenes*) remain promising but require further evidence. In uric acid stones, the main contributing factor is low urinary pH. Therefore, urinary alkalization with potassium

citrate is the cornerstone of therapy, accompanied by purine restriction and allopurinol if hyperuricosuria persists. Meanwhile, cystine stones require an intensive strategy including high and evenly distributed fluid intake throughout the day, urinary alkalization to a pH of around 7, and, if unsuccessful, the use of cystine-binding agents such as tiopronin or D-penicillamine with close monitoring of adverse effects. Overall, pharmacological therapy for pediatric nephrolithiasis is individualized and stepwise, aiming to reduce recurrence, prevent complications, and support growth and bone health.<sup>18,19</sup>

### **ESWL**

ESWL in children with urinary tract stones has been established as a safe and effective method in the pediatric population. A retrospective studies by Öncel et al. with 433 patients aged  $\leq 16$  years who underwent ESWL between 2010 and 2021, demonstrated that the success rate of ESWL significantly increased after repeated sessions, with stone-free rates reaching approximately 86% after multiple treatments. The most important factors influencing success and residual stones were stone size and stone location, with larger stones and stones located in the renal pelvis associated with a higher risk of residual fragments. In contrast, shock wave energy and the total number of shock waves were not significantly associated with residual stones. The larger the stone burden, the greater the need for additional ESWL sessions, JJ stent placement, and ureterorenoscopy (URS). Stones in the lower calyx and renal pelvis tend to be more difficult to clear compared with other locations, especially when the stone size is large. Nevertheless, major complications were not observed, and minor complications such as colicky pain or steinstrasse were manageable. The rate of post-ESWL JJ stent placement was approximately 14.5%, consistent with previous literature reports. No long-term adverse effects on renal function were observed.<sup>10</sup>

### **Determinants of Therapeutic Outcome**

The success of non-invasive modalities in the management of pediatric nephrolithiasis is influenced

by various clinical factors, stone characteristics, and the patient's metabolic status. Stone size is the most consistent determinant associated with outcomes of conservative therapy, with smaller stones showing higher rates of spontaneous resolution. A cohort study by Hodhod et al. reported that renal stones  $\leq 4$  mm have a greater likelihood of spontaneous resolution without surgical intervention, whereas stones  $\geq 4$  mm are significantly associated with symptomatic episodes and the need for subsequent operative procedures. This finding was reinforced by multivariate regression analysis, which identified stone size as the only independent factor associated with surgical intervention in prepubertal children.<sup>17</sup>

Age also plays an important role in the success of non-invasive management, particularly in infants and young children. Hodhod et al. found that patients diagnosed during infancy had higher stone-free rates compared with older children, along with a lower risk of complications during observation. These findings may be attributed to differences in stone composition, greater urinary tract elasticity, and enhanced renal adaptive capacity in younger patients. Additionally, most stones in children are detected incidentally and are asymptomatic, thus active observation with serial ultrasonography and adequate hydration can yield satisfactory clinical outcomes without increasing the risk of complications.<sup>11</sup>

Stone location also influences the success of non-invasive modalities, especially for fragmentation-based therapy such as ESWL. Stones located in the lower calyx are known to have lower clearance rates compared with other locations due to anatomical factors, as reported in various pediatric studies. Nevertheless, ESWL using low energy and pediatric-adjusted protocols has been shown to be safe and effective, with good stone-free rates and minimal complications such as mild hematuria and transient pain.<sup>20</sup>

Metabolic factors are a crucial aspect that often determines long-term success of non-invasive modalities. Hypocitraturia, as one of the main risk factors for stone formation in children, has been shown to contribute to stone recurrence if not adequately

addressed. A systematic review by Castellani et al. demonstrated that a combination of dietary therapy, increased fluid intake, and potassium citrate supplementation is effective in normalizing urinary citrate excretion, reducing stone size, and lowering recurrence rates without significant adverse effects. This approach is highly relevant as a first-line non-invasive modality in patients with asymptomatic stones and identified metabolic abnormalities.<sup>18,21</sup>

Comprehensive metabolic evaluation and preventive strategies also play an important role in improving the success of non-invasive management and reducing the need for invasive interventions later. Pecoraro et al. emphasized that early identification of metabolic risk factors, accompanied by long-term dietary and hydration education, can significantly reduce stone recurrence in the pediatric population. This preventive approach aligns with clinical guideline recommendations and narrative reviews stating that the success of non-invasive therapy depends not only on initial stone resolution but also on preventing recurrent stone formation.<sup>8</sup>

Overall, the success of non-invasive modalities in pediatric nephrolithiasis results from a complex interaction between stone size and location, patient age, symptomatic status, and underlying metabolic factors. An individualized approach based on clinical characteristics and comprehensive metabolic evaluation is key to optimizing conservative treatment outcomes and minimizing invasive interventions in the pediatric population.

## CONCLUSION

Non-invasive modalities constitute the primary approach in the management of pediatric nephrolithiasis and have been shown to be effective and safe in the majority of cases. Active observation, optimization of hydration and dietary measures, and pharmacotherapy tailored to underlying metabolic disorders provide favorable clinical outcomes, particularly in patients with small stones and those who are asymptomatic. ESWL represented an effective non-invasive option for small to moderate-sized renal

and ureteral stones, achieving high stone-free rates with minimal complications.

The success of non-invasive therapy is influenced by stone size and location, patient age, and underlying metabolic factors. Therefore, an individualized approach based on comprehensive clinical and metabolic evaluation is essential to optimize long-term outcomes and prevent recurrence. These findings support the use of non-invasive modalities as first-line management in pediatric urolithiasis.

## FUTURE RESEARCH DIRECTIONS

Future research should focus on prospective, controlled clinical trials with standardized study designs to evaluate the effectiveness and safety of non-invasive modalities in pediatric urolithiasis. Greater uniformity in the definition of clinical outcomes is needed, including stone-free rates, symptom resolution, quality of life, and long-term recurrence rates. In addition, studies assessing the systematic role of metabolic evaluation and intervention, as well as subgroup analyses based on age, stone size, location, and composition, would be highly valuable in supporting a more individualized and evidence-based management approach for children with nephrolithiasis.

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