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Deep Learning Reconstruction in Pediatric Low-Dose Computed Tomography: A Systematic Review of Image Quality and Radiation Dose Reduction.

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Abstract

Background: Radiation exposure remains a critical concern in pediatric computed tomography (CT) due to heightened radiosensitivity and increased lifetime attributable risk of malignancy. Technological advances in image reconstruction have enabled substantial radiation dose optimization. Deep learning reconstruction (DLR), a novel artificial intelligence-based approach, has emerged as a promising method to improve image quality while permitting further dose reduction.

Purpose: To systematically evaluate current evidence regarding the impact of deep learning reconstruction on image quality and radiation dose reduction in pediatric low-dose CT.

Method: A systematic review was conducted in accordance with PRISMA 2020 guidelines. PubMed and Google Scholar were searched for English-language original research article published between January 2019 and March 2026. Studies were eligible if they include pediatric patients (≤ 18 years), evaluated CT imaging with deep learning reconstruction and reported objective or subjective image quality metrics and/or radiation dose outcomes. Data were extracted using standardized forms, and risk of bias was assessed using an adapted Newcastle-Ottawa framework. Due to heterogeneity in reporting and incomplete availability of variance data, a structured narrative synthesis was performed.

Result: Fifty-three records were identified; for studies met inclusion criteria. All included studies demonstrated significant reductions in image noise and improvements in signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) with DLR compared to conventional iterative reconstruction techniques. Two studies reported radiation dose reductions of approximately 50-55% while maintaining diagnostic image quality. Risk of bias was low to moderate across studies.

Conclusion: Available pediatric evidence indicates that deep learning reconstruction improves image quality and enables meaningful radiation dose reduction in low- dose CT protocols. Although current data remain limited, findings consistently support integration of DLR into pediatric CT imaging strategies.

Keywords: Deep learning reconstruction; pediatric CT; Low-dose computed tomography; Radiation dose reduction; Image quality; Artificial intelligence; Iterative reconstruction.

Introduction

Computed tomography (CT) plays a crucial role in pediatric diagnostic imaging due to its rapid acquisition, high spatial resolution and ability to visualize complex anatomical structures.(1) CT examination is frequently utilized in children for evaluation of trauma, congenital anomalies, oncologic conditions, infectious diseases and various thoracic and abdominal pathologies. Despite these clinical benefits, CT imaging exposes patients to ionizing radiation, which raises particular concern in the pediatric population. Children are more radiosensitive than adults, and their longer expected lifetime increases the cumulative risk of radiation-induced malignancies.(2) As a result, minimizing radiation exposure while maintaining diagnostic image quality remains a fundamental priority in pediatric imaging.

Over the past two decades, several strategies have been developed to reduce radiation dose in CT imaging.(3) These include optimization of scanning parameters such as tube current modulation, lower tube voltage protocols, automated exposure control systems and improved detector technology.(4) In addition to acquisition-related strategies, image reconstruction algorithms have played an increasingly important role in radiation dose optimization.(5) Traditional CT reconstruction relied primarily on filtered back projection (FBP), which is computationally efficient but highly sensitive to noise, particularly in low dose imaging settings. As radiation dose decreases, image noise increases, potentially compromising diagnostic quality.(6)

To address these limitations, iterative reconstruction (IR) algorithms were introduced as an alternative to FBP. These techniques incorporate physical models of the CT acquisition process and iteratively refine image reconstruction to reduce noise and artifacts.(7) Hybrid and model-based iterative reconstruction methods have demonstrated significant improvements in image quality compared to FBP, allowing moderate reductions in radiation dose.(8) However, iterative reconstruction approaches have several limitations, including increased computational demands and potential alterations in image texture.(9) Radiologists have sometimes reported overly “smooth or plastic-like” appearances in images reconstructed using aggressive iterative techniques, which may affect diagnostic interpretation.(10)

Recent advances in artificial intelligence have led to the development of deep learning-based reconstruction techniques. Deep learning reconstruction (DLR) utilizes convolutional neural networks trained on large datasets of high-quality images to distinguish true anatomical signals from noise.(11) During the reconstruction process, these algorithms learn complex relationships between low-dose input data and high-quality reference images, enabling improved noise suppression while preserving fine anatomical details. Unlike traditional reconstruction methods that rely primarily on mathematical modeling, DLR incorporates data-driven learning approaches that allow adaptive enhancement of image quality.(12)

The application of deep learning reconstruction in CT imaging has gained significant attention in recent years. Studies in adult population have demonstrated substantial improvements in

objective image quality metrics, including reductions in image noise and increases in signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR).(13) Furthermore, DLR has shown potential to maintain diagnostic image quality even when radiation dose is significantly reduced.(14) These advantages suggest that DLR may represent a transformative advancement in CT imaging technology.

Despite the promising results observed in adult imaging studies, the application of deep learning reconstruction in pediatric CT requires careful evaluation.(15) Pediatric imaging presents several unique challenges that differ from adult imaging. These include smaller patient size, variable anatomy across different developmental stages, increased susceptibility to motion artifacts, and the need for rapid acquisition to minimize the need for sedation.(16) In addition, pediatric CT protocols are often already optimized for low radiation exposure, which may limit the extent to which further dose reduction is possible without compromising image quality.(17)

Another important consideration is that the majority of research on deep learning reconstruction has focused on adult imaging populations. Pediatric-specific evidence remains comparatively limited and the available studies vary in terms of patient populations, anatomical regions examined, CT acquisition protocols and reconstruction algorithms used. As deep learning technologies continue to be integrated into clinical imaging workflows, it is essential to critically evaluate their performance in pediatric imaging settings.(18)

A systematic synthesis of the available evidence can provide valuable insight into the potential benefits and limitations of deep learning reconstruction in pediatric CT. by evaluating published studies that investigate image quality metrics and radiation dose outcomes, it is possible to determine whether DLR offers meaningful advantages compared to conventional reconstruction techniques in pediatric populations. Such evidence is essential to guide clinical decision-making, inform protocol optimization and support the safe implementation of emerging imaging technologies.

Therefore, the aim of this systematic review is to evaluate the current literature regarding the use of deep learning reconstruction in pediatric low dose CT imaging. Specifically, this review seeks to assess the impact of DLR on objective and subjective image quality parameters and to examine its potential role in enabling radiation dose reduction while maintaining diagnostic performance. By synthesizing existing pediatric evidence, this study aims to contribute to the growing body of knowledge surrounding artificial intelligence applications in medical imaging and to highlight areas where further research is needed.

Methods

Study design: This systematic review was conducted according to the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) 2020 guidelines, which provide a standardized framework for transparent and reproducible reporting of systematic reviews. The objective of this review was to synthesize existing evidence evaluating the impact of deep learning reconstruction (DLR) on image quality and radiation dose reduction in pediatric computed tomography (CT). The methodology was designed to identify relevant studies, apply predefined eligibility criteria and systematically evaluate available evidence from eligible publications.

Search Strategy: A comprehensive literature search was performed to identify relevant studies evaluating deep learning reconstruction in pediatric CT imaging. The databases PubMed and Google Scholar were searched for studies published between January 2019 to March 2026. This time frame was selected to capture contemporary literature following the clinical introduction and increasing adoption of deep learning-based reconstruction algorithms in CT imaging.

The search strategy was developed using combinations of keywords and Boolean operators relevant to the research topic. The primary search terms included: (“deep learning reconstruction” OR “deep learning–based reconstruction” OR “DLR”) AND (“pediatric” OR “children”) AND (“computed tomography” OR “CT”) AND (“low dose” OR “ultra-low dose”). The search filters were applied to restrict results to English-language publications and original research articles. No restrictions were applied regarding geographic location or CT scanner manufacturer.

To ensure comprehensive coverage, the reference lists of relevant articles were manually reviewed to identify additional eligible studies that may not have been captured during the initial database search. Due to limited database access, additional bibliographic databases such as Scopus and Web of Science were not searched. However, Google Scholar was included to enhance search sensitivity and capture potentially relevant studies not indexed in PubMed.

Eligibility Criteria

Studies were selected based on predefined inclusion and exclusion criteria designed to ensure relevance to the study objective.

Inclusion Criteria:

Studies were included if they met the following criteria; Investigated pediatric patients (≤ 18 years of age), Evaluated computed tomography imaging, assessed deep learning reconstruction algorithms, Reported objective image quality parameters, such as: (Image noise, Signal-to-noise ratio, Contrast-to-noise ratio) Reported subjective image quality assessment by radiologist or imaging experts, Included radiation dose metrics, such as

CTDIvol, dose-length product (DLP), or size specific dose estimate (SSDE), Were published as original research articles in peer-reviewed journals.

Exclusion Criteria

Studies were excluded if they met any of the following criteria; Studies conducted exclusively in adult populations, Studies not involving CT imaging, Articles that did not evaluate deep learning reconstruction techniques, Review articles, editorials, conferences abstracts or letters to the editor, Studies without available full text and Studies that did not evaluate low-dose or dose-optimized CT protocols.

Study Selection process

- The study selection process followed the PRISMA framework, which includes identification, screening, eligibility assessment, and final inclusion.
- The initial database search yielded 53 records, including 22 articles from PubMed and 31 articles from Google Scholar. After removal of 15 duplicate records, 38 studies remained for title and abstract screening.
- During the screening stage, titles and abstracts were reviewed to identify studies relevant to the research objective. Thirty studies were excluded due to reasons including adult-only populations, absence of deep learning reconstruction analysis, review-type publications, or unrelated imaging modalities.
- Following this stage, eight full-text articles were retrieved and assessed for eligibility. Full-text evaluation was conducted to determine whether each study satisfied the predefined inclusion criteria.
- Of the eight full-text articles assessed, four were excluded for the following reasons: adult-only population (n = 2), review article (n = 1), and lack of low-dose CT protocol evaluation (n = 1).
- Ultimately, four studies met all inclusion criteria and were included in the final qualitative synthesis.
- Although the search window covered the period from 2019 to 2026, all eligible studies were published between 2021 and 2022, reflecting the relatively recent clinical implementation of deep learning reconstruction technology in pediatric CT imaging.

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only.

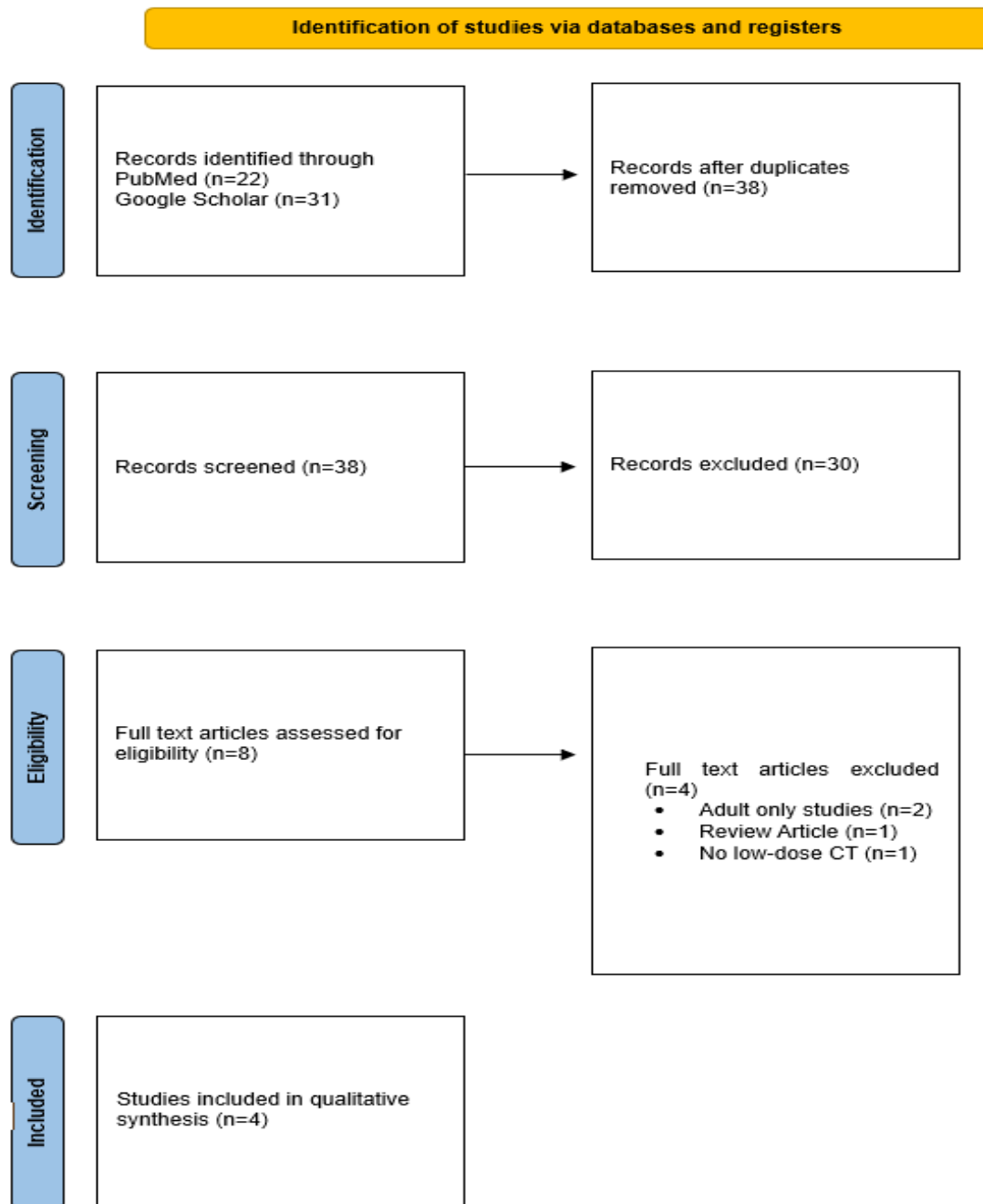


Table 1. PRISMA study selection summary

Data Extraction

Data extraction was performed using a standardized data collection from designed to capture key methodological and outcome variables from each included study. The following information was extracted: Study author and year of publication, Study design (prospective and retrospective), Sample size, Patient age range, CT acquisition parameters, CT anatomical region examined, Reconstruction methods compared, Objective image quality metrics (image noise, SNR, CNR), Subjective image quality assessments, Radiation dose parameters (CTDIvol, DLP, SSDE) and Reported percentage dose reduction. Data were organized into summary table to facilitate comparison studies.

Risk of Bias Assessment

The methodological quality of included studies was evaluated using an adapted Newcastle-Ottawa Scale (NOS) for observational studies. This tool assesses three major domains: Selection bias, including representativeness of the study population, Comparability of study groups, particularly regarding reconstruction techniques evaluated. Outcome assessment, including the reliability of image quality measurements and radiologist evaluations. Each study was categorized as having low, moderate or high risk of bias based on these criteria.

Data Synthesis

Due to variability in study designs, CT protocols, reconstruction algorithms and reporting formats as well as limited availability of variance data required for pooled statistical analysis, a formal quantitative meta-analysis was not performed. Instead, findings were synthesized using a structured narrative approach, focusing on key outcome domains: Image noise reduction, Signal-to-noise improvement, Contrast-to-noise enhancement and Radiation dose reduction. Comparative trends across studies were analyzed to identify consistent patterns in the performance of deep learning reconstruction relative to conventional reconstruction methods.

Result

Study Selection

The study selection process followed the PRISMA 2020 guidelines for systematic reviews. The database search initially identified a total of 53 records, including 22 articles retrieved from PubMed and 31 records from Google Scholar. These records were exported and screened for duplicates and eligibility.

After removing 15 duplicate records, 38 unique studies remained for title and abstract screening. During this screening phase, articles were evaluated for relevance to the study objective, specifically focusing on pediatric CT imaging, deep learning reconstruction techniques and evaluation of image quality or radiation dose outcomes.

A total of 30 studies were excluded during title and abstract screening for several reasons. The most common reasons for exclusion included studies conducted exclusively in adult populations, articles evaluating non-CT imaging modalities, studies that did not investigate deep learning reconstruction and review articles or editorials without original research data.

Following the screening stage, eight articles were selected for full-text review to determine their eligibility for inclusion in the systematic review. Each full-text article was carefully assessed according to the predefined inclusion and exclusion criteria described in the Methods section.

During full-text assessment phase, four studies were excluded for the following reasons: Studies involving adult-only population (n=2), Review article without original data (n=1), Study not evaluating low-dose CT protocols (n=1)

After applying all eligibility criteria, four studies were included in the final qualitative synthesis. Although the literature search covered the period from 2019 to 2026, all eligible studies were published between 2021 and 2022, reflecting the relatively recent introduction of deep learning reconstruction algorithms into pediatric CT imaging practice

Study Characteristics

The four studies included in this review evaluated the performance of deep learning reconstruction algorithms in pediatric CT imaging. Study sample sizes ranged from 19 to 65 pediatric patients, resulting in a combined total sample of more than 170 patients across all included investigations.

The studies both prospective and retrospective study designs. Three studies involved clinical patient data, while one study incorporated both clinical data and phantom experiments to validate reconstruction performance.

The CT examination evaluated across studies included thoracic CT imaging, abdominal CT imaging and mixed body CT protocols. The reconstruction algorithms evaluated varied slightly across studies depending on CT scanner vendors but all studies compared deep learning

reconstruction methods with conventional reconstruction techniques, including filtered back projection (FBP) or iterative reconstruction (IR) methods such as ASIR-V.

All included studies assessed at least one objective image quality parameter, including image noise, signal-to-noise ratio (SNR) and contrast-to noise ratio (CNR). Several studies also included subjective image quality assessment performed by experienced radiologists using standardized scoring systems. Radiation dose metrics were reported in some studies using CTDIvol, dose-length product (DLP) or size-specific dose estimate (SSDE).

Study	Design	Sample Size	CT Region	Comparator
Brady et al. (2021)	Prospective	19	Mixed	FBP/IR
Nagayama et al. (2022)	Prospective	65	80-KVp CT	Hybrid IR
Yoon et al. (2021)	Retrospective	51	Chest/Abdomen	ASIR-V
Zang et al. (2022)	Clinical + Phantom	40+	Chest/Abdomen	ASIR-V

Table 2. Characteristics of Included Studies.

Image Quality Outcomes

Image Noise Reduction: All four included studies consistently reported significant reduction in image noise when deep learning reconstruction was applied compared to conventional reconstruction techniques noise reduction ranged approximately between 30% and 40% across studies.

This reduction in image noise was particularly evident in low-dose CT protocols, where noise levels are typically elevated due reduced photon counts. By effectively suppressing noise while preserving anatomical structures, DLR allowed improved visualization of soft tissues and vascular structures.

Study	Reconstruction Methods Compared	Image Noise Outcome	Signal-to-Noise Ratio (SNR)	Contrast-to-Noise Ratio (CNR)	Subjective Image Quality
Brady et al. (2021)	DLR vs FBP/IR	Significant reduction in image noise with DLR (~30-35%)	Improved SNR compared with conventional reconstruction	Moderate improvement in CNR	Radiologists rated DLR images superior in overall image quality
Nagayama et al. (2022)	DLR vs Hybrid IR	Substantial noise reduction in noise observed with DLR	Significant increase in SNR values	Marked improvement in CNR in low-kVp imaging	Diagnostic confidence maintained or improved
Yoon et al. (2021)	DLR vs ASIR-V	Image noise reduced by ~35-40%	SNR significantly increased with DLR	CNR improved compared with iterative reconstruction	Higher subjective image quality scores for DLR
Zang et al. (2022)	DLR vs ASIR-V	Consistent noise suppression observed with DLR	Improved SNR across evaluated protocols	CNR increased, particularly in soft tissue evaluation	Radiologists preferred DLR images for diagnostic interpretation

Table 3. Image Quality Outcomes in Included Studies.

Signal-to-Noise Ratio (SNR): SNR is a key indicator of image clarity and diagnostic usefulness. All included studies reported increased SNR values in images reconstructed using deep learning algorithms compared with traditional iterative reconstruction techniques. Improved SNR indicates that the signal intensity representing anatomical structures becomes more distinguishable relative to background noise, thereby improving the overall quality of diagnostic images.

Contrast-to-Noise Ratio (CNR): CNR reflects the ability to distinguish structures of different densities within an image. Enhanced CNR improves lesion detectability and diagnostic confidence. Studies included in this review demonstrated notable improvements in CNR valuable with DLR, with one study reporting increases exceeding 100% in selected imaging protocols. This suggests that DLR may improve the visibility of subtle anatomical differences and pathological findings, particularly in low-dose imaging conditions.

Subjective Image Quality Assessment: In addition to objective measurements, several studies included subjective evaluation of image quality by radiologists. These evaluations typically used standardized scoring systems assessing parameters such as overall image quality, image noise perception, edge sharpness and diagnostic confidence.

Across all studies, radiologists rated DLR images as equal or superior in diagnostic quality compared with images reconstructed using conventional techniques. Importantly, none of the included studies reported deterioration in diagnostic confidence associated with DLR reconstruction. Radiologists also noted that DLR images retained natural image texture, avoiding the overly smooth or artificial appearance sometimes associated with aggressive iterative reconstruction techniques.

Radiation Dose Reduction: Two of the included studies specifically evaluated the potential of deep learning reconstruction to enable further radiation dose reduction while maintaining diagnostic image quality. The studies demonstrated that CT protocols using DLR could achieve radiation dose reduction of approximately 50-55% compared with standard iterative reconstruction protocols. Despite this reduction, image quality remained diagnostically acceptable. Other studies included in the review demonstrated that DLR maintained high image quality even at already optimized pediatric low-dose settings, suggesting that the technology may allow further dose optimization without compromising diagnostic performance.

Study	CT protocol	Dose Metric Reported	Dose Reduction with DLR	Key Findings
Brady et al. (2021)	Pediatric body CT	CTDIvol, DLP	Not directly quantified	DLR maintained diagnostic image quality at low-dose settings
Nagayama et al. (2022)	80 kVp pediatric CT	CTDIvol, SSDE	~50-55% reduction	Significant dose reduction achievable while maintaining image quality
Yoon et al. (2021)	Pediatric chest/abdomen CT	DLP	Moderate dose reduction reported	DLR enabled lower dose protocols without compromising image quality
Zang et al. (2022)	Low-dose pediatric CT	CTDIvol	Dose reduction demonstrated in phantom and clinical testing	DLR preserved diagnostic quality at reduced radiation levels

Table 4. Radiation Dose Outcomes in Included Studies

Risk of Bias Assessment

The risk of bias across the included studies was assessed using an adapted Newcastle-Ottawa Scale. Overall methodological quality was considered low to moderate risk of bias. Strengths observed in the included studies included clearly defined patient populations, standardized CT imaging protocols and objective image quality measurements. However, several limitations were identified, including relatively small sample sizes, single-center study designs and lack of randomized comparisons.

Despite these limitations, the consistency of findings across multiple independent studies strengthens the reliability of the observed trends regarding improvements in image quality and potential radiation dose reduction associated with deep learning reconstruction.

Discussion

This systematic review evaluated the available literature on the application of deep learning reconstruction (DLR) in pediatric low-dose computed tomography (CT) imaging, focusing on its effects on image quality and radiation-dose reduction. The results of this review demonstrate that deep learning-based reconstruction techniques consistently improve objective image quality parameters, including reductions in image noise and increases in signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). In addition, several studies reported that DLR enables meaningful reduction in radiation dose while maintaining or improving diagnostic image quality.(19) These findings suggest that deep learning reconstruction may represent an important technological advancement in pediatric CT imaging, where balancing diagnostic accuracy with radiation safety remains a critical concern.(20)

One of the most consistent findings across the included studies was the ability of deep learning reconstruction to significantly reduce image noise.(21) Image noise is a major limitation in low-dose CT protocols because reducing radiation dose inevitably reduces the number of detected photons, which increases statistical noise in reconstructed images.(22) Traditional reconstruction approaches such as filtered back projection (FBP) are particularly susceptible to noise in low-dose conditions, often resulting in degraded image quality and reduced diagnostic confidence.(23) Although iterative reconstruction techniques have partially addressed this issue by incorporating physical models of the imaging system, they may introduce overly smooth image textures that can affect lesion detection or radiologist interpretation.(24) In contrast, deep learning reconstruction algorithms use trained neural networks to distinguish noise from true anatomical structures, enabling more effective noise suppression while preserving fine structural details.(25)

The reviewed studies consistently reported noise reductions ranging approximately between 30% and 40% when DLR was compared with conventional reconstruction methods. This level of improvement is clinically relevant, particularly in pediatric imaging where CT protocols are already optimized to minimize radiation exposure. By reducing image noise without sacrificing spatial resolution, DLR enables clearer visualization of anatomical structures and may improve the detectability of subtle beneficial in pediatric thoracic and abdominal imaging, where small anatomical structures and low-contrast lesions may otherwise be difficult to identify.(26)

In addition to reducing noise, deep learning reconstruction also improved signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) across the included studies. Both SNR and CNR are key metrics used to quantify image quality and diagnostic performance in CT imaging. Higher SNR indicates that the signal representing anatomical structures is more distinguishable relative to background noise, while improved CNR enhances the visibility of differences between tissues of varying density.(27) Increased CNR is particularly important for identifying lesions or abnormalities that may only subtly differ from surrounding tissues.(28) The improvements in SNR and CNR observed in DLR-reconstructed images therefore suggest that deep learning

algorithms may enhance diagnostic performance, especially in low-dose imaging environments.(29)

Subjective image quality assessments performed by radiologists further supported the objective findings. Across the included studies, radiologists consistently rated DLR-reconstructed images as equal or superior in overall quality compared with images reconstructed using conventional iterative reconstruction techniques. Importantly, none of the studies reported reduced diagnostic confidence associated with the use of deep learning reconstruction. In some cases, radiologists specifically noted improved edge definition and more natural image texture compared with traditional iterative reconstruction methods, which sometimes produce excessively smooth images that may alter familiar image appearances. By preserving natural image characteristics while reducing noise, DLR appears to offer advantages that may facilitate radiologist acceptance and integration into clinical workflows.(30)

Another important finding of this review is the potential of deep learning reconstruction to support additional radiation dose reduction in pediatric CT imaging. Radiation exposure is a major concern in pediatric radiology due to the increased radiosensitivity of children and their longer lifetime risk of radiation-induced malignancies.(31) Consequently, significant efforts have been made to develop dose optimization strategies that adhere to the ALARA principle.(32) Several studies included in this review demonstrated that CT protocols incorporating deep learning reconstruction could achieve radiation dose reductions of approximately 50% while maintaining diagnostic image quality. These findings indicate that DLR may enable further dose reductions beyond what is achievable with conventional iterative reconstruction methods.

The ability to reduce radiation dose without compromising diagnostic accuracy has important clinical implications. Pediatric CT examinations are commonly performed for evaluation of trauma, congenital abnormalities, oncologic surveillance and infectious diseases. In many cases, children may require repeated imaging studies over time, which increases cumulative radiation exposure. Implementing reconstruction techniques that allow further dose reductions while maintaining diagnostic performance could therefore significantly improve the safety profile of CT imaging in pediatric populations.

Despite the promising findings observed in this review, several limitations should be considered when interpreting the result. First, the number of eligible studies was relatively small. Although the literature search covered a bad time period from 2019 to 2026, only four studies met the predefined inclusion criteria. This reflects the relatively recent clinical introduction of deep learning reconstruction technology and the limited number of pediatric-specific investigations currently available. As a result, the conclusions of this review should be interpreted as preliminary evidence rather than definitive confirmation of the benefits of DLR in pediatric CT imaging.

Second, the included studies exhibited variability in study design, patient populations, imaging protocols and reconstruction algorithms. Differences in CT scanner manufacturers and proprietary reconstruction software may influence imaging outcomes, which could limit direct comparison across studies. Additionally, most studies were conducted in single-center settings with relatively small sample sizes. Larger multicenter studies would be valuable to confirm the generalizability of the observed findings.

Another limitation relates to the lack of standardized outcome reporting across studies. Although most studies evaluated common image quality metrics such as image noise, SNR and CNR the specific measurement techniques and regions of interest varied. Similarly, subjective image quality assessment was performed using different scoring systems and evaluation criteria. These methodological differences limited ability to perform a quantitative meta-analysis and required the results to be synthesized using a narrative approach.

Furthermore, most available studies evaluated short-term imaging outcomes rather than clinical diagnostic accuracy or patient outcomes. While improvements in objective image quality metrics are encouraging, further research is needed to determine whether deep learning reconstruction leads to measurable improvements in clinical diagnostic performance or patient management. Future investigation should include larger cohort and evaluate clinically relevant endpoints such as lesion detection accuracy, diagnostic confidence and interobserver agreement.

Despite these limitations, the findings of this systematic review highlight the significant potential of deep learning reconstruction to improve pediatric CT imaging. The consistent improvements in image quality metrics and the ability to maintain diagnostic performance at lower radiation does suggest that DLR may represent an important step forward in CT imaging technology. As artificial intelligence continues to evolve, further refinements in deep learning algorithms may allow even greater improvements in image quality and dose optimization.

Future research should focus on larger multicenter clinical studies that evaluate deep learning reconstruction across diverse pediatric populations and imaging indications. Standardized reporting of image quality metrics and radiation dose parameters would facilitate more robust comparison across comparisons across studies and support future meta-analyses. Additionally, research exploring the integration of deep learning reconstruction with other dose-reduction technologies, such as automated exposure control systems and advanced detector technologies, may provide further opportunities for optimizing pediatric CT imaging protocols.(33)

At last, the current evidence suggests that deep learning reconstruction offers significant improvements in image quality and may enable substantial radiation dose reductions in pediatric CT imaging.(34) Although the available literature remains limited, the result of the included studies demonstrated consistent benefits across multiple imaging parameters. Continued research and clinical validation will be essential to fully establish the role of deep

learning reconstruction in pediatric radiology and to ensure its safe and effective implementation in routine clinical practice.

Conclusion

This systematic review evaluated the current evidence regarding the application of the deep learning reconstruction in pediatric ultra-low dose computed tomography imaging, with particular emphasis on its effects on image quality and radiation dose reduction. The findings of the included studies collectively demonstrate that deep learning-based reconstruction techniques provide meaningful improvements in image quality while supporting further reduction of radiation exposure in pediatric CT imaging. These results highlight the growing role of artificial intelligence-driven technologies in optimizing diagnostic imaging practices, particularly in patient populations where radiation safety is critically important.

Across the included studies, deep learning reconstruction consistently demonstrated substantial reductions in image noise compared with conventional reconstruction techniques such as FBP and IR. Image noise is a major limitation in low-dose CT imaging because reducing radiation dose often results in increased noise levels that can compromise diagnostic quality. Deep learning algorithms, trained to differentiate between noise and true anatomical signal, can effectively suppress noise while preserving important structural information. The reviewed studies reported noise reductions ranging from approximately 30% to 40%, indicating a significant improvement in image quality under low-dose conditions.

In addition to reducing image noise, deep learning reconstruction was associated with improvements in SNR and CNR, which are important quantitative indicators of diagnostic image quality. Increased SNR enhances the visibility of anatomical structures relative to background noise, while improvements are particularly valuable in pediatric imaging, where smaller anatomical structures and subtle pathological findings may otherwise be difficult to visualize. The consistent improvements in these metrics suggest that DLR has the potential to enhance diagnostic confidence even when CT scans are performed using low radiation doses.

Subjective image quality assessments performed by radiologists also supported these objective findings. In the studies included in this review, radiologists consistently rated images reconstructed using deep learning algorithms as equal or superior in overall diagnostic quality compared with those reconstructed using traditional methods. Importantly, DLR images maintained a more natural image appearance and avoided the overly smooth texture sometimes associated with aggressive iterative reconstruction techniques. This preservation of natural image characteristics may improve radiologist acceptance and facilitate the integration of DLR technologies into routine clinical workflow.

A key advantage highlighted in this review is the ability of deep learning reconstruction to enable further radiation dose reduction in pediatric CT imaging. Radiation exposure is a major concern in pediatric radiology because children are more sensitive to ionizing radiation and have a longer lifetime during which radiation-induced effects may develop. Several studies

included in this review demonstrated that CT protocols using deep learning reconstruction could achieve radiation dose reductions approaching 50% while maintaining acceptable diagnostic image quality. These findings support the potential of DLR to strengthen adherence to the ALARA principle in pediatric imaging.

Despite these promising results, several limitations should be acknowledged. The number of eligible studies identified in this review was relatively small, reflecting the emerging nature of deep learning reconstruction technology in pediatric CT imaging. Additionally, the included studies varied in terms of imaging protocols, reconstruction algorithms and evaluation methods which limited direct comparison across studies and prevent the performance of a quantitative meta-analysis. Most studies were also conducted at single centers with relatively small patient population.

Future research should focus on larger multicenter studies that evaluate DLR across diverse pediatric populations and clinical indications. Standardization of image quality assessment methods and radiation dose reporting would facilitate more robust comparisons across studies and support future quantitative analyses. Furthermore, additional research should investigate clinically relevant outcomes such as diagnostic accuracy, lesion detection performance and the impact of DLR on clinical decision making.

The available evidence suggests that DLR represents a promising advancement in pediatric CT imaging. By improving image quality and enabling meaningful radiation dose, DLR has the potential to enhance both the safety and diagnostic performance of CT examinations in children. Continued research and technological development will be essential to further validate these benefits and to support the safe and effective implementation of DLR in pediatric radiology practice.

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