Journal of Institute of Medicine Nepal
Institute of Medicine, Kathmandu, Nepal

View Point

JIOM Nepal. 2026 April;48(1):167-172

# Challenges and Perspectives of Pediatric Radiology in Low and Middle-Income Countries

**Pradeep Raj Regmi[1], Swachchhanda Songmen[2], Sharma Paudel[1], Benu Lohani[1], Ram Kumar Ghimire[3]**

**Author(s) affiliation**

[1]Department of Radiodiagnosis, Maharajgunj Medical Campus, Tribhuvan University Teaching Hospital, Institute of Medicine, Kathmandu, Nepal

[2]East Virginia Medical School

[3]Nepal Mediciti Hospital, Lalitpur, Nepal

**Corresponding author**

Pradeep Raj Regmi, MBBS, MD

pradeepregmi@iom.edu.np

## ABSTRACT

Radiology serves as the preeminent diagnostic tool of modern pediatric radiology. It is crucial for pinpointing subtle pathologies and directing targeted, life-saving treatments in children who often cannot articulate their symptoms. However, providing equitable, high-quality pediatric imaging in low and middle-income countries (LMICs) remains a monumental global health challenge. These regions continuously struggle against infrastructural hurdles: a severe shortage of subspecialized personnel, advanced equipment costs, and severely limited governmental investment in targeted healthcare. Furthermore, adhering to stringent dose-reduction protocols for children proves to be a daunting daily task in these resource-constrained environments. This viewpoint article explores the multifaceted challenges of pediatric radiology in LMICs, systematically categorized into service delivery, educational deficits, and socioeconomic barriers. We critically examine the disparities in specialized care between the western and eastern regions, highlighting the absolute necessity for tailored, pediatric-specific imaging protocols that prioritize patient safety and minimize ionizing radiation exposure. Crucially, this perspective explores the transformative potential of teleradiology and the ethical integration of artificial intelligence (AI) to alleviate severe workforce burdens, alleviate diagnostic burden, and standardize care across borders. By fostering robust international collaboration, advancing targeted educational fellowships, and deploying trustworthy AI, the global pediatric radiology community can actively narrow the alarming gap in pediatric radiological services, ensuring that life-saving diagnostics are accessible to the most vulnerable populations, regardless of geographic or economic boundaries.

**Keywords**

*Artificial intelligence; challenges; pediatric radiology; radiation dose; teleradiology*

**DOI**

https://doi.org/10.59779/jiomnepal.1420

**Submitted**

Nov 19, 2025

**Accepted**

Mar 25, 2026

## INTRODUCTION

Medical imaging has established itself as an indispensable diagnostic pillar in contemporary healthcare, exponentially magnified in fetal and pediatric radiology. Pre-verbal infants and young children are unable to communicate precisely and localize pain. Furthermore, common pediatric presentations such as the acute abdomen or respiratory distress often manifest with non-specific signs that overlap across a broad spectrum of benign and life-threatening etiologies.[1] Consequently, high-resolution cross-sectional and ultrasound imaging serve as a critical diagnostic arbiter, significantly reducing time-to-treatment and minimizing diagnostic errors in these highly vulnerable populations.[2,3]

These foundational systemic vulnerabilities drastically exacerbate the morbidity of infectious diseases, congenital anomalies, and traumatic injuries that are heavily reliant on early radiological evaluation for favorable outcomes.[3,4] Within the context of such severe infrastructural and nutritional deficits in low and middle-income countries (LMICs), dedicating budget to advanced pediatric imaging infrastructure might appear to policymakers as a secondary priority. Yet epidemiological evidence demonstrates that accurate, early radiologic diagnostics are the absolute prerequisite for optimizing targeted therapeutic interventions and ultimately reducing pediatric mortality.[4,5]

Examining this landscape through the lens of clinical practice in a developing nation reveals a stark dichotomy between the pediatric imaging capabilities in LMICs and those established in developed countries. The WHO estimates that approximately two-thirds of the global population still lacks access to even basic medical imaging services.[5,6] Confronted with this tremendous healthcare inequity, addressing the diagnostic disparity is not merely a logistical challenge but a critical professional and ethical imperative. This viewpoint critically examines the deficits and challenges of pediatric radiology in LMIC settings and advocates for targeted, scalable interventions to bridge this diagnostic chasm.

### Present scenario

In Nepal, the pediatric demographic is substantial, constituting approximately 30% of the nation's 30 million population.[2] Despite this immense population, specialized infrastructure is disproportionately scarce; current estimates suggest the country is served by only five dedicated pediatric hospitals. Furthermore, while general radiologists staff these facilities, the workforce is notably devoid of professionals who have undergone formal, fellowship-accredited training in pediatric radiology.

In the United States, the pediatric healthcare landscape is supported by a network of approximately 250 specialized children's hospitals, with pediatric patients accounting for roughly 10% of all diagnostic imaging examinations performed nationwide.[6] Despite this substantial clinical volume, the subspecialty workforce remains disproportionately small; only about 3% of radiologists in the United States are fellowship-trained pediatric radiologists, a figure widely acknowledged as insufficient to meet the rising demand for specialized care.[7] Concurrently, the utilization of advanced imaging in emergency settings has intensified over the last two decades. Recent data indicate that approximately 43% of pediatric emergency evaluations now involve ionizing radiation, with Computed Tomography (CT) scans being performed in about 8% of this study population.[8] This upward trend underscores the critical need for strict dose-optimization protocols in a highly sensitive population to radiation exposure.[9]

Practitioners in low-resource settings face profound barriers, where imaging modalities considered standard in developed nations remain logistically or financially inaccessible. To systematically address this disparity, we categorize the challenges in pediatric radiology into three distinct domains: service, education, and research.

### A.Service

#### Creating a favorable imaging environment

Establishing rapport is essential, as parental anxiety directly impacts patient cooperation. While child-centered environments and clear counseling effectively reduce reliance on sedation, these practices are frequently compromised in LMICs. Systemic barriers, specifically insufficient staff training, patient illiteracy, and overwhelming clinical workloads, often preclude adequate pre-procedural engagement.

**Patient monitoring**

Obtaining diagnostic-quality imaging necessitates patient immobility and physiological stability, a requirement that often mandates sedation. In developed settings, sedation is administered via structured protocols by designated specialists. In contrast, LMICs frequently lack defined sedation teams, forcing radiologists to rely on ad-hoc support from available clinicians. Furthermore, the prohibitive cost of MRI-compatible monitoring equipment often precludes safe surveillance within the scanner. This deficit is exacerbated in mixed adult/pediatric facilities, where dedicated neonatal equipment is virtually non-existent, compromising patient safety during image acquisition.

**Imaging Protocols**

The efficacy of pediatric imaging is contingent upon succinct, pathology-specific protocols that are dynamically tailored by a supervising radiologist. However, in many LMICs, standardized pediatric protocols are rarely established, and the immense clinical workload frequently precludes direct radiologist supervision at the point of care.[10] This deficit is compounded by a lack of specialized training for radiographers and technologists, who often struggle to execute complex, age-adapted acquisition strategies without real-time guidance.

A primary objective in modern pediatric MRI is the reduction of acquisition time to circumvent the need for sedation, a goal that remains elusive in developing regions due to resource constraints.[11] Advanced image acquisition acceleration techniques, such as parallel imaging, simultaneous multi-slice (SMS) acquisition, radial k-space sampling, and compressed sensing reconstruction, are standard in high-resource settings to mitigate motion artifacts and shorten scan durations.[12,13] Yet, the hardware and software infrastructure required to implement these techniques, including pediatric-specific receiver coils and automated protocol-selection algorithms, are frequently unavailable in LMICs. Furthermore, the absence of MRI-compatible monitoring systems, particularly for neonates, renders the safe execution of long-duration scans logistically perilous in these environments.[14]

**Minimizing Radiation Dose**

Radiation protection in pediatrics is an uncompromisable ethical obligation, driven by the child's longer life expectancy and a biological susceptibility to oncogenesis estimated to be 10–11 times greater than in adults.[1] Consequently, every imaging encounter must be rigorously governed by the principles of justification, optimization, and dose limitation, strictly adhering to the ALARA (As Low As Reasonably Achievable) mandate.[15,16,17]

Technical optimization is paramount for dose mitigation. Essential strategies include the removal of anti-scatter grids in small children, the application of beam filtration to reduce skin dose, and the utilization of automatic exposure control (AEC) systems. These measures should be complemented by precise beam centering, strict collimation, and the deployment of shielding for thyroid and gonadal tissue.[15]

Furthermore, protocol modification offers significant opportunities to reduce dose. Multiphasic acquisitions should be substituted with split-bolus techniques, particularly in urography and oncology, which can reduce radiation exposure by up to 50% while preserving diagnostic efficacy.[18] Similarly, longitudinal follow-ups, such as ventricular shunt assessments, require the lowest feasible tube potentials to minimize cumulative radiation exposure. Unfortunately, the consistent application of these dose-sparing techniques and awareness of radiation hazards remain critical implementation gaps within many LMICs.[16]

**Access to health facilities (socio-economic burden)**

Healthcare financing determines the accessibility of pediatric diagnostic facilities. In the United States, a robust network of private and government insurance covers approximately 84% of the population, buffering families against the costs of advanced imaging.[19] In contrast, LMICs rely heavily on out-of-pocket payments. Although initiatives like Nepal's national health insurance program (NHIP) aim for universal coverage, initial enrollment reached only 5% of the target population.[20] For a subsistence farming family, the cost of a pediatric MRI combined with travel to a tertiary center is often insurmountable, leading to delayed diagnosis of treatable congenital or infectious conditions.

This chronic underfunding creates a "two-tiered" pediatric healthcare system. Public hospitals, which serve most children, often lag decades behind the private sector in technological capability. Consequently, economically disadvantaged children are frequently managed based on clinical guesswork, while only the affluent have access to the standard diagnostic facilities.

In this landscape, the ultrasound is not just an alternative; it is the cornerstone of pediatric radiology in the developing world.[21] Its value extends beyond the absence of ionizing radiation in LMICs:

No Sedation Required: Unlike CT or MRI, ultrasound allows parents to hold and soothe the child, eliminating the need for anesthesia support, which is scarce in LMICs.

Point-of-Care Diagnosis: Portable, battery-operated units can diagnose critical pediatric emergencies such as intussusception or pyloric stenosis in rural settings with intermittent electricity ("load-shedding").

Neonatal Utility: Cranial ultrasound serves as a vital, low-cost alternative to MRI for screening high-risk neonates for hemorrhage or hydrocephalus.

However, sustainability remains a critical failure point. A lack of biomedical engineering support has turned many public hospitals into "equipment graveyards," where high-end machines sit non-functional due to minor faults or a lack of spare parts. Furthermore, harsh environmental factors like dust, heat, and voltage fluctuations rapidly degrade sensitive pediatric probes, rendering them useless without robust preventive maintenance contracts.

### B. Education

The epidemiological landscape of pediatric disease exhibits a distinct geographic dichotomy. High-income countries have largely transitioned toward injury-related mortality; in the United States, trauma accounts for over 60% of pediatric deaths.[22] Conversely, LMICs remain heavily burdened by infectious etiologies. Diarrheal diseases, respiratory infections, and malnutrition continue to drive the majority of hospital admissions and mortality in South Asia and Sub-Saharan Africa.[23] Consequently, radiological training curricula in these regions must be modulated to reflect local disease prevalence rather than solely mimicking the western models.

Currently, global credentialing pathways for pediatric radiologists are heterogeneous. While the United States and the United Kingdom mandate formal subspecialty fellowships following general residency, many nations in Latin America and Asia rely on "experience-based" specialization, where general radiologists manage pediatric caseloads without formal certification.

This scarcity of subspecialized expertise constitutes a critical barrier to the standard of care. General radiologists and technologists, often untrained in pediatric-specific protocols, face significant challenges in image acquisition and interpretation. A primary risk involves the misidentification of normal developmental variants as pathology, potentially leading to iatrogenic morbidity. To mitigate these risks, academic frameworks must be restructured, comprehensive pediatric modules should be integrated into general radiology residency curricula, and formal, accessible fellowship programs must be established within developing nations.

### C. Research, teleradiology, and artificial intelligence (AI)

Given that the pediatric demographic constitutes approximately 30% of the Nepalese population, the optimization of diagnostic and interventional radiology services is an urgent public health imperative. To achieve this, continuous health systems research is required to quantify service gaps and guide policy interventions.

Technologically, the "digital divide" remains a significant barrier. Picture Archiving and Communication Systems (PACS) are restricted to selected urban centers, resulting in data silos that impede the archiving necessary for developing context-specific AI models.[24,25] However, digital health solutions offer a critical lifeline. Teleradiology can democratize access, allowing the few available subspecialists to consult on complex cases nationwide. Furthermore, international collaboration is vital to incubate local expertise, utilizing web-based platforms to facilitate remote fellowships and strengthen indigenous pediatric radiology training programs.

**Unregulated Utilization and Regulatory Gaps**

The expansion of digital connectivity in developing nations has democratized access to medical information, paradoxically driving a surge in patient self-referral without professional gatekeeping.[26] Private diagnostic enterprises frequently capitulate to this consumerist demand, prioritizing commercial viability over clinical justification, thereby increasing the prevalence of unwarranted examinations and cumulative radiation burden.[26] This phenomenon is compounded by fragile regulatory frameworks, which lack the legislative capacity to enforce appropriateness criteria or ensure the standardized operation of diagnostic equipment.[27]

## CONCLUSION

The fundamental mandate of pediatric radiology is clear: to deliver standardized, high-precision diagnostics while adhering to the strict principles of radiation safety. Yet, for much of the developing world, this goal remains aspirational, heavily constrained by obsolete infrastructure and a critical scarcity of subspecialized expertise. Bridging this chasm requires a synergistic approach. It demands that local health systems rigorously rectify infrastructural deficiencies while simultaneously engaging in robust international collaboration. By prioritizing equipment modernization and fostering global partnerships for specialized training, the medical community can ensure that safe, effective, and equitable imaging becomes a reality for every child, regardless of geography.

## REFERENCES


1. Frush DP, Applegate K. Computed tomography and radiation: understanding the issues. J Am Coll Radiol. 2004 Feb;1(2):113–9. doi:10.1016/j.jacr.2003.11.012 PubMed PMID: 17411538.
2. United Nations Children's Fund (UNICEF). The State of the World's Children 2019: Children, Food and Nutrition: Growing well in a changing world. New York: UNICEF; 2019. - Google Search [Internet]. [cited 2026 Mar 4]. Available from: https://data.unicef.org/resources/state-of-the-worlds-children-2019/
3. Mollura DJ, Lungren MP, editors. Radiology in Global Health: Strategies, Implementation, and Applications [Internet]. New York, NY: Springer New York; 2014 [cited 2026 Mar 4]. Available from: https://link.springer.com/10.1007/978-1-4614-0604-4 doi:10.1007/978-1-4614-0604-4
4. Diagnostics - Global [Internet]. [cited 2026 Mar 4]. Available from: https://www.who.int/health-topics/diagnostics
5. Nafade V, Sen P, Arentz M, Kadam R, Bigio J, Allen LN, et al. The value of diagnostic imaging for enhancing primary care in low- and middle-income countries. eClinicalMedicine. 2024 Nov 5;77:102899. doi:10.1016/j.eclinm.2024.102899 PubMed PMID: 39559185; PubMed Central PMCID: PMC11570925.
6. Merewitz L, Sunshine JH. A portrait of pediatric radiologists in the United States. AJR Am J Roentgenol. 2006 Jan;186(1):12–22. doi:10.2214/ajr.05.0615 PubMed PMID: 16357371.
7. Db L, Lw J, Bm S, Mj G, Sr S, Hp F. Rising use of CT in child visits to the emergency department in the United States, 1995-2008. Radiology. 2011 Jun;259(3). doi:10.1148/radiol.11101939 PubMed PMID: 21467249.
8. Dorfman AL, Fazel R, Einstein AJ, Applegate KE, Krumholz HM, Wang Y, et al. Use of medical imaging procedures with ionizing radiation in children: a population-based study. Arch Pediatr Adolesc Med. 2011 May;165(5):458–64. doi:10.1001/archpediatrics.2010.270 PubMed PMID: 21199972; PubMed Central PMCID: PMC3686496.
9. Bm K, C J, J K, Ms G. MRI Techniques to Decrease Imaging Times in Children. Radiographics : a review publication of the Radiological Society of North America, Inc. 2020 Apr;40(2). doi:10.1148/rg.2020190112 PubMed PMID: 32031912.
10. Expert Panel on Pediatric Imaging. "ACR–SPR Practice Parameter for the Performance and Interpretation of Magnetic Resonance Imaging (MRI)." American College of Radiology. 2022. - Google Search [Internet]. [cited 2026 Mar 4]. Available from: https://gravitas.acr.org/PPTS/GetDocumentView?docId=88
11. Jaimes C, Gee MS. Strategies to minimize sedation in pediatric body magnetic resonance imaging. Pediatr Radiol. 2016 May;46(6):916–27. doi:10.1007/s00247-016-3613-z PubMed PMID: 27229508.
12. Vasanawala SS, Alley MT, Hargreaves BA, Barth RA, Pauly JM, Lustig M. Improved pediatric MR imaging with compressed sensing. Radiology. 2010 Aug;256(2):607–16. doi:10.1148/radiol.10091218 PubMed PMID: 20529991; PubMed Central PMCID: PMC2909438.
13. Davis JT, Kwatra N, Schooler GR. Pediatric whole-body MRI: A review of current imaging techniques and clinical applications. J Magn Reson Imaging. 2016 Oct;44(4):783–93. doi:10.1002/jmri.25259 PubMed PMID: 27043465.
14. Mollura, D.J. et al. "Radiology in Global Health: Strategies, Implementation, and Applications." Springer. 2014. - Google Search [Internet]. [cited 2026 Mar 4]. Available from: https://

www.researchgate.net/publication/290925675_Radiology_in_Global_Health_Strategies_Implementation_and_Applications

15. Bravo ME. Strauss and Kaste ALARA Concept in Pediatric Imaging The ALARA Concept in Pediatric Interventional and Fluoroscopic Imaging: Striving to Keep Radiation Doses as Low as Possible During Fluoroscopy of Pediatric Patients- A White Paper Executive Summary. ALARA. 2014 Jan 1. doi:10.2214/AJR.06.0543
16. Zacharias C, Alessio AM, Otto RK, Iyer RS, Philips GS, Swanson JO, et al. Pediatric CT: Strategies to Lower Radiation Dose. AJR Am J Roentgenol. 2013 May;200(5):950–6. doi:10.2214/AJR.12.9026 PubMed PMID: 23617474; PubMed Central PMCID: PMC4748846.
17. Alzen G, Benz-Bohm G. Radiation protection in pediatric radiology. Dtsch Arztebl Int. 2011 Jun;108(24):407–14. doi:10.3238/arztebl.2011.0407 PubMed PMID: 21776310; PubMed Central PMCID: PMC3132617.
18. Scialpi M, Schiavone R, D'Andrea A, Palumbo I, Magli M, Gravante S, et al. Single-phase Whole-body 64-MDCT Split-bolus Protocol for Pediatric Oncology: Diagnostic Efficacy and Dose Radiation. Anticancer Res. 2015 May;35(5):3041–8. PubMed PMID: 25964593.
19. Keisler-Starkey K, Bunch LN. Health Insurance Coverage in the United States: 2020.
20. Ghimire P, Sapkota VP, Poudyal AK. Factors Associated with Enrolment of Households in Nepal's National Health Insurance Program. Int J Health Policy Manag. 2019 Jul 7;8(11):636–45. doi:10.15171/ijhpm.2019.54 PubMed PMID: 31779289; PubMed Central PMCID: PMC6885856.
21. Maru DSR, Schwarz R, Jason A, Basu S, Sharma A, Moore C. Turning a blind eye: the mobilization of radiology services in resource-poor regions. Global Health. 2010 Oct 14;6:18. doi:10.1186/1744-8603-6-18 PubMed PMID: 20946643; PubMed Central PMCID: PMC2964530.
22. GBD 2017 Child and Adolescent Health Collaborators, Reiner RC, Olsen HE, Ikeda CT, Echko MM, Ballestreros KE, et al. Diseases, Injuries, and Risk Factors in Child and Adolescent Health, 1990 to 2017: Findings From the Global Burden of Diseases, Injuries, and Risk Factors 2017 Study. JAMA Pediatr. 2019 Jun 1;173(6):e190337. doi:10.1001/jamapediatrics.2019.0337 PubMed PMID: 31034019; PubMed Central PMCID: PMC6547084.
23. Cunningham RM, Walton MA, Carter PM. The Major Causes of Death in Children and Adolescents in the United States. N Engl J Med. 2018 Dec 20;379(25):2468–75. doi:10.1056/NEJMsr1804754 PubMed PMID: 30575483; PubMed Central PMCID: PMC6637963.
24. Mollura DJ, Culp MP, Pollack E, Battino G, Scheel JR, Mango VL, et al. Artificial Intelligence in Low- and Middle-Income Countries: Innovating Global Health Radiology. Radiology. 2020 Dec;297(3):513–20. doi:10.1148/radiol.2020201434 PubMed PMID: 33021895.
25. Kogha Nicholas, Emuoghenerue Onoriode Ekokidolor, Eberegwa Eguono, Anyanwu Ebiringa Blaise. The challenges of installing Picture Archiving and Communication Systems (PACS) in a low- or poor-income resource nation: Our experience in a teaching hospital in Sub-Saharan Africa. Int J Life Sci Res Arch. 2024 Jul 30;7(1):001–3. doi:10.53771/ijlsra.2024.7.1.0049
26. Eysenbach G. The impact of the Internet on cancer outcomes. CA Cancer J Clin. 2003;53(6):356–71. doi:10.3322/canjclin.53.6.356 PubMed PMID: 15224975.
27. Ngoya PS, Muhogora WE, Pitcher RD. Defining the diagnostic divide: an analysis of registered radiological equipment resources in a low-income African country. Pan Afr Med J. 2016;25:99. doi:10.11604/pamj.2016.25.99.9736 PubMed PMID: 28292062; PubMed Central PMCID: PMC5325496.