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Radiography

Caregiver experiences during their child's medical imaging examinations and potential preparatory interventions: A mixed methods systematic review

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Introduction

In the UK, children and young people undergo over 150,000 MRI Scans, 50,000 CT scans and 2 million plain radiographs annually [1]. In most imaging departments, a caregiver accompanying the child will be invited into the scanning room to provide comfort and practical support. Their roles may include preparing the child for the procedure [2] ensuring their child follows instructions, such as remaining still for imaging [3] and communicating important information about the child's medical history or specific needs to the radiology team [4].

Parental presence in healthcare settings is essential for child healthcare [5] and is important to the child [6]. Qualitative studies have shown that children perceive parental presence as a coping strategy, with sentiments like "dad makes me feel brave" and "I wanted mummy, it made me feel more comfortable" [7]. Many healthcare professionals acknowledge the contribution of caregivers and recognise the parent or guardian as part of the team [8].

The journey of guiding a child through healthcare pathways can be distressing for parents or guardians. They often feel thrust into situations where they must quickly become experts and make decisions on behalf of their child [9]. In the context of medical imaging, additional risks such as radiation exposure can heighten anxiety [10]. To better improve caregivers for medical imaging experiences, the profession has seen an influx of interventions to better prepare and educate. A recent scoping review identified 36 papers related to interventions and methods to prepare, educate or familiarise children and young people about their radiological procedure [11].

Most of the included papers focused on older children who may have more autonomy or understanding of the situation and what is required. For examinations of younger children, parents play a far more active role. The availability and effectiveness of resources aimed at adults supporting younger children in medical imaging tests is currently unknown. If preparatory materials are unavailable or unsatisfactory, caregivers have shown a tendency to undertake their own research, from potentially unreliable resources from the internet, before accompanying their child to scan [6]. Reading unregulated and incorrect information before an imaging procedure can have catastrophic effects on the caregiver and child's experience.

Therefore, it is vital to provide adequate information to empower caregivers and guardians to make informed decisions about their child's care.

This systematic review aims to address this gap by identifying and synthesising literature to answer the following two research questions

1. What is the caregiver experience of attending paediatric imaging tests in a hospital setting?
2. What interventions and methods are currently used to prepare, educate and familiarise caregivers with radiological procedures?

Methods

Findings are reported according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA 2020) guidelines for systematic reviews.

Eligibility criteria

Included

- Studies focusing on the experiences of adults supporting children during medical imaging tests
- Interventions for adults aimed at educating and supporting them in this context

Excluded

- Non-English publications
- Prenatal imaging studies
- Research written from the perspective of staff on perceived experiences of parents
- Studies focusing on the experiences of children
- Preparatory materials aimed at children

Search strategy the following electronic databases were searched Ovid MEDLINE, Radiography Journal, Journal of Medical Imaging and Radiation Sciences, British Journal of Radiology, CINAHL. The following search strategy was applied Parent* Or Carer* Or Comforter* Or Guardian Or Child Or Children AND Experience OR Anxiety AND Medical imaging (MeSH) Or Scan (MeSH)

No filters or date limitations were applied to the search. All searches were undertaken on the 25th of October 2024.

Reference lists of potentially eligible studies were reviewed, and citation tracking was used to identify additional studies.

Study selection All journal articles were managed via a systematic review online tool named Raayan [13]. All titles and abstracts of potentially eligible studies were independently screened by two authors (JE, IS) using Rayyan Software [13]. Full text articles were obtained for all short-listed studies and reviewed for eligibility by two authors (JE, IS). Any discrepancies that could not be resolved between the two authors were adjudicated by a third reviewer (OA). Four discrepancies were identified during the screening process which were resolved.

Data extraction A data extraction proforma was used to extract data (JE) from eligible studies, including year of publication, country of origin, study design, data collection method, location, recruitment strategy, imaging tests, outcome measures, carer demographics, qualitative results of carer experience, quantitative results of carer experience, intervention, theory for intervention and results of intervention. The data extraction form was pilot tested on a sample of six studies to check for consistency and comprehensiveness before commencing data extraction.

Risk of bias assessment Each study was assessed for risk of bias using the Critical Appraisal Skills Programme (CASP) checklist tools [14], with each classed as “low, moderate or high” risk of bias. Two authors (JE, IS) scored each study.

Data synthesis After registration of the protocol on PROSPERO, the data synthesis approach was adapted to facilitate meaningful integration of the qualitative and quantitative data. A convergent integrated approach was used [15] which drew upon the Joanna Briggs Institute (JBI) guidance for mixed methods systematic reviews [16]. This approach involved a process of data transformation, specifically the “qualitizing” of quantitative data. Studies considering question 1 and question 2 were addressed separately.

Qualitizing quantitative data: This process involved extracting data from quantitative studies and converting it into textual descriptions. This narrative interpretation of quantitative results allowed for integration with qualitative data and ensured the data could be meaningfully combined.

Integration of data: The textual descriptions derived from quantitative data were pooled with qualitative data extracted directly from studies. This integrated dataset underwent repeated, detailed examination to identify categories based on similarity in meaning. In cases where data could not be combined due to differing meanings, they were treated separately. This method ensured a comprehensive synthesis of diverse data types. The findings were synthesised in inductively developed categories for question 1 and in categories for specific intervention types for question 2.

Results

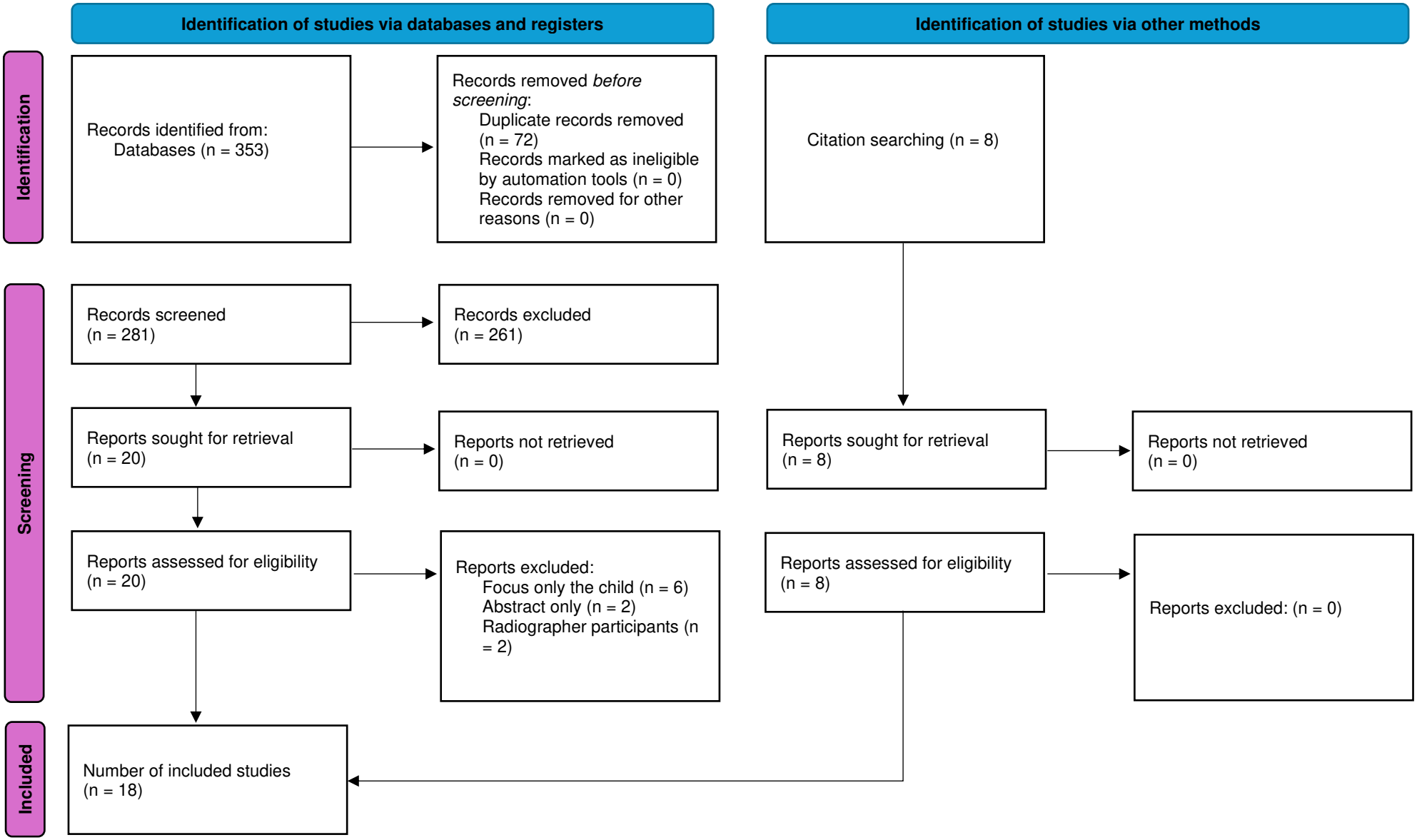

Figure 1 PRISMA Flowchart

Study selection electronic database searches identified 353 records (including duplicates). A Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) flowchart [17] of the review process is provided in Figure 1. After screening titles and abstracts, 20 full text articles were considered for eligibility. 8 records were identified through citation tracking and reference lists. Ultimately, 18 studies were included in the review (Figure 1).

Quality assessment Ultimately, 3/18 were assessed as low risk, 10/18 moderate, and 5/18 as high risk of bias. Four studies had conflicting classifications and were resolved locally between the two reviewers (IS, JE). The most frequently identified quality issues included the failure to consider or control for potential confounders, recruitment bias, and small sample sizes limited to a single centre or hospital.

Characteristics of included studies All 18 studies included parents of children undergoing medical imaging tests, providing a total of 1,008 participants from 8 countries (Table 1, Table 2). 4/18 studies did not report the number of caregivers involved in their study. Sample sizes ranged from 1- 263 caregivers, the majority of which were university level educated, white females. 8/18 papers did not report the demographics of the caregivers involved in their studies.

The children in their care ranged from 0-19 years of age, with most children over the age of 10. 6/18 studies included caregivers attending medical imaging tests for children under the age of 2 years. The medical imaging tests the child underwent included x-ray, fluoroscopy, ultrasound, CT, MRI, Interventional Radiology, Nuclear Medicine and Radiotherapy.

There were 6 cross sectional studies, 2 Randomised Control Trials, 1 Feasibility study, 2 narrative articles, 5 qualitative studies and 2 Controlled Trials included in this review. Recruitment strategies included approaching participants before their medical imaging appointment (10), online (4) and in the community (1). The other 2 studies were narrative pieces, and 1 study did not report its recruitment strategy.

Question 1. What is the caregiver experience of attending paediatric imaging tests? (Nine studies)

9/18 included studies focused on measuring and exploring the caregiver experience while attending medical imaging tests to support a child [18] [19] [6] [20] [21] [22] [23] [24] [25]. In 4/18 studies a quantitative approach utilising surveys as their data collection method was employed [18] [6,19] [20]. 4/18 studies qualitative interviews [22,23] [24] [25] and 1/18 narrative piece was written by a parent [21]

The included studies measured a wide range of outcomes in association with caregivers including preparation (2), anxiety (6), satisfaction (4) support (1) experiences of hospital care and or scans (6) and their views on sources of information for preparation of medical imaging procedures (2). Most studies combined measures assessing both child and caregiver-related outcomes, with only 6 out of 18 studies exclusively focusing on caregiver outcomes.

Table 1 Caregiver experiences of medical imaging tests

Author	Countries	Caregiver Sample Size	Imaging Tests	Outcome Measurements	Caregiver Results	Suggested improvements	Risk of Bias
	Quantitative Studies						
Oikarinen et al 2019 [18]	Finland	41	X-ray	Knowledge of radiation	34/41 received enough information about the purpose of the exam 3/41 on the dose 10/41 aware of radiation use 3 oral from staff, 1 oral and written 2 internet, 2 poster 38/40 want information on purpose of radiograph 35/40 radiation dose	Preferred method of information was oral, symbols, natural background radiation comparisons	High
Bjorkman et al 2016 [19]	Sweden	110	X-ray	Child and parent satisfaction with care provided Scale 1-5 Parent Perception (1 very dissatisfied, 5 very satisfied) (mean score)	Parental satisfaction: Highest scores for, Radiographers Kindness and ability to help 4.53/5 (5 is high) Lowest scores for, Radiographers time to ask questions 3.85/5 and time to meet child's needs scored lowest 3.94/5 Correlation found between parent and child satisfaction scores, radiographers' sensitivity to emotional needs and ability to explain the examination process clearly (correlation values 0.52 - 0.62)		Moderate
Inhestern et al 2023 [6]	Germany	132 before scan 93 after scan	MRI	Child and parent reported information status before MRI Experiences during MRI	Parents reported low to medium levels of burden, anxiety and nervousness before the MRI Parents reported high knowledge and information status about the	Suggested improvements include examination timeframes, better communication	Moderate

Author	Countries	Caregiver Sample Size	Imaging Tests	Outcome Measurements	Caregiver Results	Suggested improvements	Risk of Bias
				Needs and suggestions for improvement	MRI procedure But families attending for their child's first MRI scan reported higher anxiety levels in their children and worse information status Parents expressed needs regarding organisation of the MRI, age-appropriate information and communication	and room temperature adjustment.	
Nelson et al 2012 [20]	USA	263	Ultrasound, Fluoroscopy, Nuclear medicine	Patient and family experiences: pain, anxiety, time burden, satisfaction	80% parents rate experience as Good or Very Good Reported pain and psychological distress were worse for tests involving catheterization. Non white families reported worse experiences in psychological, pain and time domains in comparison to white families (p=0.04).		Moderate
	NarrativeStudies						
Shiner 2023 [21]	UK	1	X-ray, Ultrasound, Prenatal MRI, Interventional, CT	Experiences of hospital care with a focus around imaging and how the results are often the centre of much bigger life changing experiences	Challenges of person-centred care: Highlighting gaps in understanding Down Syndrome, particularly communication and respect for person-first language Emotional journey through healthcare: Emotional toll and varied healthcare experiences,	Advocacy for improved training: Need for healthcare professionals to be better trained in compassionate communication and handling	High

Author	Countries	Caregiver Sample Size	Imaging Tests	Outcome Measurements	Caregiver Results	Suggested improvements	Risk of Bias
					especially in imaging Systematic gaps: Critique of procedural rigidity and lack of individualised care, such as delayed communication and invasive protocols that overlook family wellbeing Parental resilience and Advocacy: Proactive role parents often must adopt to ensure appropriate care for their children	complex, sensitive cases	
Qualitative studies							
Hazell et al 2024	South Africa	15	x-ray	Explore and describe parents' perceptions of paediatric care.	Positive care received by child in radiology department - Professionalism, empathy, balancing act of radiographers Limitations prohibiting a caring environment - intimidating appearance of equipment - lack of information - minimal time for questions - time constraints	Need for parent-centred paediatric care through the implementation of Family Centred Care - Information sharing - effective communication - desire to participate in child's care - respect for cultural and individual needs	Moderate
H-Yazdi et al 2021[23]	USA	27	Proton beam therapy	The way parents of children treated with proton beam therapy view both the	Fear of radiation Seeking information about Proton Beam Therapy - Reliable/credible sources		Low

Author	Countries	Caregiver Sample Size	Imaging Tests	Outcome Measurements	Caregiver Results	Suggested improvements	Risk of Bias
				treatment and the sources of information surrounding the treatment	important to parents Sources include online, health care professionals, pamphlets Importance of hearing experience from other families using this treatment		
Gardling et al 2014 [24]	Sweden	8	MRI	Children and Parent's perceptions after an MRI scan	Parents perceived a sense of security when they received preparatory material Parents felt anxious because they knew little about the MRI scan and did not receive any information beforehand Little understanding of how still the child needed to be	Parents requested more information related to the duration of the MRI and the need for extra time if child was restless	Moderate
Hogberg et al 2020 [25]	Sweden	12	CT and X-ray	Parents experiences of Seeking healthcare for their infant Being accused of shaken baby syndrome/abusive head trauma being reported to social services undergoing criminal proceedings	Imaging was performed without parental knowledge/consent The results of these tests contributed to the parents' experiences of being accused. Associated legal and social challenges they faced because of the results Emotional and psychological impact on parents due to the use of these imaging tests		Low

Author	Countries	Caregiver Sample Size	Imaging Tests	Outcome Measurements	Caregiver Results	Suggested improvements	Risk of Bias
				impact on family			

Caregivers reported positive experiences when attending medical imaging tests with their children. The kindness and support of radiographers were significant contributors to caregiver satisfaction. Caregivers rated radiographers highly, with a mean score of 4.53 out of 5 for their kindness and ability to assist [26]. Radiographers' professionalism and empathy, alongside their ability to balance technical proficiency with compassionate care, were noted as pivotal in shaping positive experiences for both caregivers and children [22]. Overall, caregivers expressed high levels of satisfaction with the medical imaging experience, with 80% rating their experience as "good" or "very good" [20].

Caregivers suggested improvements in communication would assist in their experience, including being given clearer examination timeframes [6] and hearing about the experiences of other caregivers undergoing similar treatments to better prepare themselves [23]. Studies highlighted that providing preparatory materials and offering sufficient time for questions could significant reduce caregiver anxiety, improve their understanding and ensure smoother imaging procedures for their children [22] [24].

Need for information

Caregivers consistently emphasised the importance of receiving information before attending medical imaging tests with their children. In Oikarinen et al (2019) caregivers expressed a need to understand the purpose of the radiograph. However, only 10 out of 41 caregivers were aware that administering radiation to their child was a necessary part of the test. Once that information was presented to caregivers, 35/40 agreed specific information about radiation doses should be presented. Caregivers valued receiving information from credible sources, such as healthcare professionals, pamphlets and online resources [23] and reported a sense of security when preparatory materials were provided in advance [24].

Limited opportunities to ask questions and insufficient time for tailored discussions were commonly cited concerns. Radiographers received average scores of 3.85/5 for their availability to answer questions [26]. Participants specifically requested better communication regarding organisational aspects, such as duration of the scan and how to manage potential restlessness in younger children [6] [24].

Equality, diversity and inclusion

The analysis revealed disparities in the experiences of non-white caregivers during paediatric medical imaging tests, reporting worse overall satisfaction compared to their white counterparts [20]. Respecting cultural and individual needs was emphasised as a critical factor in fostering a supportive and inclusive environment for caregivers and children [22].

Additional gaps were identified in the understanding of specific conditions, such as Down Syndrome, where inadequate communication and a failure to use person first language were reported [21]. Caregivers reported rigidity in care delivery and a lack of individualised approaches which further detracted from their experiences [21].

Impact of medical imaging examination on caregiver

The experience often takes an emotional toll on the caregiver [21]. Tests involving invasive protocols, such as catheterisation, were particularly distressing, as they heightened children's pain which caregivers found upsetting [20].

In addition, the intimidating appearance of imaging equipment and fear of radiation were common concerns among caregivers, adding to their anxiety before and during the procedure [22,23].

Caregivers often perceived the protocols in medical imaging to be overly rigid and invasive, overlooking the wellbeing of caregivers [21]. To mitigate these impacts, caregivers highlighted the need for healthcare professionals to adopt family-centred care practices that prioritise both the child's and caregivers needs [22]. Caregivers expressed a strong desire to participate in their child's care, noting that inclusive practices helped reduce their stress and improve their overall experience [22].

Imaging examinations for investigations of child abuse were of particular distress to caregivers [25]. They experienced shock and confusion when their children were taken for extended investigations, including repeated radiological imaging, without clear explanations from healthcare professionals. This lack of communication led to feelings of despair and panic, as caregivers were not given the opportunity to provide consent or understand the necessity of the imaging, intensifying their anxiety. The sudden transformation from being caregivers to being treated as suspects created a sense of betrayal and mistrust towards medical professionals. The separation from their children and the accusations based on imaging results led to intense grief and a sense of loss. Overall, the medical imaging process and accusations of abuse had a profound and traumatic emotional impact on the caregivers, affecting their trust in healthcare and their emotional well-being [25].

Question 2. What interventions and methods are currently used to prepare, educate and familiarise caregivers with radiological procedures?

9 papers looked at interventions for caregivers, 1 mixed methods, 6 quantitative and 1 qualitative paper and 1 narrative piece. A range of interventions to improve the experience of adults attending medical imaging tests were evaluated. (**Error! Reference source not found.**). This included 4 parent and child preparation books/leaflets, 2 targeted radiographer training packages, 2 "apps", 2 child life services, 1 distraction toolkit, 1 virtual reality experience, 1 website and 1 mock scanner. A further description of the interventions provided by the authors of each study can be found in Table 3. 3/18 papers provided a theory base for their intervention including health literacy [27] [27] experiential learning and social cognitive theory [28] and family self-management framework [29].

Table 2 Interventions

Author	Countries	Caregiver Sample Size	Imaging Tests	Outcome Measurements	Intervention	Intervention effect on caregiver	Risk of bias
Mixed Method studies							
Bray et al 2019 [27]	UK	80	X-ray and Ultrasound	Primary outcome: Procedural anxiety, perceived procedural knowledge, satisfaction and involvement (children and parent) Secondary: Engagement and acceptability of the intervention	Xploro App	Quantitative results Reduction in procedural anxiety t = 3.942, P = .051 Increased parental satisfaction t= -3.63 P= 0.72 not statistically significant Qualitative results Improved communication and preparation Positive feedback on platform	Moderate

Author	Countries	Caregiver Sample Size	Imaging Tests	Outcome Measurements	Intervention	Intervention effect on caregiver	Risk of bias
						usability and engagement Support managing child's anxiety	
Quantitative Studies							
Baron et al 2016 [30]	USA	"Nearly 100"	Fluoroscopy, ultrasound, CT and MRI	Preparation for radiographers and parents before imaging children	Radiographer Training Child distraction toolkit Parent and child preparation book	87% preprepared for child's exam 60% felt their child was preprepared 42% had preparation material beforehand would they use online resource 82% said yes	High
Johnson et al 2014 [31]	USA	16	X-ray, CT, MRI, Ultrasound, Fluoroscopy, Interventional Radiology	Parent anxiety (state anxiety inventory) pre and post intervention Child anxiety (heart rate and blood pressure) Child challenging behaviours (behaviour observation tool) Procedure time	"Going to Imaging" app	Time: the step for children to hold still (D2) was slightly shorter for the app group, effect size small (0.15) Parental anxiety: Small reduction in anxiety, with a mean decrease of 0.6 points, while control group demonstrated increase of 2.5 points. Small effect size (0.33)	Moderate
Tyson et al 2014 [32]	USA	Not reported	CT, FL, nuclear medicine, radiography, US and MRI	Parent, staff and child satisfaction Perception of child pain and distress	Child life service. Initial assessment before imaging test	Satisfaction: higher satisfaction compared to control in 8/12 areas of survey Preparation: Mean score of 4.5 compared to 3.9 in control group ($p<0.05$)	Moderate

Author	Countries	Caregiver Sample Size	Imaging Tests	Outcome Measurements	Intervention	Intervention effect on caregiver	Risk of bias
						Emotional needs: 4.6 (intervention) vs 3.9 (control) (p<0.05) Overall satisfaction: 4.8 (intervention) vs 4.4 (control) (p<0.05) Perceived distress: 2.1 mean (intervention) vs 2.5 (control) (p<0.05) Pain: 1.5 (intervention) vs 1.8 (control) (p<0.05)	
Stunden et al 2020 [28]	Canada	Not reported	MRI	MRI simulation success (head movement) Child report anxiety Secondary outcomes Caregiver anxiety, preparation time, satisfaction, usability ratings	Child Life Service Virtual Reality Information Manual	Anxiety: Parents reported lower anxiety using virtual MRI and Child Life Support compared to standard information manual VR MRI vs Manual mean difference 5.33 95% CI [2.93, 7.74] p=<0.001 Manual vs Child Life Groups mean difference of 3.73, 95% CI [2.07, 6.40] p=0.004 Effect size 0.319 95% CI [0.15, 0.448] Correlation with child anxiety. Statistically significant positive correlation between caregiver anxiety and child anxiety after preparation. correlation coefficient r=-.421 (p<0.001) Caregivers reported higher satisfaction with VR MRI and Child	Moderate

Author	Countries	Caregiver Sample Size	Imaging Tests	Outcome Measurements	Intervention	Intervention effect on caregiver	Risk of bias
						Life Interventions compared to the standard manual p<0.001 (exact figures not provided) Effect size of 0.268, 95% CI [0.104, 0.402]	
Larson et al 2007 [33]	USA	100	CT scans	Parents understanding of radiation risks from CT scans Parents willingness to allow their child to undergo CT scans	Information leaflet	66% of parents believed scans increase lifetime cancer risk, this increased to 99% after reading the information handout Parent willingness to allow CT scanning increased from 67% to 80% after reading the handout Parents showed increased willingness for CT if their doctor considered it as valuable 5% of parents either refused or requested to defer their child's CT scan after reading the handout	Moderate
Morel et al 2020 [34]	France	91	MRI	Anxiety levels of children and parents Rate of motion artifacts during MRI scan	Teddy bear scale model of mock MRI scanner	Parental reported anxiety levels did not significantly change after the explanation phase but were significantly lower at the end of the MRI Parents reported a better understanding of the MRI procedure	Moderate
NarrativeStudies							
Pimm et al 1997 [35]	UK	Not reported	Radiotherapy	Qualitative improvements for child relaxation and co operation	Dedicated Paediatric Radiographer	Parents reported lower anxiety levels and higher confidence due to the continuity of having dedicated paediatric radiographer. Parents	Moderate

Author	Countries	Caregiver Sample Size	Imaging Tests	Outcome Measurements	Intervention	Intervention effect on caregiver	Risk of bias
				sedation use staff satisfaction Parental anxiety and support		reported feeling more informed and emotionally supported.	
Qualitative Studies							
Bolejko et al 2021 [36]	Sweden	12	Cystourethrogram	Parents perceptions of the impact of information received before and during the VCUG	Information website and information letter	Parents appreciated having information that helped them focus on their child rather than the technical aspects of the test Information allowed them to feel more in control, to provide emotional support to their child and to make informed decisions Parents valued the radiology nurse's expertise, which facilitated a sense of partnership and trust.	Moderate

Table 3 Intervention descriptions

Author	Intervention	Description
Bray et al 2019 [27]	Xploro App	**Health Information Delivery**: Xploro provides detailed information about hospital environments, key health staff, and medical equipment. This helps children understand what to expect during their hospital visit. **Gamification and Serious Games**: The platform includes various games with health themes that make learning about medical procedures fun and engaging for children. **Chatbot and Augmented Reality Avatar**: Children can interact with a customisable avatar that acts as a guide and chatbot, answering their questions and providing information in an interactive manner. **User-Centred Design**: Developed with input from children, health professionals, and parents, Xploro is tailored to meet the needs and preferences of its young users. This ensures the content is engaging and accessible. **Procedural Information**: The app covers a wide range of procedures, environments, and sensory experiences, helping children build coping strategies and reduce anxiety.
Baron et al 2016 [30]	Radiographer training Parent and child preparation book	**Radiographer Training**: The training sessions covered language choices, developmental considerations, comfort techniques, patient- and family-centred care practices, procedural support techniques, and coping styles. Conducted over several months, these sessions were tailored to different imaging modalities (fluoroscopy, ultrasound, CT, MRI) and included real-time support from child life specialists during high-volume paediatric imaging times. **Preparation book:** These books used child-friendly language and photographs to describe each imaging modality, and the steps involved in the procedures. They are available online and in radiology waiting

		areas, with information provided to patients during scheduling.
Johnson et al 2014 [31]	“Going to Imaging” app	Features a social script with 10 screens of photos and 1-2 sentences of text per screen, written at a first grade reading level. The app includes professional photos of children, hospital staff, and imaging equipment, along with a voice recording of a child reading the script.
Tyson et al 2014 [32]	Child life service	Comprehensive support from a Certified Child Life Specialist (CCLS) to children undergoing imaging procedures. The intervention included: **Preparation**: Verbal explanations, visual demonstrations, medical play, and discussions to build coping skills. **Procedural Support**: Distraction techniques, deep breathing exercises, non-procedural talk, emotional support, guided imagery, and advocacy with medical staff. **General Support**: Therapeutic activities, engagement in play, parental and sibling support, and advocacy for patient needs. The CCLS tailored these services based on an initial assessment of each child's and family's needs
Stunden et al 2020 [28]	Child life service Virtual Reality Information manual	**Child Life Service** The Child Life Program (CLP) involved a Certified Child Life Specialist preparing the child for the MRI using a hospital-based MRI simulator. The preparation included developing rapport with medical professionals, familiarising the child with the hospital setting and medical equipment, discussing the upcoming procedure, and helping the child get comfortable with earplugs, headphones, loud noises, restraints, the head coil, and holding still. The preparation was individualised and adapted to each child's needs. **Virtual Reality** The VR-MRI application was a custom-designed virtual reality experience developed by the BC Children's Hospital Digital Lab. It included a tutorial and a tour sequence to

		familiarise the child with the hospital environment, medical staff, and MRI procedure. The VR experience involved interactive elements, such as hotspots to transition between rooms, and a game-based activity to help the child practice staying still during the MRI. The VR-MRI aimed to provide an immersive, engaging, and standardised preparation experience. **Information Manual** The Standard Preparatory Manual (SPM) was the hospital's standard guide for non-sedated MRI preparation. It contained a series of photos showing the MRI experience step-by-step, intended to help children and their families prepare for the procedure. Caregivers were instructed to use the manual to prepare their child as they would at home, with materials such as a chair and MRI sounds provided for practice. The preparation was not standardised to reflect the current environment
Larson et al 2007 [33]	Information leaflet	Provides parents with essential information about CT scans and their associated radiation risks. The leaflet included: **Description of CT and Radiation**: A brief explanation of what a CT scan is and the type of radiation it uses. **Comparison Table**: A table comparing radiation exposure from various activities (e.g., daily background radiation, a 3-hour airline flight, a chest radiograph) to the radiation dose from a head CT and an abdominopelvic CT. **Risk Information**: An explanation that, although the long-term effects of CT radiation are controversial and not fully understood, low levels of radiation exposure from CT are assumed to slightly increase the risk of cancer. It provided an estimated lifetime risk of fatal cancer attributable to radiation from a single abdominal CT examination in infancy.

		Alternatives to CT: A section listing alternatives to CT, including observation in some circumstances. **Readability**: The leaflet was 757 words long and written at an eighth-grade readability level, making it accessible for most parents to read in under 5 minutes.
Morel et al 2020 [34]	Teddy bear scale model of mock MRI scanner	Involved using a small, toy-like model of an MRI scanner to help prepare children for their actual MRI scans. This model was designed to be child-friendly, made from materials like wood, plexiglass, and cotton fabric, and included features such as a removable head antenna, gentle restraints, and a stereo system that played MRI sequence sounds to familiarise children with the loud noises. The intervention took place in a preparation room where MRI technologists used the teddy bear-scale mock MRI to explain the procedure to the children. Children were encouraged to bring a teddy bear (MRI-compatible) into the real MRI scanner and keep it with them during the scan.
Pimm et al 1997 [35]	Dedicated Paediatric Radiographer	Appointing a radiographer specifically responsible for overseeing the course of treatment for children undergoing radiotherapy. This role included providing continuous support, encouragement, information, and facilitating movement throughout the clinical environment for both the child and their family. Key responsibilities of the paediatric radiographer included: **Introduction and Orientation**: Greeting and introducing the child and family to key personnel involved in the treatment, and providing a guided tour of the department, including the children's waiting room, mould room, simulator, and treatment unit. **Support and Communication**: Answering questions related to the treatment, care, and

		welfare of the child, and accompanying the child and parents to clinic appointments with the consultant oncologist. **Appointment Coordination**: Arranging appointments for the mould room, simulator, and treatment sessions, and ensuring they fit in with other family commitments. **Treatment Assistance**: Assisting at all mould room and planning sessions, attending the first few treatment appointments, and introducing the staff responsible for subsequent treatments. **Regular Check-ins**: Meeting the child and parents regularly during radiotherapy, attending relevant review clinics, and ensuring any required actions are executed. The paediatric radiographer also underwent specialised training, for example the Oncology Course for Nurses.
Bolejko et al 2021 [36]	Information website and information letter	Providing parents with an appointment letter and reference to an information website before their child's voiding cystourethrogram (VCUG) examination. **Information Letter** The appointment letter sent to parents included: A brief description of the VCUG examination procedure. Instructions to arrive at the department at least one hour ahead of the scheduled time. Preparation instructions, such as ensuring the child has eaten and rested. Information on how parents can participate during the examination, including tips for distraction (e.g., singing, standing close to the child). Contact information and directions to the radiology department. **Information Website**

		The website provided detailed information about the VCUG, including: The reason for the VCUG and the diagnostic information it may provide. A detailed description of the examination procedure, including catheter insertion, the use of a contrast agent, and the process of performing the VCUG during micturition. Examples of how parents can support their child during the examination. Additional preparation instructions and contact details. Parents were also encouraged to call the radiology department before the examination date to review the procedure information and ask any questions. This information was reiterated verbally by a radiology nurse in the waiting room and during the examination.

Radiographer training packages (2 studies)

The packages were reported to be effective, with 87% of caregivers feeling prepared for their child's exam [30]. Parents spoke of lower anxiety and increased confidence when supported by a dedicated paediatric radiographer, providing continuity, emotional support and information to caregivers [35]

Child life services (2 studies)

This service improved preparation and emotional outcomes. Caregivers reported higher satisfaction compared to controls (4.8 vs 4.4, $p<0.05$) and better emotional support (4.6 vs 3.9, $p<0.05$) [32]. These services also reduced perceived distress (2.1 vs 2.5, $p<0.05$) and pain (1.5 vs 1.8, $p<0.05$). Caregivers in these programs reported lower anxiety compared to those using manuals (mean difference = 3.73, 95% CI[2.07, 6.40], $p = 0.004$) [28]. *Distraction toolkits* yielded similar outcomes, with 87% of caregivers feeling prepared [30]

Technology (3 studies)

The use of apps for caregivers demonstrated a small reduction in anxiety (mean

decrease 0.6 points), compared to a mean increase of 2.5 points in the control group, with a small effect size of 0.33 [31]. Apps also demonstrated a reduction in procedural anxiety and improved communication and preparation during examinations [27]. *Virtual reality use in MRI* reduced caregiver anxiety compared to manuals (mean difference = 5.33, 95% CI [2.93, 7.74], $p<0.001$). While virtual reality preparation required more time (mean 11.79 minutes, 95% CI[11.05, 12.55]) it was associated with improved caregiver satisfaction and reduced anxiety [28].

Mock scanner (1 study)

Only one controlled trial reported the use of a mock scanner, demonstrating a better understanding of the MRI procedure, though caregiver anxiety did not significantly change after the explanation phase. Anxiety levels were lower at the end of the procedure, likely due to relief that the test had been completed [34]

Written information (5 studies)

Written information was provided in the form of paper information leaflets [36] [33] [28] [30] and website [36]. Bolejko et al [36] found that caregivers appreciated having information from websites and letters, which helped them focus on their child and feel more in control, providing emotional support and making informed decisions. Larson et al [33] reported information leaflets significant increased caregivers understanding of radiation risks for CT scans, with an increased willingness to allow CT scans for their child from 67% to 80%. But Baron et al highlighted that only 42% of caregivers had preparation material beforehand, suggesting a gap in the distribution of information. Stunden et al [28] noted that caregivers reported lower anxiety and higher satisfaction with virtual MRI and Child Life Support compared to standard information manuals.

Discussion

This review synthesises evidence from 18 studies examining the experiences of caregivers attending medical imaging tests with their children and the effectiveness of various preparatory interventions. Overall, the findings highlight the complex interplay between caregiver anxiety, child distress and the critical role of preparation and communication in optimising outcomes for the child.

Positive and negative experiences were documented regarding the caregiver experience attending medical imaging tests with their child. We found no high-quality evidence to suggest a particular resource is superior for preparing and improving the experience for caregivers attending medical imaging tests.

The role of the caregiver and family centred care.

More recently, radiography departments have been advised to adopt a family-centred care model [22]. Historically, paediatric nursing and medicine have been at the forefront of advancing family-centred care and integrating it into the healthcare environment [37]. This model places the patient and family at the centre of all healthcare decisions [38] and promotes true collaboration, partnership, and information sharing between patients, families, and healthcare team members [39] . Efforts to empower families to be more effective participants in their children's care are a step towards family-centred care [40] and represent an achievable goal for medical imaging departments providing care to children. Attainable actions include allowing parents into the medical imaging room to assist with positioning, allowing the caregiver to take on the play/distraction role during examinations and building rapport and trust with caregivers through clear and empathetic communication before, during and at the end of tests.

Impact on caregivers

This review emphasises the emotional and psychological challenges faced by caregivers during their child's medical imaging tests/ It underscores the need for transparency and active inclusion of caregivers by the medical staff to help alleviate these negative impacts. The adverse effects of hospitalisation on parents are well documented [41] and hospitalising a child, whether planned or unplanned, is stressful for even the most organised and functional families [42].

Radiology could be identified as a unique setting in comparison to other hospital settings. Departments may only be visited briefly but may have a large impact by diagnosing a child's illness and indicating the treatment regime to be followed. Departments are often perceived by families as highly technological and "a frightening place to be" [43] and may offer a different experience to a ward setting. This review highlighted that parent's had specific concerns related to invasive radiological procedures and fear of radiation. In addition, Högberg et al [25] emphasised the emotional and social challenges caregivers faced during suspected physical abuse investigations. However, the studies included in this review investigated a multitude of different scan types across a range of settings. Each test will provide its unique set of worries and concerns for caregivers and this study has

highlighted the need for a deeper understanding of the impact of these tests on caregivers. There is an urgent need to explore caregivers' experiences and identify the best ways to support parents involved in emotionally charged radiological examinations.

Inequities in care

Most participants in the included studies were predominantly from well educated, white middle-class families. This causes a disparity in understanding the experiences of caregivers from different backgrounds and provides a gap in the understanding of different cultural needs due to the limited demographics of participants of included studies.

The study by Nelson et al [20] demonstrated that caregivers from non-white backgrounds experienced worse scores for anxiety, distress, and overall experience. A patient's interaction with the healthcare system is complex, influenced by factors such as health literacy, medical mistrust, previous experiences, cultural differences, and communication or linguistic barriers. The disparities experienced by caregivers from non-white backgrounds urgently need to be addressed to eliminate healthcare inequities in medical imaging.

Effectiveness of preparatory interventions

A range of preparatory interventions were reviewed, including radiographer training packages, written materials like leaflets and booklets, apps, websites, virtual reality, child life services, and mock scanners. However, many of these interventions were not primarily designed to enhance caregivers' experiences; instead, they used parental outcomes as evaluation tools. This approach may reflect the early stages of understanding family-centred care within the radiographic profession.

This review demonstrates that caregivers value information from trusted sources before attending imaging examinations to better understand the test and how to prepare and support their child. Clear information provided to parents before imaging tests benefits their experience. This is supported by broader paediatric nursing literature, where sufficient and consistent information is crucial for caregivers [44] and necessary for advice and clarification of their role [42] to enable meaningful parent participation [45].

The use of interventions also appeared to have secondary effects on the length of radiological examinations. After receiving an information handout, 5% of parents refused or requested to defer the procedure [33] and the provision of additional information left caregivers with more questions. Therefore, researchers designing complex interventions for caregivers attending medical imaging tests must consider factors such as examination times, radiographer training, and communication post-implementation.

Strengths and limitations

One of the key strengths of this study is its comprehensive approach to evaluating parental experiences during paediatric medical imaging tests. By including a diverse

range of studies from multiple countries and employing various methodologies (e.g., cross-sectional studies, randomised control trials, qualitative studies), the review provides a broad and nuanced understanding of the topic. Additionally, the review highlights the importance of caregiver involvement and the impact of preparatory materials and interventions, offering valuable insights for improving clinical practices and policies.

However, the study also has several limitations. The predominance of well-educated, white female participants limits the generalisability of the findings to more diverse populations [46]. Many studies did not report detailed demographic information, which further restricts the ability to understand the experiences of different caregiver groups, for example fathers and families from diverse cultural and socioeconomic backgrounds. Only 6 studies focused exclusively on caregiver outcomes and many amalgamated caregiver and child data, limiting the ability to draw definitive conclusions about the impact on caregivers.

The review also identified significant quality issues in the included studies, such as small sample sizes, potential recruitment biases, and a lack of control for confounding variables. These limitations highlight the need for more robust and inclusive research to better inform guidelines and support mechanisms for caregivers during paediatric medical imaging procedures.

The systematic review process also offers some limitations. As a result of time and financial constraints, this review excludes studies published in languages other than English, leading to incomplete evidence. Due to the heterogeneity of the included studies, a meta analyses was not undertaken. In addition, systematic reviews fall victim to publication bias. Studies with positive results are more likely to be published than those with negative or inconclusive results [47] which can skew the findings of the review.

Conclusion

This review highlights the diverse range of preparatory interventions in paediatric radiology, including radiographer training packages, written materials, apps, websites, virtual reality, child life services, and mock scanners.

Despite the variety of potential interventions on offer, most were not primarily designed to enhance caregivers' experiences. The findings underscore the advantages clear and trusted information for caregivers, which significantly enhances their experience.

The implications for clinical practice and policy are substantial. There is a need for comprehensive guidelines and policies that support family-centred care in paediatric radiology, ensuring that caregivers receive the necessary information and support.

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