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Bone Age Assessment in Children Utilizing Knee MRI

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ADMINISTRATIVE INFORMATION

Support - Not applicable.

Review Stage at time of this submission - The review has not yet started.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY2025110090

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 26 November 2025 and was last updated on 26 November 2025.

INTRODUCTION

Review question / Objective Population: Children and adolescents undergoing bone age assessment • Exposure: Knee MRI (Magnetic Resonance Imaging) • Outcome: Accuracy, reliability, reproducibility, and clinical usefulness in bone age assessment.

Rationale The question of the protocol is whether knee MRI is accurate and reliable for determining bone age in children and adolescents.

Condition being studied Bone age assessment (BAA) is a crucial diagnostic tool in pediatric endocrinology and orthopedics, used to determine skeletal maturity, predict final height, and manage growth disorders. Traditional BAA relies on X-ray imaging, but Knee MRI is being investigated as a non-ionizing alternative.

METHODS

Search strategy We will search MEDLINE (via PubMed), Embase, Scopus, Google Scholar. Additionaly we will apply manual search of references from included articles and citation chaining (forward and backward tracking).

Participant or population Children and adolescents (aged 0–18 years) who have undergone Knee MRI for the purpose of bone age assessment. Studies including subjects with pre-existing skeletal or growth disorders will be included, provided they specifically report the accuracy of the MRI technique for BAA. Studies focusing exclusively on adult populations will be excluded.

Intervention Not applicable.

Comparator The comparator will be the conventional reference standard method for Bone Age Assessment (BAA) used in the primary studies, which is typically X-ray of the hand and wrist (e.g., the Greulich and Pyle or Tanner and Whitehouse methods).

Study designs to be included We will include diagnostic accuracy studies that evaluate the performance of Knee MRI methods for bone age assessment. This includes cross-sectional studies, case-control studies, and cohort studies where a reference standard (e.g., Greulich and Pyle method from X-ray) is compared against a Knee MRI method.

Eligibility criteria
Inclusion:
– humans
– age <18 y.o.

Information sources We will search MEDLINE (via PubMed), Embase, Scopus, Google Scholar. Additionaly we will apply manual search of references from included articles and citation chaining (forward and backward tracking).

Main outcome(s) The primary outcome is the accuracy of Knee MRI for bone age assessment, measured by: 1) Correlation coefficient between MRI-derived bone age and reference standard age. 2) Mean difference (bias) and limits of agreement (precision) from Bland-Altman plots. 3) Sensitivity and specificity, where reported.

Additional outcome(s) Secondary outcomes include: 1) Reliability and reproducibility (inter- and intra-observer agreement) of the MRI methods. 2) Clinical usefulness as discussed by authors, including practical factors such as scanning time, cost, and patient acceptance. 3) The specific MRI sequence and technique used (e.g., T1-weighted, T2-weighted, 3D, 2D).

Data management Search results will be imported into a dedicated systematic review management software for deduplication and screening. Two independent reviewers will screen titles, abstracts, and full-text articles. Extracted data (study characteristics, patient demographics, outcomes, and QUADAS-2 domains) will be recorded in a standardized, pre-piloted data extraction form. Discrepancies at all stages will be resolved by consensus or by consultation with a third reviewer.

Quality assessment / Risk of bias analysis The risk of bias in the included diagnostic accuracy studies will be assessed using the Quality Assessment of Diagnostic Accuracy Studies-2 (QUADAS-2) tool. This tool covers four domains: patient selection, index test, reference standard, and flow and timing. Two independent reviewers will apply the tool, and disagreements will be resolved by consensus or a third reviewer.

Strategy of data synthesis We will provide a narrative synthesis of the findings, grouping studies by the specific MRI method used. Where appropriate and if sufficient data homogeneity exists, a meta-analysis will be performed. For correlation coefficients, a random-effects model will be used to pool estimates. Statistical analysis will be performed using RevMan or Stata software.

Subgroup analysis We plan to perform subgroup analyses based on key methodological and clinical factors, including: 1) Age group (e.g., pre-pubertal vs. pubertal children). 2) Sex (males vs. females). 3) Specific MRI technique (e.g., specific pulse sequences or scoring systems used).

Sensitivity analysis We will conduct sensitivity analyses to assess the robustness of our pooled estimates. This will include:
– Excluding studies deemed to have a high risk of bias in one or more QUADAS-2 domains.
– Excluding studies that do not use the most common reference standard (e.g., Greulich and Pyle method).
– Performing a fixed-effect meta-analysis for comparison with the primary random-effects model, where applicable.

Language restriction English only.

Country(ies) involved Poland.

Keywords Bone age assessment; Knee MRI; Magnetic Resonance Imaging; Children; Adolescents; Diagnostic accuracy.

Dissemination plans Peer-revied publication in open access model.

Contributions of each author
Author 1 - Oleg Nowak - Conceptualization, methodology development, protocol drafting, supervision, and final manuscript approval. Oleg Nowak is the guarantor for the veracity and accuracy of the protocol.
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Author 2 - Michał Dębiński - Contributed to the development of the search strategy, statistical analysis plan, and data synthesis strategy. Critically reviewed and approved the final manuscript.

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Author 3 - Jakub Szczerbicki - Contributed to the development of the selection criteria, the risk of bias assessment strategy (QUADAS-2), and full-text screening protocol. Reviewed and approved the final manuscript.
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Author 4 - Marcin Waśko - Provided clinical expertise on Bone Age Assessment and Knee MRI. Critically revised the protocol for intellectual content and approved the final version.
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