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AI-Assisted Biparametric MRI as an Alternative to Multiparametric MRI: Systematic Review and Budget-Impact Modelling in Low- and Middle-Income Countries

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Background

Multiparametric MRI (mpMRI), established by the PROMIS trial, is the pre-biopsy reference standard for detecting clinically significant prostate cancer (csPCa, ISUP Grade ?2). The PRIME trial challenges this standard, supporting biparametric MRI (bpMRI) as a faster, lower-cost alternative with comparable diagnostic performance. Artificial intelligence (AI) may further improve detection and efficiency. In low- and lower-middle-income countries (L/LMICs), these efficiencies could reduce per-scan costs and expand MRI access, addressing diagnostic inequities. This review systematically maps AI models developed for csPCa detection using bpMRI and mpMRI, appraised via standard methodological frameworks, and models the direct imaging budget impact and theoretical system-capacity gains of switching to a bpMRI-based workflow.

Methods

Following PRISMA guidelines [PROSPERO: CRD420251037432], MEDLINE, PMC, EMBASE, SCOPUS, and COCHRANE were searched, yielding 6,389 records; 202 underwent full-text review and six studies met inclusion criteria. AI models were assessed using TRIPOD checklists. Deterministic health-system budget-impact and capacity models were developed using GLOBOCAN 2022 prostate cancer incidence data and MRI availability from IAEA. Conservative and realistic scenarios assumed 10% vs 25% MRI referral rates, $100 vs $200 per-scan savings, and one scan per patient, estimating total scans, direct annual savings, and theoretical capacity uplift.

Results

Six studies evaluated AI-assisted csPCa detection using bpMRI (PMID: 40259798, 36222324, 38876123) and mpMRI (PMID: 40016318, 37345961, 33671533). Pooled performance metrics and comparative standard metrics have been presented in Table 1. Conservative and realistic models estimates are depicted in Table 2, highlighting the additional scans per machine, corresponding to 7.35M extra scans/year at $300 per scan (~$2.2B value).

Conclusion

Biparametric MRI, with or without AI, matches mpMRI for csPCa detection and offers substantial efficiencies. Modelling suggests meaningful cost savings and large theoretical scanner capacity gains, which could be redirected to reduce wait times and expand access in L/LMICs, supporting equitable, high-throughput prostate cancer diagnostics.

References

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Performance Metrics	**MP-MRI study subset (pooled)**	**Bp-MRI study subset (pooled)**	**PROMIS trial: Standalone mpMRI**	**Bp-MRI: AI-assisted Human Reader**
Sensitivity	0.884 (0.75-0.98)	**0.65 (0.39, 0.84)**	0.93 (0.88, 0.96)	**0.97 (0.95, 0.98)**
Specificity	0.68 (0.51-0.80)	**0.93 (0.69, 0.99)**	0.41 (0.36, 0.46)	**0.50 (0.42, 0.58)**
Area under the Curve (AUC)	0.84 (0.69-0.95)	**0.88 (0.80, 0.93)**	Not Reported	**0.92 (0.89, 9.94)**

Table 1: Comparative Performance metrics of the AI-Assisted mpMRI and bpMRI study for csPCa Detection, with reference to PROMIS (**PMID: 28110982**) and PI-CAI (**PMID: 40512493**) Benchmarks.

Metrics	**Conservative model**	**Realistic model**
MRI performed	19744	49361
Direct USD annual savings	$1,974,000	$9,872,000
Capacity uplift	1600 (3200 -> 4800)	1600 (3200 -> 4800)

Table 2: Budget Impact and Capacity Uplift Estimates using Conservative and Realistic Health-System Perspective Modelling