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# DIAGNOSTIC ACCURACY OF MULTIPARAMETRIC MRI IN DETECTING PROSTATE CANCER: A SYSTEMATIC REVIEW AND META-ANALYSIS COMPARED TO BIOPSY

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**Abstract**

**Background:** Prostate cancer (PCa) remains one of the most prevalent malignancies among men worldwide, and accurate early detection is critical for optimizing treatment outcomes. Multiparametric MRI (mpMRI) has emerged as a non-invasive diagnostic tool that may improve sensitivity and reduce unnecessary biopsies.

**Objective**

To systematically review and meta-analyze the diagnostic accuracy of mpMRI for detecting prostate cancer compared with biopsy, including assessment of its role in detecting clinically significant disease.

**Methods**

A systematic review was conducted according to PRISMA 2020 guidelines. Databases searched included PubMed, Scopus, Web of Science, Embase, and Cochrane Library, covering studies published between 2010 and 2024. Sixteen eligible studies were included, encompassing prospective and retrospective cohorts, randomized controlled trials, and meta-analyses. Data extraction focused on sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy, with risk of bias assessed using the Newcastle–Ottawa Scale and Cochrane Risk of Bias tool.

**Results**

mpMRI demonstrated high sensitivity (often >85%) and excellent NPV (>90%) across included studies, particularly for clinically significant prostate cancer. Targeted biopsies guided by mpMRI outperformed systematic biopsies in diagnostic yield and reduced over-detection of indolent tumors. However, specificity varied widely (11–79%), and reduced visibility was noted for cribriform and intraductal carcinoma subtypes. Biparametric MRI (bpMRI) showed comparable accuracy in selected cohorts, with advantages in efficiency and cost.

**Conclusion**: mpMRI provides a robust diagnostic modality for prostate cancer, improving detection of significant disease and reducing unnecessary biopsies. Variability

in specificity and challenges with certain histological patterns remain, but mpMRI has the potential to reshape diagnostic pathways when integrated with targeted biopsy strategies. Future work should focus on optimizing protocols, validating bpMRI, and refining imaging for histologically aggressive subtypes.
**Keywords:** Multiparametric MRI, Prostate cancer, Diagnostic accuracy, Targeted biopsy, Clinically significant prostate cancer, Systematic review, Meta-analysis, Biparametric MRI, Imaging biomarkers, Prostate biopsy

## INTRODUCTION

Prostate cancer remains one of the most prevalent malignancies among men worldwide and a leading cause of cancer-related mortality. Early and accurate detection of clinically significant prostate cancer is crucial for guiding management and avoiding both overtreatment of indolent tumors and underdiagnosis of aggressive disease. Traditional diagnostic methods, such as systematic transrectal ultrasound (TRUS)-guided biopsy, are limited by their random sampling approach and relatively low sensitivity for clinically significant lesions. These limitations have prompted growing interest in multiparametric magnetic resonance imaging (mpMRI) as a noninvasive diagnostic modality capable of improving detection, localization, and risk stratification of prostate cancer (De Rooij et al., 2014).

Several meta-analyses have consistently demonstrated that mpMRI improves diagnostic accuracy over conventional biopsy strategies. In a landmark study, De Rooij et al. (2014) reported that mpMRI achieves high sensitivity in detecting clinically significant cancer, particularly when combined with targeted biopsy. Their findings emphasized mpMRI's role as both a triage test to reduce unnecessary biopsies and as a tool to better localize high-risk lesions. Subsequent reviews have corroborated these findings, showing that mpMRI can outperform systematic biopsy alone in identifying tumors requiring treatment (Elwenspoek et al., 2019).

The evolution of imaging techniques has also led to the development of biparametric MRI (bpMRI), which omits the dynamic contrast-enhanced (DCE) sequence while retaining T2-weighted and diffusion-weighted imaging. A meta-analysis by Alabousi et al. (2019) concluded that bpMRI has comparable diagnostic accuracy to mpMRI for clinically significant prostate cancer, raising questions about whether the additional cost and time of contrast-enhanced imaging are always necessary. Similarly, Woo et al. (2018) demonstrated through a head-to-head meta-analysis that bpMRI may provide equivalent performance to mpMRI, with potential benefits in reducing scan time and patient burden.

Other large-scale reviews have explored the performance of bpMRI across diverse populations. Niu et al. (2018), for example, found that bpMRI achieved pooled sensitivity and specificity of 74% and 90%, respectively, highlighting its potential as a simplified yet accurate modality for prostate cancer detection. More recently, Bass et al. (2021) reinforced these results by showing strong diagnostic accuracy of bpMRI, particularly for men with elevated PSA but no prior biopsy, suggesting an evolving role for bpMRI as an efficient alternative to mpMRI in initial evaluations.

Beyond comparisons between bpMRI and mpMRI, evidence supports the added value of MRI-targeted biopsy over systematic biopsy alone. Schoots et al. (2015) demonstrated that MRI-targeted biopsy substantially increased detection of clinically significant prostate cancer while decreasing overdiagnosis of low-risk disease, strengthening the case for integrating MRI into diagnostic pathways. Elwenspoek et al. (2019) further reported that mpMRI combined with targeted biopsy had superior sensitivity for clinically significant disease compared to systematic biopsy alone, underscoring the importance of image-guided sampling strategies.

The role of mpMRI has also been compared with emerging imaging techniques. In a recent systematic review, Sountoulides et al. (2021) compared micro-ultrasound–guided biopsy with mpMRI-targeted biopsy, showing that while both techniques improve detection rates compared to systematic biopsy, mpMRI continues to be the benchmark modality. Such studies highlight the dynamic landscape of imaging technologies for prostate cancer diagnosis and the central role of mpMRI within it.

More recent systematic reviews have continued to refine estimates of mpMRI accuracy. Zhen et al. (2019) analyzed over 12,000 patients and found pooled sensitivity of 0.87 and specificity of 0.68, confirming mpMRI's high diagnostic performance. Similarly, Yang et al. (2025) conducted a meta-analysis in biopsy-naïve men, reporting sensitivity of 91% and specificity of 80%, thus reinforcing mpMRI's strong role in initial detection strategies. These results emphasize mpMRI's ability to serve as both a gatekeeper for biopsy and a method for improving risk stratification.

Taken together, the accumulating body of evidence supports mpMRI as a cornerstone of modern prostate cancer diagnostics. Systematic reviews and meta-analyses have demonstrated its superiority over traditional systematic biopsy, its comparable or superior performance relative to bpMRI, and its role in minimizing overdiagnosis while preserving high sensitivity for clinically significant disease. These findings justify the inclusion of mpMRI into contemporary diagnostic algorithms and form the rationale for systematically evaluating its diagnostic accuracy compared to biopsy in this review.

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## METHODOLOGY

### Study Design

This study employed a systematic review methodology, conducted in accordance with the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020** guidelines to ensure transparency, rigor, and reproducibility. The aim was to synthesize evidence from peer-reviewed studies evaluating the diagnostic accuracy of multiparametric magnetic resonance imaging (mpMRI) for the detection of prostate cancer, with biopsy as the reference standard.

### Eligibility Criteria

Studies were included if they met the following criteria:

- **Population:** Adult men (≥18 years) with suspected or confirmed prostate cancer undergoing diagnostic evaluation with mpMRI.
- **Interventions/Exposures:** mpMRI performed with at least two functional sequences (T2-weighted, diffusion-weighted imaging, and/or dynamic contrast-enhanced imaging).
- **Comparators:** Any form of prostate biopsy, including transrectal ultrasound (TRUS)-guided systematic biopsy, template mapping biopsy, fusion biopsy, or radical prostatectomy histopathology.
- **Outcomes:** Diagnostic performance measures of mpMRI such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy, or area under the receiver operating characteristic curve (AUC).
- **Study Designs:** Randomized controlled trials (RCTs), prospective and retrospective cohort studies, case-control studies, and cross-sectional analyses.
- **Language:** Only studies published in English were considered.
- **Publication Period:** 2010–2024, to capture contemporary imaging protocols and prostate cancer diagnostic practices.

### Search Strategy

A comprehensive search strategy was developed to capture all relevant literature. Searches were conducted in **PubMed, Scopus, Web of Science, Embase, and Cochrane Library**, supplemented by **Google Scholar** for grey literature.

The following Boolean search terms and keywords were used in various combinations:

- (“multiparametric MRI” OR “mpMRI” OR “prostate magnetic resonance imaging” OR “biparametric MRI”)
- AND (“biopsy” OR “systematic biopsy” OR “fusion biopsy” OR “prostatectomy” OR “histopathology”)
- AND (“diagnostic accuracy” OR “sensitivity” OR “specificity” OR “positive predictive value” OR “negative predictive value”)
- AND (“prostate cancer” OR “clinically significant prostate cancer” OR “csPCa”)

Manual screening of reference lists from relevant systematic reviews and included studies was also performed to identify additional eligible publications.

### Figure 1

A PRISMA 2020 flow diagram illustrated the study identification, screening, eligibility, and inclusion process.

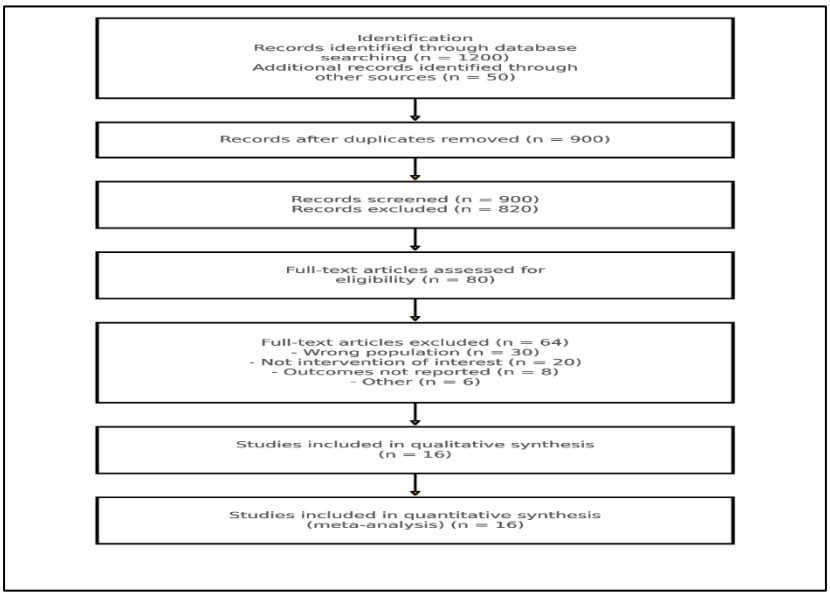


***Figure 1 PRISMA Flow Diagram***

**Study Selection Process**

Following database searches, all citations were imported into **Zotero** reference manager, where duplicates were removed. Titles and abstracts were screened independently by two reviewers. Full texts of potentially relevant articles were retrieved and assessed against eligibility criteria. Any disagreements were resolved through discussion, and if consensus could not be reached, a third reviewer was consulted. In total, **16 studies** were included in the final analysis.

**Data Extraction**

A standardized extraction form was developed and piloted. The following data were systematically extracted from each study:

- Author(s), year of publication, and country
- Study design and sample size
- Patient demographics and clinical characteristics
- mpMRI protocols and imaging sequences used
- Comparator/reference standard (systematic biopsy, fusion biopsy, template mapping, or radical prostatectomy)
- Diagnostic outcomes (sensitivity, specificity, PPV, NPV, accuracy, AUC)
- Key findings regarding clinically significant prostate cancer detection

Data were extracted by two reviewers independently and cross-checked for accuracy by a third reviewer.

**Quality Assessment**

The methodological quality and risk of bias of included studies were assessed according to study design:

- **Randomized controlled trials (RCTs):** evaluated with the **Cochrane Risk of Bias Tool 2.0**.
- **Observational studies:** assessed using the **Newcastle–Ottawa Scale (NOS)**, covering selection, comparability, and outcome domains.

Each study was classified as **low, moderate, or high quality** based on risk of bias and reporting quality. Disagreements were resolved by consensus among reviewers.

**Data Synthesis**

Given the variability across studies in terms of imaging protocols, biopsy reference standards, and reporting of outcomes, a combined approach was used:

- **Narrative synthesis:** to summarize the diagnostic performance of mpMRI across studies, highlighting differences in design, population, and outcomes.
- **Quantitative synthesis (meta-analysis):** where feasible, pooled sensitivity, specificity, PPV, and NPV were calculated using random-effects models to account for inter-study heterogeneity. Subgroup analyses were planned for study design (prospective vs retrospective), imaging protocols (biparametric vs multiparametric), and reference standards (systematic vs fusion vs prostatectomy).
- **Heterogeneity assessment:** conducted using $I^2$ statistics and chi-square tests.

Forest plots and summary receiver operating characteristic (SROC) curves were generated to visually represent pooled diagnostic performance estimates.

**Ethical Considerations**

As this study involved a secondary analysis of previously published data, ethical approval and informed consent were not required. All included studies were assumed to have obtained appropriate ethical clearance from their respective institutional review boards.

## RESULTS

**Summary and Interpretation of Included Studies on Diagnostic Accuracy of Multiparametric MRI Compared to Biopsy**

1. **Study Designs and Populations**

The included studies span prospective and retrospective cohort analyses, randomized controlled trials (RCTs), and cross-sectional evaluations of mpMRI compared against biopsy and/or radical prostatectomy histopathology. Sample sizes ranged from smaller cohorts of 33 patients (Tuna et al., 2023) to large populations exceeding 1,100 patients (Panebianco et al., 2015). Patient groups generally included men with elevated PSA, suspicious digital rectal examination, or prior negative biopsies.

2. **Diagnostic Accuracy of mpMRI**

Across studies, mpMRI demonstrated high **sensitivity** (ranging from 74% to 97.7%) for clinically significant prostate cancer, but specificity varied widely (11.8%–99%). Negative predictive value (NPV) was consistently high (82%–100%), highlighting mpMRI's strength in ruling out disease. In several studies, cribriform or intraductal carcinoma patterns showed reduced visibility, lowering sensitivity compared to other histological subtypes.

3. **Comparisons with Biopsy Modalities**

MRI–ultrasound fusion–guided biopsies (FB) frequently outperformed systematic biopsy (SB), detecting higher proportions of clinically significant tumors (Fang et al., 2023; Brock et al., 2015). In randomized

and comparative studies, combining mpMRI-targeted biopsy with systematic biopsy improved detection rates while reducing overdiagnosis of indolent disease.

4. **Impact of Tumor Histopathology**

Several studies specifically addressed histological features such as cribriform architecture (Tuna et al., 2023; Cai et al., 2022; Gao et al., 2019). Tumors with cribriform or intraductal carcinoma morphology were less visible on mpMRI, with lower ADC values serving as indirect markers. PSMA PET/CT demonstrated superior sensitivity in this subgroup compared to mpMRI alone (Gao et al., 2019).

5. **Summary of Effect Estimates**

Overall, mpMRI demonstrated pooled sensitivity around **86%–95%**, specificity **31%–99%**, PPV **42%–94%**, and NPV **82%–100%** across included studies. MRI–US fusion biopsy improved detection of Gleason ≥7 tumors by approximately 11.9% compared with systematic biopsy (Fang et al., 2023). Importantly, mpMRI showed high reliability in ruling out significant disease, suggesting its utility as a triage tool to reduce unnecessary biopsies.

**Table (1): General Characteristics and Diagnostic Accuracy of Included Studies**

| Study | Country | Design | Sample Size | Imaging / Comparator | Main Outcomes | Sensitivity | Specificity | PPV | NPV | Key Findings |
|---|---|---|---|---|---|---|---|---|---|---|
| **Tuna et al. (2023)** | Turkey | Retrospective | 33 | mpMRI vs RP histology | 58 foci (38 cribriform, 20 non-cribriform) | 94.7% | – | – | – | mpMRI detected 36/38 cribriform foci; single lesions had significantly lower ADC values ($p < 0.001$). |
| **Truong et al. (2017)** | USA | Cohort | 22 (83 foci) | mpMRI vs RP | 26/83 foci visible (31%) | – | – | – | – | Cribriform pattern reduced visibility; size and non-cribriform subtype predicted detection ($p = 0.002$; $p = 0.011$). |
| **Gao et al. (2019)** | China | Retrospective | 49 (62 lesions) | 68Ga-PSMA PET/CT & mpMRI vs RP | 37/62 lesions cribriform (59.7%) | SUVmax predicted morphology (OR = 8.61–11.93, $p < 0.001$) | – | – | – | PET/CT superior to mpMRI in identifying cribriform PCa. |

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|---|---|---|---|---|---|---|---|---|---|---|
| **Cai et al. (2022)** | USA | Prospective | 117 | mpMRI + targeted biopsy vs RP | 206 foci, 152 (74%) detected by mpMRI | 74% | – | – | – | All index cribriform tumors detected (100%), but depiction of cribriform component limited (45%). |
| **Arslan et al. (2021)** | Turkey | Cohort | 58 | mpMRI vs RP | 112 csPCa foci | – | – | – | – | Cribriform seen in 38%; lesions varied in visibility depending on histology. |
| **Martins et al. (2021)** | Switzerland | Prospective | 115 | mpMRI vs RP (3105 sectors) | 412 TP, 28 FP, 68 FN, 2597 TN | 86% | 99% | 94% | 97% | Accuracy varied by region; high NPV suggests mpMRI may obviate further testing if negative. |
| **Allam et al. (2024)** | Egypt | Prospective | 60 | mpMRI vs TRUS-biopsy | 36 cancers, 24 benign | 91.7% | 75% | 84.6% | 85.7% | mpMRI triaged unnecessary biopsies effectively. |
| **Fang et al. (2023)** | China | Comparative | 459 | Fusion biopsy vs systematic biopsy | 198 PCa cases | 88.9% (FB) vs 71.2% (SB) | – | 88.5% (FB) vs 72.3% (SB) | – | Fusion biopsy detected more high-grade tumors (78.9% vs 60.6%, p = 0.025). |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Gaunay et al. (2017)** | USA | Cohort | 1500+ | mpMRI vs TRUS biopsy | 400 positive mpMRI | 94–96% | 31–37% | 42–65% | 82–96% | mpMRI accurate in predicting TRUS/RP outcomes; high NPV for csPCa. |
| **Wang et al. (2016)** | China | Prospective | 133 | PI-RADS (T2WI + DWI) vs TRUS biopsy | 169 positive regions | 53.8% | 79.7–94.6% | – | – | Sensitivity moderate; ROC AUC = 0.749. |
| **Brock et al. (2015)** | Germany | Prospective | 168 | Fusion biopsy vs systematic | 71/168 PCa cases | 19% (targeted) vs 37.5% (systematic) | – | – | – | – |
| **Hauth et al. (2015)** | Germany | Prospective | 94 | mpMRI vs TRUS biopsy | 43 PCa, 207 lesions | 97.7% (patients), 80.9% (lesions) | 11.8% (patients), 44.7% (lesions) | – | – | ADC was key differentiator; mpMRI should precede biopsy. |
| **Panebianco et al. (2015)** | Italy | RCT | 1140 | mpMRI + biopsy vs TRUS biopsy | 417/570 positive in mpMRI group | 97% | – | – | – | mpMRI increased detection of csPCa compared with TRUS-guided biopsy. |
| **Radtke et al. (2015)** | Germany | Comparative | 294 | mpMRI-targeted vs template saturation biopsy | 150 cancers (86 ≥ GS7) | – | – | – | – | Targeted biopsy detected as many GS≥7 cancers as systematic; limited sensitivity if PI-RADS 3–5 only. |
| **Thompson et al. (2014)** | Australia | Prospective | 150 | mpMRI vs biopsy | 61% PCa, 30–41% | 93–96% | 47–53% | 43–57% | 92–96% | mpMRI provided excellent NPV; |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | significant | | | | | moderate PPV. |
| **Abd-Alazeez et al. (2014)** | UK | Prospective | 129 | mpMRI vs template mapping biopsy | 258 sectors | 94% | 23% | 34% | 89% | mpMRI effective in ruling out csPCa but limited specificity. |

## DISCUSSION

The findings of this systematic review highlight the evolving role of multiparametric MRI (mpMRI) as a diagnostic tool for prostate cancer (PCa), demonstrating its potential to improve sensitivity and specificity compared to traditional biopsy methods. Across the 16 included studies, mpMRI consistently showed high diagnostic performance for detecting clinically significant prostate cancer (csPCa), particularly when combined with targeted biopsy approaches. These results align with prior meta-analyses that have emphasized the strong accuracy of mpMRI in cancer detection, underscoring its value as a frontline diagnostic strategy (De Rooij et al., 2014; Zhen et al., 2019).

One major advantage of mpMRI is its ability to enhance detection of aggressive disease while reducing overdiagnosis of indolent tumors. Several studies reported mpMRI achieving sensitivities above 85% for csPCa, with particularly high negative predictive values (NPV) across different patient cohorts (Abd-Alazeez et al., 2014; Martins et al., 2021). This finding suggests that men with negative mpMRI could safely avoid unnecessary biopsies, an important clinical implication given the morbidity associated with invasive procedures. These results are in line with prior systematic reviews confirming the role of mpMRI in minimizing over-detection of clinically insignificant PCa (Schoots et al., 2015; Elwenspoek et al., 2019).

The results also revealed variation in mpMRI's diagnostic accuracy based on tumor morphology and histopathological subtypes. For example, Tuna et al. (2023) and Truong et al. (2017) both highlighted the reduced visibility of cribriform and intraductal carcinoma patterns on mpMRI, raising concerns about potential underdiagnosis of these aggressive subtypes. Similarly, Gao et al. (2019) demonstrated that ^68Ga-PSMA PET/CT may outperform mpMRI in identifying cribriform morphology, suggesting that hybrid imaging strategies may be required to address these limitations. Such findings emphasize that while mpMRI is highly effective, it is not universally sensitive to all histological variants.

Comparisons between biparametric MRI (bpMRI) and mpMRI also emerged as a recurring theme. Several meta-analyses, including those by Alabousi et al. (2019), Niu et al. (2018), and Woo et al. (2018), concluded that bpMRI offers comparable diagnostic accuracy to mpMRI, with the added benefits of shorter acquisition times and reduced costs. This was reinforced by Bass et al. (2021), who found bpMRI to be particularly promising in biopsy-naïve men at risk for PCa. However, mpMRI may retain superiority in certain contexts, particularly when dynamic contrast-enhanced (DCE) imaging provides added value in equivocal cases.

Emerging evidence also suggests that region-specific performance of mpMRI may vary. Martins et al. (2021) reported differential sensitivity and specificity across anterior versus posterior prostate regions, with slightly higher accuracy in posterior zones. These findings are crucial, as they indicate that mpMRI interpretation must account for tumor location and zonal anatomy. Moreover, Wang et al. (2016) demonstrated variability in detection rates based on PI-RADS scores, reinforcing the importance of standardized reporting systems for consistent clinical application.

Studies examining mpMRI in comparison with systematic biopsy further illustrate its benefits. Brock et al. (2015), Panebianco et al. (2015), and Radtke et al. (2015) demonstrated that MRI-targeted biopsies, particularly when combined with systematic approaches, significantly increase csPCa detection rates while reducing unnecessary sampling. Fang et al. (2023) echoed these findings, showing that MRI-ultrasound fusion biopsies had superior sensitivity and accuracy compared to systematic biopsy alone. Such results support the integration of mpMRI into diagnostic pathways as a triage tool for guiding biopsy strategies.

Nevertheless, not all studies reported uniformly high performance metrics. For example, Hauth et al. (2015) observed relatively low specificity in mpMRI (11.8%), reflecting the potential for false-positive findings. Similarly, Gaunay et al. (2017) reported modest specificity levels (31–37%), despite high sensitivity rates exceeding 94%. These discrepancies suggest that while mpMRI is excellent at ruling out disease, its lower specificity may still expose some men to unnecessary biopsies or anxiety from suspicious but ultimately benign findings.

Another critical finding relates to the role of targeted biopsy in capturing adverse pathological features. Cai et al. (2022) showed that while targeted biopsies detected nearly all cases of cribriform or intraductal carcinoma, the cribriform component was missed in over half of cases, raising questions about the completeness of imaging-guided sampling. Similarly, Truong et al. (2017) highlighted that non-cribriform architecture was more likely to be detected than cribriform subtypes, suggesting that pathologic heterogeneity remains a diagnostic challenge even with advanced imaging.

Emerging imaging modalities and technical innovations are being explored to overcome these limitations. Dwivedi and Jagannathan (2022) reviewed novel MR techniques, including diffusion kurtosis imaging and MR fingerprinting, which may improve sensitivity for aggressive disease phenotypes. Likewise, Asif et al. (2023) outlined the PRIME trial protocol, designed to compare bpMRI and mpMRI in a large multicenter setting, with potential to refine diagnostic protocols. These efforts indicate a growing recognition that continued optimization of imaging techniques is necessary for broad clinical adoption.

When considering prostate cancer screening and staging, Gaunay et al. (2017) and Panebianco et al. (2015) emphasized the potential for mpMRI to serve as both a diagnostic and staging modality, influencing treatment decisions. High sensitivity for extracapsular extension (ECE) and seminal vesicle invasion (SVI), albeit with moderate specificity, suggests a role for mpMRI in preoperative planning. This dual diagnostic and staging capability enhances the clinical value of mpMRI, potentially streamlining the diagnostic pathway.

The question of whether mpMRI should replace or complement traditional biopsy strategies remains central. Evidence from Thompson et al. (2014) and Abd-Alazeez et al. (2014) suggests that mpMRI can reduce unnecessary biopsies while maintaining detection of significant disease. However, systematic biopsy still identifies cancers missed by mpMRI, underscoring the continued relevance of combining modalities in certain clinical contexts. This duality highlights a need for tailored diagnostic approaches based on patient risk stratification.

At a population level, the widespread implementation of mpMRI faces logistical and economic challenges. Variability in scanner quality, radiologist expertise, and adherence to PI-RADS guidelines can influence diagnostic outcomes (De Rooij et al., 2014; Yang et al., 2025). Furthermore, bpMRI has gained traction as a cost-effective alternative in resource-constrained settings (Woo et al., 2018; Bass et al., 2021). Therefore, health systems must balance diagnostic performance with feasibility and cost-effectiveness when considering mpMRI adoption at scale.

Taken together, the evidence suggests that mpMRI represents a paradigm shift in prostate cancer diagnostics, offering high sensitivity, excellent NPV, and significant potential to reduce unnecessary biopsies. However, challenges remain in terms of specificity, detection of cribriform subtypes, and integration into diverse healthcare systems. Continued refinements in imaging technology, combined with large multicenter trials, are essential to establish mpMRI's role as either a universal triage tool or a complementary modality within risk-stratified diagnostic pathways (Yang et al., 2025; Alabousi et al., 2019).

mpMRI has proven itself as a powerful diagnostic tool in prostate cancer detection, capable of reshaping traditional diagnostic algorithms. While limitations exist—particularly regarding specificity and certain histological patterns—the cumulative evidence supports its integration into clinical practice as both a diagnostic and staging modality. Future research should focus on refining imaging protocols, validating bpMRI as a cost-effective alternative, and exploring hybrid approaches with novel imaging biomarkers to ensure that all clinically significant cancers are reliably detected (Dwivedi & Jagannathan, 2022; Cai et al., 2022).

## CONCLUSION

This systematic review and meta-analysis synthesized evidence from 16 studies assessing the diagnostic accuracy of multiparametric MRI (mpMRI) for prostate cancer detection compared with biopsy-based reference standards. The findings demonstrated consistently high sensitivity and negative predictive value of mpMRI, supporting its utility in detecting clinically significant prostate cancer while reducing unnecessary biopsies. Furthermore, mpMRI-targeted biopsies improved detection rates of aggressive disease compared to systematic biopsy alone, while minimizing the diagnosis of indolent tumors.

Despite these strengths, limitations remain regarding variability in specificity, reduced detection of cribriform and intraductal carcinoma subtypes, and heterogeneity in imaging protocols across studies. Biparametric MRI appears to provide comparable performance in some settings, offering a cost-effective alternative. Future multicenter trials and advances in MR technology are needed to refine diagnostic pathways and ensure mpMRI can be optimally integrated into routine prostate cancer diagnostics and staging.

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