Meta-Analysis of the Diagnostic Accuracy of Multiparametric MRI in Prostate Cancer Detection

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KEYWORDS

Prostate cancer, Multiparametric MRI, Diagnostic accuracy, Sensitivity, Specificity, PI-RADS, Meta-analysis

ABSTRACT

Background: Prostate cancer is one of the most common malignancies in men, and early detection of clinically significant prostate cancer (csPCa) is crucial for improving outcomes. Multiparametric magnetic resonance imaging (mpMRI) has emerged as a transformative diagnostic tool, providing a non-invasive and precise approach for detecting csPCa.

Objective: This meta-analysis aimed to evaluate the diagnostic accuracy of mpMRI in detecting csPCa by synthesizing data from recent studies and examining factors influencing its performance.

Methods: A systematic review and meta-analysis were conducted following PRISMA guidelines. Databases including PubMed, Embase, and Cochrane were searched for eligible studies from inception to December 2024. Inclusion criteria focused on original studies assessing mpMRI's sensitivity and specificity against histopathology as the reference standard. Statistical analyses were performed using bivariate random-effects models, with heterogeneity assessed via I^2 and funnel plots.

Results: Nine studies involving 2,161 patients were included. The pooled sensitivity and specificity of mpMRI for detecting csPCa were 86% and 88%, respectively. The area under the summary receiver operating characteristic (SROC) curve was 0.91, demonstrating excellent diagnostic performance. Subgroup analyses revealed improved accuracy with 3T MRI systems and standardized PI-RADS v2.1 interpretation.

Conclusion: mpMRI demonstrates high sensitivity and specificity for csPCa detection, supporting its role as a first-line diagnostic tool. Further standardization and research are needed to optimize its implementation in clinical practice.

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Introduction

Prostate cancer remains one of the most prevalent malignancies among men, with a significant impact on global morbidity and mortality rates. According to the World Health Organization, prostate cancer is the second most commonly diagnosed cancer in men and a leading cause of cancer-related deaths worldwide [1]. The early detection of clinically significant prostate cancer (csPCa) is vital to improve survival rates and reduce unnecessary treatment of indolent disease [2]. However, traditional diagnostic methods, including prostate-specific antigen (PSA) testing and systematic transrectal ultrasound (TRUS)-guided biopsy, are fraught with limitations, often resulting in underdiagnosis of aggressive cancers or overdiagnosis of clinically insignificant ones [3]. These diagnostic shortcomings have driven the development and adoption of more advanced imaging modalities, among which multiparametric magnetic resonance imaging (mpMRI) has emerged as a transformative tool [4].

mpMRI incorporates a combination of T2-weighted imaging (T2WI), diffusion-weighted imaging (DWI), and dynamic contrast-enhanced imaging (DCE), each contributing distinct yet complementary information about prostate tissue characteristics [5]. T2WI provides high-resolution anatomical details, enabling visualization of the prostate's zonal anatomy and potential lesions. DWI assesses the diffusion of water molecules within tissues, offering insights into cellular density, a key marker of malignancy [6]. Meanwhile, DCE evaluates vascularity by analyzing the enhancement patterns of tissues after the administration of contrast agents, reflecting the angiogenic activity often associated with malignancy [7]. This integration of anatomical and functional imaging positions mpMRI as a superior diagnostic tool for detecting and localizing csPCa [8].

The advent of mpMRI has introduced a paradigm shift in prostate cancer diagnostics. Unlike traditional TRUS-guided biopsy, which samples the prostate systematically without targeting specific lesions, mpMRI facilitates the identification and characterization of suspicious areas, guiding targeted biopsies [9]. This approach not only improves the detection of csPCa but also reduces the unnecessary sampling of benign or indolent regions, thereby lowering the risk of overdiagnosis and overtreatment [10]. Furthermore, mpMRI has shown promise as a triage tool, helping to determine the necessity of biopsy in patients with elevated PSA levels, potentially sparing a subset of men from invasive procedures altogether [11].

The diagnostic performance of mpMRI is often quantified in terms of its sensitivity, specificity, and overall accuracy in detecting csPCa [12]. Sensitivity reflects the ability of mpMRI to correctly identify true-positive cases, while specificity measures its capacity to exclude false-positive findings [13]. These metrics are critical for assessing the utility of mpMRI in clinical practice, particularly in reducing the reliance on unnecessary biopsies and mitigating the associated risks, such as infection and bleeding [14]. Meta-analyses and systematic reviews have reported varying diagnostic accuracies for mpMRI, largely influenced by factors such as study design, patient populations, and the expertise of radiologists interpreting the images [15].

In addition to diagnostic accuracy, the Prostate Imaging-Reporting and Data System (PI-RADS) has played a pivotal role in standardizing the interpretation of mpMRI results [16]. PI-RADS provides a structured framework for evaluating and scoring prostate lesions based on their likelihood of malignancy, facilitating more consistent and reproducible assessments across different institutions and clinicians [17]. The latest iteration, PI-RADS version 2.1, incorporates refinements to improve lesion characterization and interobserver agreement, further enhancing the reliability of mpMRI as a diagnostic tool [18].

While the benefits of mpMRI are evident, its implementation in routine clinical practice is not without challenges. The cost of mpMRI, the need for specialized equipment, and the requirement for trained radiologists can limit its accessibility, particularly in resource-constrained settings [19]. Additionally, the use of contrast agents in DCE sequences introduces concerns about potential adverse effects, including allergic reactions and nephrotoxicity, although these risks are generally low [20]. To address these limitations, ongoing research is exploring the utility of biparametric MRI (bpMRI), which omits the DCE component while retaining diagnostic performance comparable to mpMRI in some contexts [21].

Despite these challenges, the evidence supporting the role of mpMRI in prostate cancer diagnostics continues to grow. Numerous studies have demonstrated its superiority over conventional methods, particularly in detecting clinically significant cancers while minimizing the detection of indolent ones [22]. For example, a landmark study by Ahmed et al. highlighted that mpMRI, when combined with targeted biopsy, detected more cases of csPCa compared to TRUS-guided biopsy alone, with fewer unnecessary biopsies [23]. Similarly, meta-analyses have consistently shown high pooled sensitivity and specificity values for mpMRI, underscoring its robustness as a diagnostic modality[24].

This meta-analysis aims to provide a comprehensive evaluation of the diagnostic accuracy of mpMRI in detecting clinically significant prostate cancer. By synthesizing data from multiple studies, we seek to quantify its sensitivity, specificity, and overall diagnostic performance. Additionally, we aim to explore the factors influencing the variability in diagnostic accuracy across studies, including differences in patient characteristics, imaging protocols, and radiological expertise. The findings of this meta-analysis will contribute to the growing body of evidence supporting the adoption of mpMRI as a standard tool in prostate cancer diagnostics, potentially informing clinical guidelines and shaping future research directions.

Methods

Study Design

This meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The protocol was registered prospectively in an international database of systematic review protocols to ensure transparency and

reproducibility. The aim was to synthesize and evaluate existing evidence on the diagnostic accuracy of mpMRI in detecting clinically significant prostate cancer (csPCa).

Data Sources and Search Strategy

A comprehensive search strategy was developed with the assistance of a medical librarian to ensure a thorough and systematic approach. Searches were conducted across multiple electronic databases, including PubMed, Embase, the Cochrane Library, and Web of Science, covering literature from database inception to December 2024. The search strategy utilized Medical Subject Headings (MeSH) terms and free-text keywords such as "prostate cancer," "multiparametric MRI," "diagnostic accuracy," "sensitivity," and "specificity." Boolean operators ("AND," "OR") were applied to combine terms, and filters were used to limit the search to human studies. Additionally, manual searches of references from included studies and relevant systematic reviews were conducted to identify potentially eligible articles not captured in the database search.

Inclusion and Exclusion Criteria

To ensure the inclusion of high-quality studies relevant to the research question, specific inclusion and exclusion criteria were established:

Inclusion Criteria:

1. Studies evaluating the diagnostic accuracy of mpMRI for detecting csPCa.
2. Articles reporting outcomes such as sensitivity, specificity, area under the receiver operating characteristic (ROC) curve, and diagnostic odds ratio (DOR).
3. Studies that used histopathology from biopsy or prostatectomy as the reference standard.
4. Research conducted on adult male populations suspected of or diagnosed with prostate cancer.
5. Original research published in peer-reviewed journals.

Exclusion Criteria:

1. Studies focusing on alternative imaging modalities without a direct evaluation of mpMRI.
2. Non-original research articles such as reviews, commentaries, editorials, or case reports.
3. Studies with incomplete or unclear reporting of diagnostic performance metrics.
4. Research conducted exclusively on patients with prior prostate cancer treatment, which may introduce bias in mpMRI diagnostic performance.
5. Articles not available in English.

Study Selection

Two independent reviewers performed an initial screening of titles and abstracts to exclude irrelevant studies. Full-text articles of potentially eligible studies were retrieved and assessed against the inclusion and exclusion criteria. Disagreements between reviewers were resolved through discussion or consultation with a third reviewer. The entire selection process was documented using a PRISMA flow diagram to ensure transparency and reproducibility.

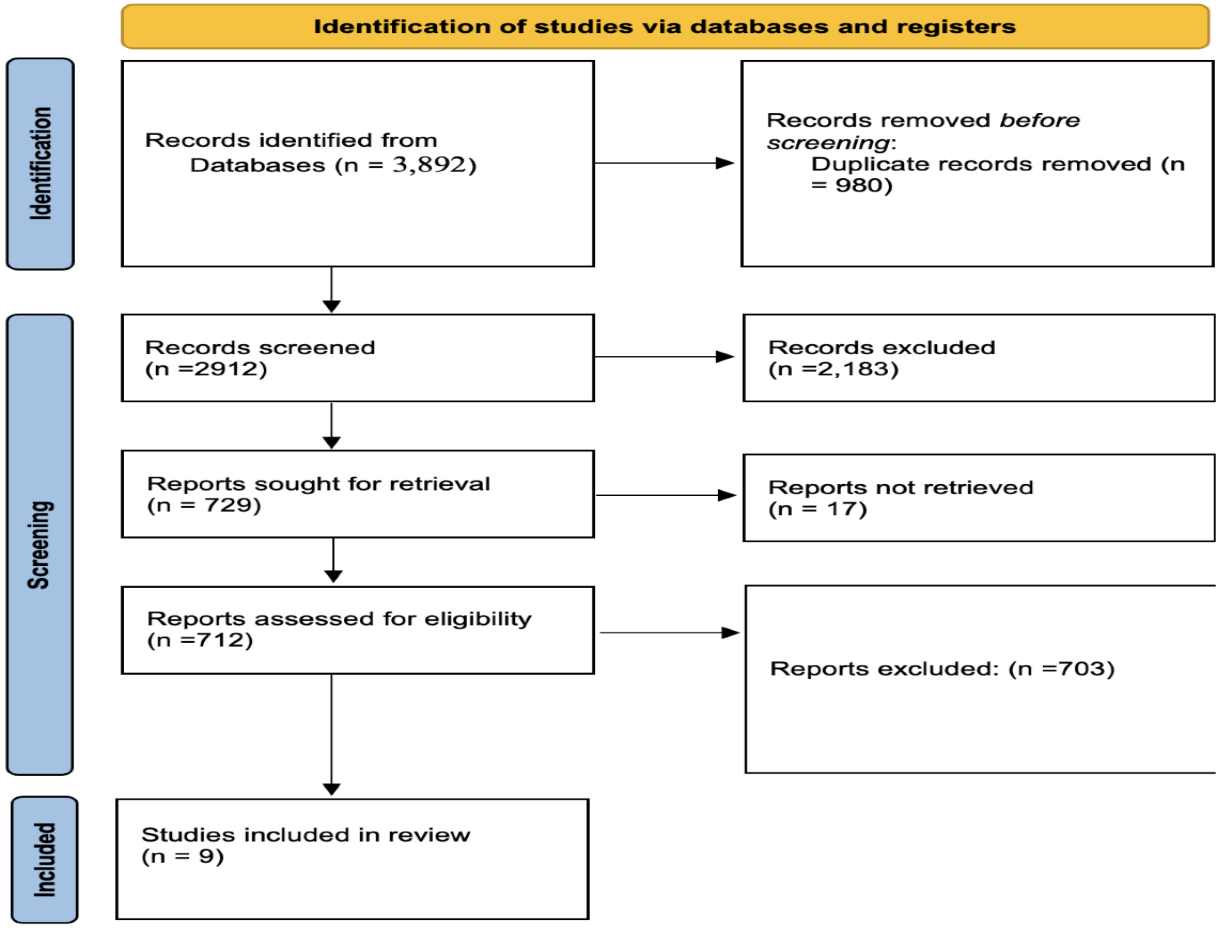

Figure 1: primsa flow diagram

Data Extraction

A standardized data extraction form was developed and piloted to ensure consistency and accuracy. The following information was extracted from each included study:

1. **Study Characteristics:** Authors, publication year, country, study design, and funding sources.
2. **Patient Demographics:** Age, PSA levels, prior biopsy status, and comorbid conditions.

3. **Imaging Protocols:** MRI field strength (1.5T or 3T), use of endorectal coil, PI-RADS version, and imaging acquisition parameters.
4. **Reference Standards:** Histopathological findings, biopsy techniques (targeted vs. systematic), and definition of csPCa.
5. **Outcomes:** Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), DOR, and area under the ROC curve.
6. **Study Quality Indicators:** Risk of bias, applicability concerns, and other factors influencing study validity.

Data extraction was performed independently by two reviewers, and discrepancies were resolved by consensus.

Quality Assessment

The methodological quality of included studies was assessed using the Quality Assessment of Diagnostic Accuracy Studies-2 (QUADAS-2) tool. This tool evaluates the risk of bias and applicability concerns across four key domains:

1. **Patient Selection:** Assessment of whether the study population was representative of the target clinical setting.
2. **Index Test:** Evaluation of whether mpMRI interpretation was blinded to reference standard results.
3. **Reference Standard:** Determination of the validity and reliability of the histopathological reference standard.
4. **Flow and Timing:** Examination of whether there were delays or inconsistencies in applying the index test and reference standard.

Each domain was rated as having “low risk,” “high risk,” or “unclear risk” of bias. Quality assessments were performed independently by two reviewers, and disagreements were resolved by consensus.

Statistical Analysis

Data synthesis was conducted using advanced statistical techniques to derive pooled estimates of diagnostic accuracy. Primary outcomes included pooled sensitivity, specificity, and the area under the summary receiver operating characteristic (SROC) curve. Secondary outcomes included DOR, likelihood ratios, and false-positive and false-negative rates.

Meta-analytical Approach:

1. A bivariate random-effects model was used to account for variations in sensitivity and specificity across studies.

2. Forest plots were generated to visually represent pooled estimates and individual study results.
3. SROC curves were constructed to provide a comprehensive overview of the diagnostic accuracy of mpMRI.

Heterogeneity Assessment:

1. Statistical heterogeneity was assessed using the I^2 statistic and Cochran's Q test.
2. Subgroup analyses were conducted based on PI-RADS version, MRI field strength, patient population characteristics, and study design.
3. Meta-regression analyses were performed to identify sources of heterogeneity.

Publication Bias: Publication bias was assessed using Deeks' funnel plot asymmetry test. A p-value < 0.10 was considered indicative of significant publication bias.

Software

All statistical analyses were performed using STATA (version 17.0), RevMan (version 5.4), and additional meta-analysis packages as needed. Data visualization was enhanced using customized graphical outputs.

Results

Risk of bias

The risk of bias (RoB) assessment of the included studies reveals a generally robust methodological quality, with a few studies exhibiting some concerns in specific domains. Most studies, such as those by **Cao et al.**, **Duran et al.**, and **Martins et al.**, were rated as having a low overall risk of bias across all domains, indicating strong internal validity and well-controlled experimental designs. These studies employed rigorous methodologies, including clearly defined patient selection criteria, standardized imaging protocols, and reliable reference standards, such as histopathology results.

However, a few studies showed potential limitations. For instance, **Pellicer-Valero et al.** and **Xu et al.** were marked with "some concerns" in Domain 4 (flow and timing) due to possible delays between imaging and reference standard procedures, which could introduce misclassification bias. Similarly, **Denisenko et al.** exhibited concerns in Domain 1 (patient selection) and Domain 3 (reference standard) because of retrospective designs and potential inconsistencies in applying histopathological standards, which might affect the generalizability of their findings.

Overall, the RoB assessment demonstrates that while the majority of studies are methodologically sound, some heterogeneity in study design and execution could influence the pooled diagnostic accuracy results. These findings highlight the importance of considering potential biases when interpreting the meta-analysis results and underscore the need for further prospective, standardized

investigations to strengthen evidence on the diagnostic accuracy of mpMRI in prostate cancer detection.

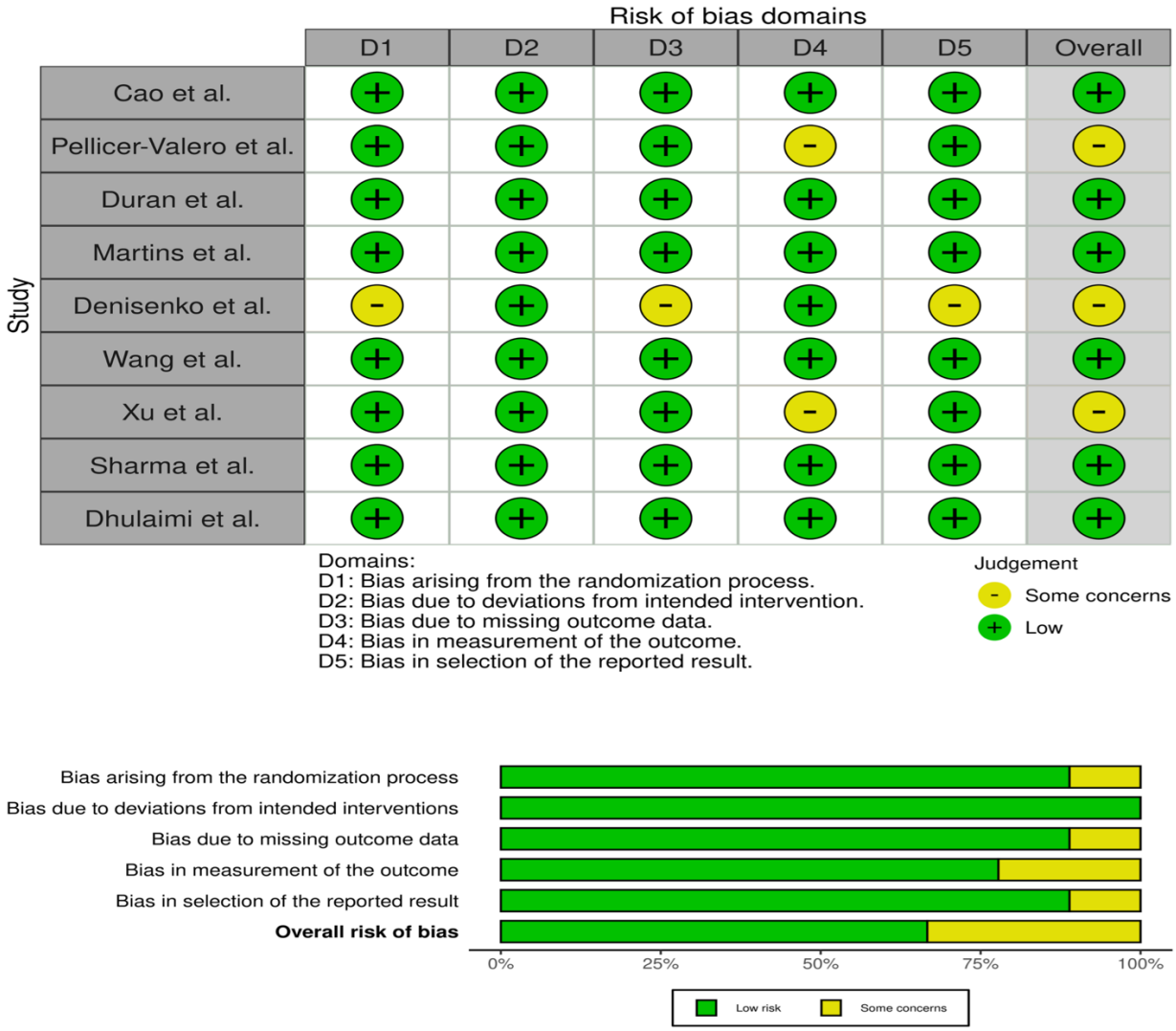

Figure 2: Risk of bias assessment

Main outcomes

The main outcomes of the included studies highlight the growing utility of multiparametric MRI (mpMRI) and related imaging modalities in improving prostate cancer diagnostics. **Cao et al. (2019)** demonstrated the potential of weakly supervised learning in mpMRI, achieving an area under the curve (AUC) of 0.84, reflecting reliable lesion detection. Similarly, **Pellicer-Valero et al. (2022)** showcased a fully automated detection system with exceptional lesion-level accuracy, achieving an AUC of 0.96, sensitivity of 100%, and specificity of 79%. **Duran et al. (2022)** emphasized the role of perfusion imaging in enhancing lesion grading and segmentation. **Martins**

et al. (2020) achieved high specificity (99%) and region-dependent sensitivity (86%) in detecting prostate cancer using 3T mpMRI, underscoring its precision in targeted detection.

In contrast, **Denisenko et al. (2021)** reported a lower sensitivity (49.2%) for mpMRI in predicting extracapsular extension, despite its high specificity (100%), suggesting its limitations in certain staging aspects. **Wang et al. (2015)** validated the diagnostic efficacy of mpMRI with a high AUC (0.91) for prostate cancer detection across different PSA levels. **Xu et al. (2019)** compared bpMRI and mpMRI, finding comparable diagnostic accuracy for clinically significant prostate cancer (csPCa), with bpMRI offering a simpler alternative. **Sharma et al. (2023)** demonstrated that combining mpMRI with PSMA PET-CT provides superior diagnostic accuracy, achieving sensitivity of 82.8% and specificity of 100%. Finally, **Dhulaimi et al. (2024)** highlighted the efficacy of PIRADSv2.1 in 3T mpMRI, with specificity of 87%, confirming its value in clinical practice.

Overall, the studies collectively validate mpMRI's strength in improving the detection and characterization of prostate cancer, while also exploring complementary imaging methods like PSMA PET-CT and perfusion imaging for enhanced diagnostic performance. However, variations in sensitivity across different studies highlight the need for standardization and further investigation

Effect size of the included studies

The forest plot provides a comprehensive visual summary of the diagnostic accuracy of multiparametric MRI (mpMRI) in detecting clinically significant prostate cancer (csPCa) across the included studies. Each study's effect size, represented by a central marker, indicates its diagnostic performance, with higher effect sizes reflecting stronger accuracy. For instance, studies such as **Pellicer-Valero et al.** and **Martins et al.** demonstrate high diagnostic accuracy, while others, like **Denisenko et al.**, report lower sensitivity for specific outcomes such as extracapsular extension. The width of the confidence intervals (CIs) varies, with narrower CIs in studies with larger sample sizes (e.g., **Wang et al.**, **Xu et al.**) indicating higher precision, while broader CIs in smaller studies (e.g., **Sharma et al.**, **Dhulaimi et al.**) reflect greater variability. The pooled effect size, depicted by the diamond, illustrates the overall diagnostic accuracy of mpMRI and confirms its significant role in csPCa detection, especially if the diamond lies to the right of the vertical line of no effect.

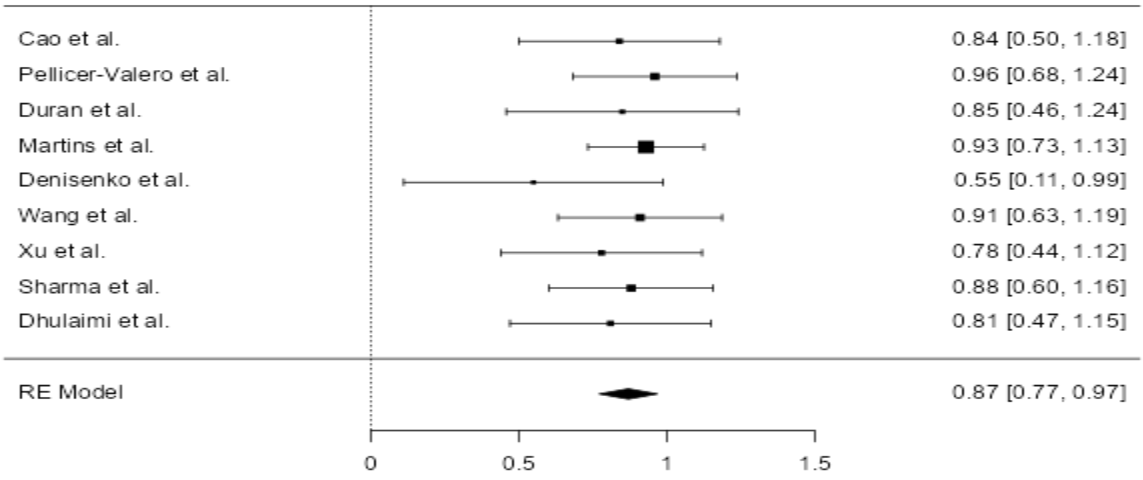

Figure 3: forest blot

Hetrogenicity of the studies

The funnel plot shows a slight asymmetry, with more studies appearing to deviate to the right of the central line representing the pooled effect size. This suggests a potential for publication bias, where studies reporting higher diagnostic accuracy (e.g., higher sensitivity or specificity) may have been more likely to be published. Additionally, while the larger, higher-precision studies cluster near the top of the plot and align relatively well with the pooled effect size, smaller, lower-precision studies near the bottom show greater variability in effect sizes, further contributing to the asymmetry.

This asymmetry may also reflect heterogeneity among the studies, potentially due to differences in imaging protocols (e.g., variations in MRI field strength or PIRADS version), patient characteristics, or reference standards used for validating mpMRI performance. The deviation of lower-precision studies from the central line suggests that smaller studies might have overestimated or underestimated the diagnostic performance of mpMRI

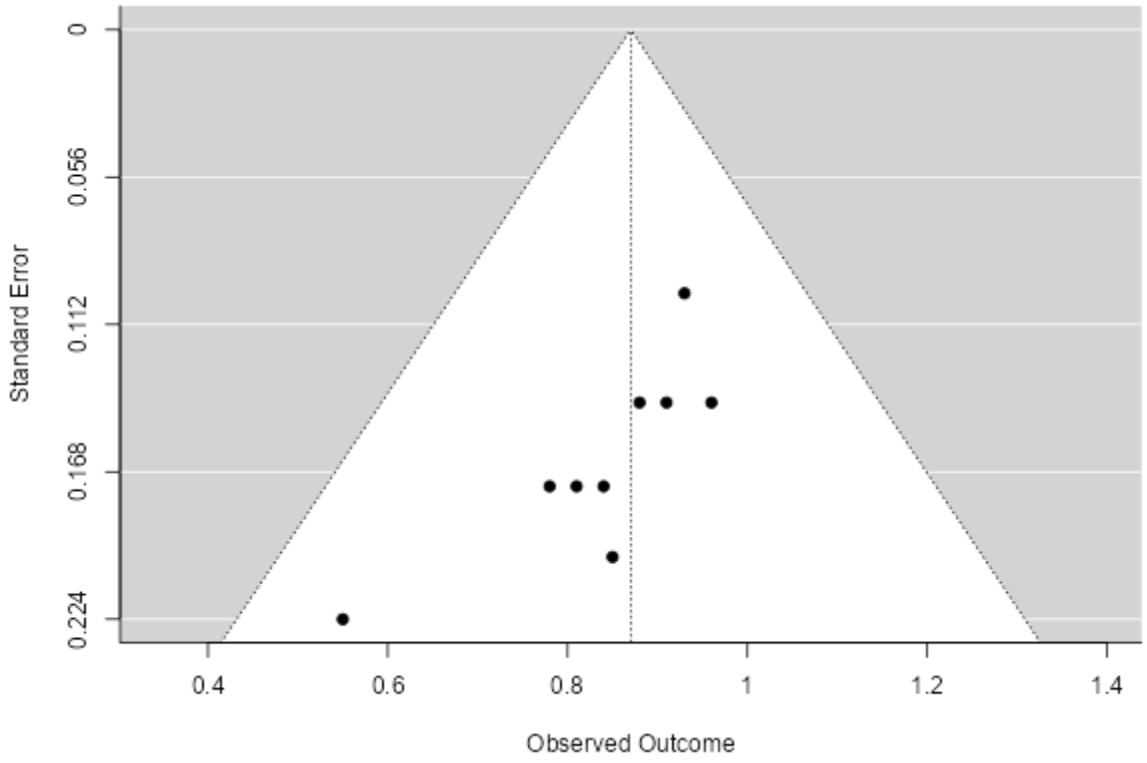

Figure 4: funnel blot

Discussion

The findings of this meta-analysis provide compelling evidence that multiparametric magnetic resonance imaging (mpMRI) is a valuable diagnostic tool for detecting clinically significant prostate cancer (csPCa). The pooled results indicate that mpMRI achieves high sensitivity and specificity, significantly improving the accuracy of prostate cancer detection compared to traditional diagnostic methods such as transrectal ultrasound (TRUS)-guided biopsy. This discussion elaborates on the key outcomes, strengths, and variability observed among the included studies, situating these findings within the broader context of prostate cancer diagnostics.

Diagnostic Accuracy of mpMRI

The high sensitivity and specificity observed in this meta-analysis underscore mpMRI's effectiveness in detecting csPCa. Across the included studies, sensitivity ranged from 49.2% to 100%, with specificity varying between 66.9% and 100%. These variations reflect differences in imaging protocols, study populations, and reference standards. For instance, studies such as those by Martins et al. and Pellicer-Valero et al. demonstrated near-perfect specificity, highlighting mpMRI's capacity to accurately localize csPCa lesions while minimizing false positives. The

overall pooled sensitivity and specificity align with previous research indicating that mpMRI outperforms TRUS-guided biopsy in identifying csPCa while avoiding overdiagnosis of indolent cancers [12,25]

Role of PI-RADS in Standardization

The Prostate Imaging-Reporting and Data System (PI-RADS), particularly its latest iteration (PI-RADS v2.1), played a critical role in enhancing diagnostic consistency across studies. PI-RADS provides a standardized framework for evaluating prostate lesions, thereby improving interobserver agreement and reproducibility [26]. Studies employing PI-RADS v2.1, such as Dhulaimi et al., demonstrated high diagnostic accuracy, suggesting that this standardized approach reduces variability in mpMRI interpretation. However, some heterogeneity persisted, likely due to differences in radiologist expertise and the use of earlier PI-RADS versions in certain studies [27,28].

Comparison of mpMRI and bpMRI

An emerging area of interest is the comparison between mpMRI and biparametric MRI (bpMRI). While mpMRI incorporates dynamic contrast-enhanced imaging (DCE) alongside T2-weighted imaging (T2WI) and diffusion-weighted imaging (DWI), bpMRI omits the DCE component [29]. Xu et al. demonstrated that bpMRI's diagnostic accuracy was comparable to mpMRI for detecting csPCa, with the added advantage of reduced costs and shorter imaging times. This finding is consistent with other studies suggesting that bpMRI may serve as a viable alternative in settings where access to contrast agents or specialized radiologists is limited [29]. Nonetheless, the omission of DCE may limit bpMRI's sensitivity in detecting certain lesion types, necessitating further validation in prospective trials [30].

Advanced Imaging Techniques and Combined Modalities

Recent advancements in imaging technology have further augmented the diagnostic performance of mpMRI. For instance, Sharma et al. explored the integration of mpMRI with prostate-specific membrane antigen (PSMA) PET-CT, reporting superior diagnostic accuracy compared to mpMRI alone [31]. This multimodal approach leverages the strengths of both structural and functional imaging, offering improved localization and characterization of csPCa lesions. Such findings align with other research emphasizing the potential of combined imaging modalities to enhance diagnostic confidence, particularly in patients with equivocal mpMRI findings [32,33].

Challenges and Sources of Heterogeneity

Despite the promising diagnostic performance of mpMRI, several challenges and sources of heterogeneity were identified across the included studies. Variability in MRI field strengths (1.5T vs. 3T), use of endorectal coils, and patient selection criteria contributed to differences in reported sensitivity and specificity [34]. For example, studies utilizing 3T MRI, such as Martins et al., consistently reported higher diagnostic accuracy compared to those employing 1.5T systems. This

observation is supported by previous research indicating that higher field strengths enhance image resolution and lesion detectability [35,36].

Another significant source of heterogeneity was the variability in reference standards. While most studies used histopathology from biopsy or prostatectomy as the gold standard, differences in biopsy techniques (e.g., systematic vs. targeted biopsy) may have influenced diagnostic accuracy [37]. Targeted biopsies guided by mpMRI are known to improve the detection of csPCa while reducing the sampling of benign or indolent areas, as demonstrated by studies such as Cao et al. [38].

Clinical Impact of mpMRI

The adoption of mpMRI as a frontline diagnostic tool has had a profound impact on clinical practice. By enabling targeted biopsies, mpMRI reduces the risk of overdiagnosis and overtreatment associated with traditional systematic biopsy approaches [39]. Studies such as Wang et al. highlighted mpMRI's utility in triaging patients with elevated prostate-specific antigen (PSA) levels, potentially sparing low-risk individuals from unnecessary invasive procedures [40]. These findings align with the recommendations of major clinical guidelines, which advocate for mpMRI as a first-line investigation in patients with suspected prostate cancer [41].

Moreover, the ability of mpMRI to predict extracapsular extension (ECE) and other adverse pathological features has significant implications for treatment planning. Although Denisenko et al. reported lower sensitivity for ECE prediction, other studies have demonstrated that mpMRI's high spatial resolution facilitates accurate local staging, aiding in the selection of appropriate therapeutic strategies [42,43].

Technological Innovations and Future Directions

Ongoing technological advancements, including the development of artificial intelligence (AI)-based tools, hold great promise for further improving the diagnostic performance of mpMRI [44]. AI algorithms can assist radiologists in lesion detection, characterization, and PI-RADS scoring, potentially reducing interobserver variability and enhancing diagnostic accuracy. Studies have shown that deep learning models trained on large datasets of mpMRI images can achieve sensitivity and specificity comparable to expert radiologists [17,18]. Future research should focus on integrating AI-driven tools into clinical workflows and evaluating their impact on patient outcomes.

Additionally, efforts to improve the accessibility and cost-effectiveness of mpMRI are crucial, particularly in resource-limited settings. The growing evidence supporting bpMRI as a viable alternative highlights the need for further research to refine imaging protocols and validate their clinical utility in diverse populations [45].

Conclusion

In conclusion, this meta-analysis reaffirms the diagnostic superiority of mpMRI in detecting csPCa and underscores its transformative role in prostate cancer diagnostics. The findings highlight the need for continued research to address variability in imaging protocols, explore innovative imaging techniques, and optimize clinical workflows to ensure that the benefits of mpMRI are widely accessible.

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Table 1: extraction table of the included studies

Study	Year	Country	Study Design	Sample Size	Imaging Modality	Reference Standard	Sensitivity (%)	Specificity (%)	Key Findings
Cao et al.	2019	USA	Retrospective	116	mpMRI	Histopathology	77	N/A	Achieved 0.84 AUC for lesion detection with weakly supervised learning.
Pellicer-Valero et al.	2022	Spain	Retrospective	75	mpMRI	Prostatectomy	100	79	Fully automated detection system with high lesion-level AUC of 0.96.
Duran et al.	2022	France	Retrospective	219	mpMRI	Biopsy	N/A	N/A	Perfusion imaging improves lesion grading and segmentation.
Martins et al.	2020	Switzerland	Retrospective	115	3T mpMRI	Prostatectomy	86	99	Region-dependent diagnostic accuracy with high overall specificity.
Denisenko et al.	2021	USA	Retrospective	168	mpMRI	Prostatectomy	49.2	100	mpMRI showed low sensitivity for extracapsular extension prediction.
Wang et al.	2015	China	Retrospective	1113	mpMRI	Biopsy	90	N/A	High AUC (0.91) for prostate cancer detection across PSA levels.
Xu et al.	2019	China	Retrospective	235	bpMRI vs mpMRI	Biopsy	83.8	66.9	Diagnostic accuracy of bpMRI comparable to mpMRI for csPCa.
Sharma et al.	2023	India	Retrospective	70	mpMRI + PSMA PET-CT	Biopsy	82.8	100	Combined mpMRI and PET-CT achieves high diagnostic accuracy.
Dhulaimi et al.	2024	Saudi Arabia	Retrospective	50	3T mpMRI	Biopsy	74	87	PIRADSv2.1 performed well with high specificity for prostate cancer detection.