

REVIEW

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Prostate cancer screening with MRI: insights from the ESUR Prostate MRI Working Group

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Abstract

Prostate-specific antigen (PSA)-based screening for prostate cancer (PCa) remains controversial due to uncertain long-term benefits, overdiagnosis, and overtreatment of indolent disease. Magnetic resonance imaging (MRI) has transformed the diagnostic pathway of PCa and is increasingly explored as a screening tool. This special report from the ESUR Prostate MRI Working Group provides an overview of current evidence and insights into the potential role of MRI in PCa screening. MRI-based screening strategies appear to improve detection of clinically significant PCa while reducing unnecessary biopsies and diagnoses of non-significant disease, though long-term outcome data, including mortality impact and interval cancer rates, remain limited. Biparametric MRI is particularly suited for screening due to its shorter acquisition time, reduced operational complexity, and lower costs compared with multiparametric MRI. Two main implementation approaches have emerged: MRI-first pathways, which maximise detection but require substantial resources, and risk-stratified strategies, in which MRI is used after initial assessment (e.g. PSA), potentially offering greater feasibility and cost-effectiveness. Evidence from large trials supports integrating MRI into screening pathways, particularly as a reflex test after PSA screening, although uncertainties remain regarding optimal protocols, interpretation thresholds, follow-up strategies, and long-term outcomes. Key barriers include limited MRI capacity, economic considerations, and the need for standardisation and quality assurance. Advances in artificial intelligence may further enhance efficiency. Overall, MRI has the potential to improve the balance between benefits and harms in PCa screening, but further evidence is required to define its optimal implementation.

Key Points

Question Can prostate MRI be effectively integrated into population-based prostate cancer screening pathways?

Findings MRI-based screening improves detection of csPCa while reducing unnecessary biopsies; biparametric MRI should be the protocol of choice to enhance feasibility, although optimal implementation and long-term outcomes remain uncertain.

Clinical relevance MRI may overcome key limitations of PSA-based screening by enhancing the detection of clinically significant prostate cancer while reducing harms such as overdiagnosis and unnecessary biopsies.

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Keywords Prostate cancer, Screening, Magnetic resonance imaging, PSA

Graphical Abstract

Prostate cancer screening with MRI: insights from the ESUR Prostate MRI Working Group

Can prostate MRI be effectively integrated into population-based prostate cancer screening pathways?

Methodology

Special report, which is based on the agreement of members of the ESUR prostate MRI working group

Screening Prostate MRI (bpMRI)

Multinational consensus

MRI screening improves detection of clinically significant prostate cancer while reducing unnecessary biopsies and overdiagnosis. Biparametric MRI should be the preferred protocol.

	Key points
Rationale	- PSA-based PCa screening is associated with suboptimal cancer detection rates (CDR), substantial overdiagnosis, and overtreatment of indolent disease, with inconsistent mortality reduction across settings. - MRI-based screening reduces unnecessary biopsies, increases detection of clinically significant csPCa and decreases overdiagnosis, offering a more favourable benefit-harm balance.
MRI acquisition, interpretation, and reporting	- MRI should be acquired according to PI-RADS technical requirements and checked for image quality using PI-QUAL v2 criteria. - An abbreviated bpMRI protocol is preferred and should include small-field-of-view axial T2-weighted imaging (with optional coronal and/or sagittal planes), DWI and ADC maps. - Patient preparation (e.g., enemas, antispasmodic agents) can be considered to improve image quality and reduce equivocal or non-diagnostic scans, taking into account additional patient and operational burden. - The PI-RADS scoring system should be used to ensure standardised interpretation and reporting of MRI findings. - A PI-RADS ≥4 threshold should be considered as the positivity cutoff to reduce overdiagnosis and unnecessary biopsies. - Centre accreditation, quality assurance and quality control (QA/QC) programmes, reader training and certification are recommended to support effective delivery of MRI for prostate cancer screening.
Implementation strategies	- PSA-first strategies, with MRI used as a reflex test, may provide greater cost-effectiveness and scalability for population-level implementation. - MRI-first pathways maximise detection of csPCa but can result in a high proportion of negative examinations, increased unnecessary biopsies, and substantial demands on MRI capacity.
Areas of development	- AI-accelerated MRI acquisition, applied to abbreviated bpMRI protocols, may further reduce scan times. - AI-assisted interpretation might be considered to help reducing radiologist workload and potentially improve diagnostic accuracy. - AI tools for assisted interpretation must be trained and prospectively validated in screening populations before clinical implementation.

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Introduction

Prostate cancer (PCa) is one of the most frequently diagnosed malignancies among men worldwide and a leading cause of cancer-related mortality, with incidence increasing with age [1]. Despite advances in treatment, outcomes remain dependent on stage at diagnosis [1, 2]. Moreover, identifying PCa at an early stage enables a more personalised and less aggressive treatment approach, which can improve patients’ quality of life while promoting more efficient allocation of healthcare resources [2, 3]. Consequently, population-based screening strategies have been introduced to allow early diagnosis of PCa. According to the World Health Organisation principles, an ideal screening test should be safe, accurate, acceptable, and cost-effective—criteria that prostate cancer screening has struggled to fully meet [4]. In recent years, magnetic resonance imaging (MRI) has transformed the diagnostic pathway of PCa and is currently being investigated as a screening tool [5]. This special report, which is based on the agreement of members of the ESUR prostate MRI working group, explores the potential role of MRI as a transformative tool in PCa screening pathways. The conclusions presented

reflect the consensus of the working group members, reached through structured discussion and review of relevant literature identified via targeted searches and major radiological and urological conference proceedings; the report is therefore best interpreted as expert consensus opinion rather than a systematic review.

Current landscape of prostate cancer screening

Prostate cancer early detection has historically relied on prostate-specific antigen (PSA) testing [4]. It is known that increasing levels of PSA are associated with a higher probability of PCa; traditional cutoffs (3.0–4.0 ng/mL) trigger evaluation, yet cancer can occur at lower PSA values, and conversely, a raised PSA value may arise from non-pathological conditions such as benign prostatic hyperplasia or prostatitis [6]. The widespread adoption of PSA testing is regarded as one of the principal drivers of the increase in PCa incidence in the past decades [4].

The use of PSA as a population-based screening tool represents a controversial topic. By allowing the detection of early-stage disease, it may reduce cancer-specific mortality [7]: accordingly, the European Randomised Study of Screening for Prostate Cancer (ERSPC) trial

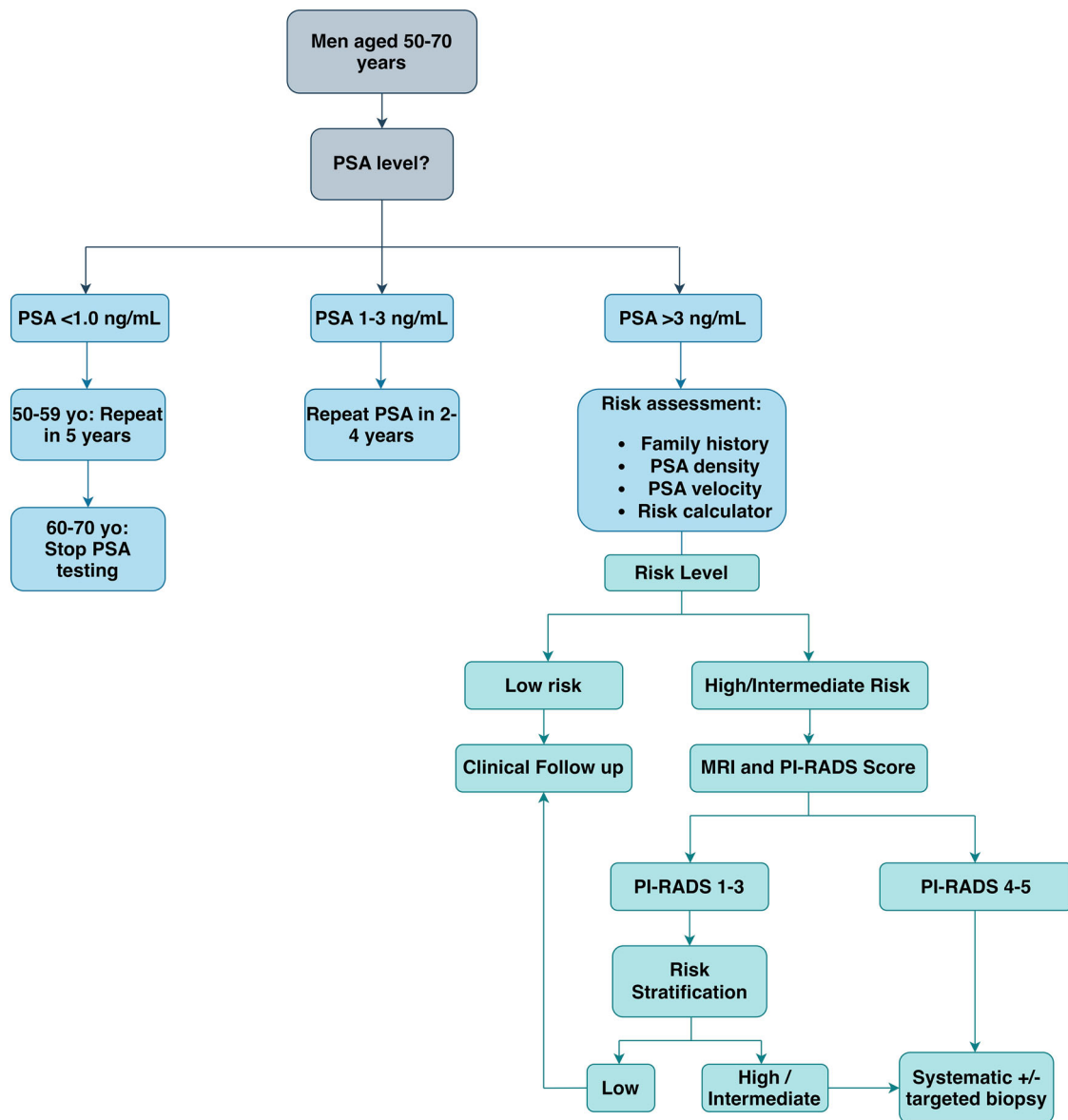


Fig. 1 Risk-adapted pathway for prostate cancer screening and diagnosis integrating PSA level, clinical risk factors, MRI findings, and biopsy outcomes. The diagram is conceptually adapted from [13] and redesigned

demonstrated a 20% reduction in PCa-specific mortality at 16 years, while the Göteborg trial reported a 35% reduction at 18 years [8, 9]. However, a meta-analysis of five randomised PSA-based screening trials found no significant reduction in mortality [7]. It has been suggested that screening intensity may be the key determinant of survival benefit, and that opportunistic or one-time screening programmes are unlikely to achieve a measurable reduction in mortality.

The major harm of PSA-based screening is overdiagnosis and overtreatment of indolent disease. In

ERSPC, overdiagnosis ranged between 30 and 40%, leading to unnecessary biopsies and treatment [8, 10].

Existing screening recommendations are flawed by considerable heterogeneity worldwide. The European Association of Urology (EAU) supports risk-adapted screening based on age, family history, ethnicity, baseline PSA, and pre-biopsy MRI, consistent with the European Commission initiatives [11–13] (Fig. 1). Conversely, the American Urological Association (AUA) advocates a patient-centred, risk-adapted approach grounded in shared decision-making, with PSA as the

Table 1 Summary of international guidelines on prostate cancer screening

Organisation	Year	Age	Main screening tool	PSA thresholds/follow-up	DRE	MRI
American Cancer Society (ACS) [76]	2023	- Age 50 for the overall population; - Age 45 for high-risk population (African American or one 1st-degree relative); - Age 40 for high-risk population (if ≥ 2 relatives)	PSA	- PSA < 2.5 ng/mL: retested every 2 years; - Prostate Cancer Screening Guidelines 2.5 ng/mL: retested yearly - No PSA if life expectancy < 10 years	Optional alongside PSA	No specific recommendation
United States Preventive Services Task Force (USPSTF) [77]	2023	- Age 55–69; - Avoid screening ≥ 70	PSA, with an individualised approach (shared decision-making)	Periodic PSA-based screening on individual evaluation, based on discussion of the potential benefits and harms with clinicians	No specific recommendation	No specific recommendation
American Urological Association (AUA)/Society of Urologic Oncology (SUO) [78]	2026	- Age 45–50 for the general population - Age 40–45 for high-risk population (black race, germline mutations, strong family history of prostate cancer)	PSA	PSA first; always repeat before biomarkers/biopsy	Additional to PSA	After repeating PSA: Recommend multiparametric MRI before biopsy
National Comprehensive Cancer Network (NCCN) [79]	2025	- Ages 45–75 for the general population - Age 40–75 for high-risk population (black/African American germline variants, family history)	PSA + /- DRE	- PSA < 1 ng/mL and normal DRE (if available): repeat testing after 2–4 years - PSA 1–3 ng/mL and normal DRE (if available): repeat testing after 1–2 years - PSA > 3 ng/mL and/or very suspicious DRE (if available): further testing - In case of high-risk and PSA ≤ 3 ng/mL and normal DRE (if available): repeat testing after 1–2 years	Additional to PSA	Use mpMRI (with PSA density calculation) before biopsy
European Association of Urology (EAU) [80]	2025	- From age 50 for the general population - From age 45 for high-risk population (family history of prostate cancer, African descent) - From age 40 for the high-risk population (men with the breast cancer gene 2 -BRCA2- mutation)	PSA testing for well-informed men (counselling on potential risks and benefits)	Risk-adapted approach (PSA-based), with follow-up intervals of 2 years for: - PSA > 1 ng/mL at 40 years of age; - PSA level > 2 ng/mL at 60 years of age	DRE recommended for staging	- MRI not recommended as initial screening tool - MRI is essential when PSA > 3 ng/mL for men at intermediate/high risk - Always perform MRI before biopsy

American Cancer Society (ACS) [76]; United States Preventive Services Task Force (USPSTF) [77]; American Urological Association (AUA)/Society of Urologic Oncology (SUO) [78]; National Comprehensive Cancer Network (NCCN) [79]; European Association of Urology (EAU) [80]
PSA prostate specific antigen, DRE digital rectal examination, MRI magnetic resonance imaging, BRCA breast cancer gene

initial screening modality and baseline testing between 45 and 50 years [14]. Although several international bodies endorse organised, risk-adapted pathways, many national committees, including the National Health Service (NHS) in the UK, do not recommend universal screening, citing concerns that harms may outweigh benefits and that overall efficacy remains uncertain [15]. A synthesis of international guidelines is presented in Table 1.

MRI in prostate cancer: principles and advances

Prostate MRI improves PCa risk stratification in the diagnostic setting by reducing unnecessary biopsies and the detection of low-risk disease, while increasing the identification of clinically significant PCa (csPCa) [16]. Throughout this report, csPCa is defined as Gleason Grade Group (GG) ≥ 2 (Gleason score $\geq 3 + 4$) or any tumour with extraprostatic extension, and clinically insignificant PCa (ciPCa) as GG1. These benefits have sparked interest in applying MRI to population screening, either as a PSA triage test or as a standalone modality; however, key implementation factors remain undefined. A summary of common practices in MRI-based screening trials is reported in Table 2.

Optimal MRI protocols for screening and MRI quality considerations

A screening tool should be cost-effective, minimally invasive, and feasible for large-scale deployment. In this

regard, MRI without intravenous contrast medium (biparametric MRI-bpMRI) is particularly attractive for screening: compared with multiparametric MRI (mpMRI), it offers shorter acquisition times, lower costs, and simplified workflows with comparable diagnostic performance [17]. Avoiding intravenous contrast also reduces patient burden, contrast-related risks, staffing needs and costs for the healthcare system. Beyond standard bpMRI, abbreviated single-plane bpMRI protocols (requiring < 10 min) are increasingly considered for screening [18, 19], and artificial intelligence (AI)-based acceleration tools on modern scanners may shorten acquisition further [20]. In contrast, optimal pre-MRI patient preparation remains unclear. Measures such as bowel emptying, enemas, or administration of antispasmodic agents may reduce motion and susceptibility artefacts and improve image quality [21], but they could also reduce patients' compliance and increase costs.

Regardless of protocol or preparation, MRI sequences should be acquired in accordance with the technical specifications outlined in the Prostate Imaging Reporting and Data System (PI-RADS) v2.1 guidelines to ensure adequate image quality and diagnostic reliability [22]. High-quality MRI improves diagnostic performance and reduces diagnostic uncertainty [23, 24], which is critical in screening to limit false positives and overdiagnosis. International initiatives such as the Prostate Imaging

Table 2 Common practices in MRI-based prostate cancer screening trials

	Common practice	Comments
Acquisition protocol	bpMRI; abbreviated/monoplanar bpMRI protocols may be considered to reduce acquisition time.	Acquisition parameters should comply with PI-RADS v2.1 technical recommendations.
Patient preparation	No consensus exists regarding routine pre-MRI preparation (e.g. rectal enema/evacuation, antiperistaltic agents).	Potential improvements in image quality should be balanced against the additional burden for patients and MRI services.
Quality assurance	Quality assurance and quality control (QA/QC) are required when MRI is used for screening. Examinations should be interpreted by experienced radiologists. Inclusion of PI-QUAL v2 scores in reports may be considered.	Centre accreditation, structured reader training and certification, and performance benchmarking should be evaluated for screening programmes.
MRI interpretation	PI-RADS v2.1 criteria may be applied for bpMRI interpretation and reporting.	Caution is warranted when applying PI-RADS v2.1 to abbreviated bpMRI protocols.
MRI reporting	Reports should include the minimum information required for screening purposes (e.g. image quality, prostate volume, presence or absence of lesions, concise lesion description).	Reporting incidental findings may increase overdiagnosis and overtreatment of indolent collateral findings; a predefined reporting threshold for collateral findings is recommended.
Positivity thresholds	Thresholds of PI-RADS 3 or 4 may be used to define a positive MRI (screen-positive vs. screen-negative).	A PI-RADS 4 threshold may provide a more favourable benefit-harm balance in screening settings.
Actions	Screen-positive patients proceed to targeted biopsy ($\pm$ systematic biopsy).	Alternative approaches, such as performing mpMRI in screen-positive patients before biopsy, have been explored to reduce unnecessary biopsies.

BpMRI biparametric magnetic resonance imaging, *PI-RADS* prostate imaging reporting and data system

Table 3 Study designs, methods, and main outcomes of large trials including MRI as a prostate cancer screening tool

Study	IP1-Prostagram [41]	Re-image [38]	MVP [42]	GÖTEBORG-2 [45]	Probase [32]	Visioning [43]	STHLM3 [47]	Proscreen [46]	PROSA [44]
Year	2021	2021	2022	2022	2023	2024	2024	2024	2025
Study design	Diagnostic accuracy paired Cohort	Feasibility study	Randomised study	Randomised: Systematic +targeted biopsy vs. targeted biopsy	Randomised immediate vs. deferred PSA (all high risk to MRI)	Prospective cohort study	Randomised Clinical Trial	Randomised Trial	Screening Pathways Randomised Study
Recruitment	GP invitation	GP invitation	Volunteers (adv)	Volunteers	Volunteers	Volunteers	Volunteers	Volunteers	Volunteers
Location	UK (multicentre)	UK (multicentre)	Canadian (sing centre)	Sweden (multicentre)	Germany (multicentre)	Switzerland single-centre	Sweden (multicentre)	Finland (multicentre)	Italy (single-centre)
Study Population									
Enrolled	411	303	525 (target 1010)	38,775	46,642 149 high risk: MRI	269	1500	7744 (screening group)	759
Age (years)	50–70	50–75	40–69	50–60	Immediate PSA screening: 45 yr deferred PSA screening: 50 yr	Over 50 (over 45 if African ancestry or family history of Pca)	50–74	50–63	49–49 (40–69 if pos family history)
Screening programme									
Test	PSA, US, bpMRI	PSA Density, bpMRI	PSA vs. bpMRI (randomised arms)	PSA+mpMRI+Bx	Immediate PSA (45 yr) vs. Deferred PSA (50 yr) and mpMRI	bpMRI	PSA + Stockholm3 risk score + bpMRI or Biopsy	Screening (PSA+Kallikrein +mpMRI+Biopsy) vs. No Screening	bpMRI vs. PSA +bpMRI (randomised arms)
PSA cut-off	≥ 3 ng/mL	PSAD ≥ 0.12	≥ 2.6 ng/mL	≥ 3 ng/mL	≥ 3 ng/mL	≥ 10 ng/mL (indication to biopsy regardless of PI-RADS score)	≥ 3.0 ng/mL/ Stockholm3 risk score ≥ 0.11	≥ 3.0 ng/mL/ 4-kallikrein risk score ≥ 7.5%	≥ 3 ng/mL
MRI protocol	bpMRI	bpMRI	bpMRI	mpMRI	mpMRI	bpMRI	bpMRI	mpMRI	bpMRI
MRI cut-off	bpPI-RADS ≥ 3 or 4	/	bpPI-RADS ≥ 4	PI-RADS ≥ 3	NA (MRI has no impact on the biopsy decision in the study protocol)	PI-RADS ≥ 3	PI-RADS ≥ 3	PI-RADS ≥ 3	bpPI-RADS ≥ 3
Reference test	Systematic + targeted biopsy	mpMRI	Systematic + targeted biopsy	Targeted +/- systematic biopsy	Systematic + targeted biopsy	Targeted +/- systematic biopsy	Targeted +/- systematic biopsy	Targeted biopsy	Targeted biopsy
Outcomes									
cPcA rate	17/406 (4.2%)	29/303 (9.6%)	15/494 (3.0%)	178/17,980 (1.0%)	33/23,301 (Immediate PSA) (0.1%)	21/229 (9.2%)	404/2293 (17.6%)	44/7457 (intervention group) (0.6%)	24/752 (3.2%)
cIPCa rate	20/406 (4.9%)	3/303 (1.0%)	8/494 (1.6%)	138/17,980 (0.8%)	14/23,301 (Immediate PSA) (0.1%)	8/229 (3.5%)	176/2293 (7.7%)	77/7457 (intervention group) (0.1%)	24/752 (1.7%)

PSA prostate-specific antigen, bpMRI biparametric magnetic resonance imaging, mpMRI multiparametric magnetic resonance imaging, cPcA clinically insignificant prostate cancer (Gleason Grade Group ≥ 2 and or any tumour with extraprostatic extension), cIPCa clinically insignificant prostate cancer (Gleason Grade Group 1)

Quality (PI-QUAL) scoring system aim to standardise prostate MRI quality across centres and reduce inter-institutional variability that may affect diagnostic outcomes [25]. Accordingly, rigorous quality assurance should be considered a fundamental component of any MRI-based screening strategy [26].

To minimise variability across centres, MRI protocols must be standardised and robust enough for deployment in community settings without substantial loss of accuracy, a challenge already observed in lower-volume practice [27, 28]. This underscores the need for ongoing centre accreditation and quality assurance/quality control (QA/QC) programmes, structured reader training and certification, and performance benchmarking.

Screening MRI interpretation, reporting and outcomes

Prostate anatomy can differ substantially between younger and older men [29, 30]. Younger patients (i.e. < 55 years) might have minimal glandular hypertrophy and a diffusely hypointense peripheral zone on T2-weighted imaging with mild diffusion restriction, reflecting physiological rather than pathological feature [31]. These patterns may increase the likelihood of equivocal interpretations; in the PROBASE trial (men aged 45–50), nearly half of MRI scans were reported as PI-RADS 3 [32]. Radiologists interpreting screening MRI in younger populations should therefore be familiar with these patterns to minimise overcalling of physiological findings.

Most MRI-based screening trials use the PI-RADS score for interpretation [33]. Although a modified version can be applicable to bpMRI, its performance with monoplanar abbreviated protocols requires further validation. Moreover, the optimal positivity threshold remains uncertain (PI-RADS 3 vs. 4). While a PI-RADS 3 cutoff is more commonly used, a PI-RADS 4 cutoff is associated with a higher positive predictive value (PPV), fewer biopsies and reduced detection of non-significant PCa, without meaningfully compromising csPCa detection [5]. Cancers that are potentially missed by setting a higher threshold are likely low-grade, with limited MRI conspicuity and may be detected in subsequent screening rounds as they become more visible [5, 34]. Overall, a PI-RADS ≥ 4 threshold may offer a more favourable benefit-harm balance for screening [5]. To further improve MRI PPV, a stage-gated approach has recently been proposed [35].

Regardless of the positivity threshold, screening outcomes can be categorised as screen-positive (requiring further evaluation) or screen-negative (return to screening). In most trials, MRI screen-positive individuals proceed directly to targeted biopsy. An alternative strategy, confirming positive findings on screening bpMRI with full mpMRI prior to biopsy, has demonstrated high PPV and

further reduction in unnecessary biopsies [19]. This approach may be suitable for MRI-first screening programmes (especially in younger men) or when ultra-fast bpMRI protocols are employed. Additional evidence is needed to define the most appropriate diagnostic pathway.

Finally, screening should be viewed as longitudinal. Men with non-suspicious or suspicious MRI but negative biopsy require structured follow-up, yet optimal intervals and the role of prior MRI or baseline risk in tailoring intensity remain unclear; data from the second screening rounds of two major trials (STHLM3-MRI and GÖTEBORG-2) suggest that extending rescreening intervals beyond the current two-year standard may be safe [36, 37].

Implementation strategies: MRI-first vs. risk stratification

MRI-first approaches offer MRI to all invited men, with biopsy performed only for those with suspicious findings. In contrast, risk-stratified strategies use an initial risk assessment (typically serum PSA) to trigger MRI as a reflex test, thereby identifying a smaller, higher-risk subgroup (Supplementary Table 1).

Early studies suggest MRI-first pathways increase cancer detection because a substantial proportion of men with PSA < 3 ng/mL harbour clinically significant disease, highlighting the limitations of PSA thresholds [38]. However, this higher detection rate may come at the cost of increased negative scans, biopsy rates and greater diagnosis of clinically insignificant cancer, potentially amplifying screening-related harms [39]. MRI-first strategies also require considerable imaging capacity and radiological expertise, and entail non-negligible financial costs, which may limit scalability in population programmes.

Conversely, PSA-first approaches concentrate MRI resources where they are most likely to yield clinical benefit. Applying PSA thresholds substantially reduces the number of men requiring MRI, while also excluding those with a very low baseline risk of PCa [40]. Overall, current evidence suggests that reflex-MRI strategies following risk stratification may represent a more pragmatic and sustainable model for large-scale screening initiatives [39].

Evidence from large trials

MRI-first strategies

In IP1-PROSTAGRAM [41], MRI-scored PI-RADS 4–5 detected more csPCa than PSA alone without increasing biopsy rates; combining low PSA thresholds (≥ 1 ng/mL) with MRI further optimised csPCa detection while limiting biopsies. The MVP randomised trial [42], comparing PSA screening with stand-alone MRI, showed

reduced biopsy rates and a non-significant increase in csPCa detection with MRI. The ReIMAGINE feasibility study evaluated upfront biparametric MRI and reported suspicious scans in 16% of participants, with csPCa diagnosed in 52% of these cases [38]. Similarly, the VISIONING study demonstrated greater MRI sensitivity for csPCa detection than traditional screening pathways, with PSA and digital rectal examination missing 38.1% of csPCa cases [43]. In the PROSA randomised trial, the MRI-first arm achieved a higher csPCa detection rate than the PSA-first arm (although not statistically significant: $p = 0.05$), with overall favourable benefit-harm metrics [44]. Together, these studies support the potential advantages of MRI-first screening approaches (Table 3).

PSA-first (risk-stratified) strategies with reflex MRI

The Göteborg-2 randomised trial [45] integrated PSA testing with MRI. At 4-year follow-up, detection of ciPCa was ~60% lower with MRI-targeted biopsy than with systematic biopsy, while csPCa detection remained comparable. The PROBASE trial used baseline PSA to stratify long-term risk and indicated that mpMRI was reserved for higher-risk subgroups [32]; applying a PI-RADS ≥ 4 threshold reduced negative biopsies by 68% and avoided 71% of nonsignificant cancer diagnoses. However, sub-optimal MRI performance in younger patients suggests that double reading could be useful in this specific setting. Stage-gated strategies incorporating additional biomarkers may further refine selection. The ProScreen trial used PSA followed by a 4-kallikrein panel and MRI only for higher-risk men, with early data showing substantial reductions in biopsies and overdiagnosis while maintaining csPCa detection (≈ 1 additional csPCa per 196 men screened; 1 ciPCa per 909) [46]. Similarly, the Stockholm3-MRI trial combined PSA with the Stockholm3 test to triage men to MRI and targeted biopsy, nearly halving biopsy rates while preserving detection of significant cancers [47].

Interpreting evidence across these trials requires careful consideration of their substantial heterogeneity. Studies differ in age ranges (spanning from 40 to 70 years), recruitment strategies (population-based vs. opportunistic), PSA thresholds used for enrolment or triage, MRI protocols (mpMRI vs. bpMRI vs. abbreviated bpMRI), biopsy approaches (targeted only vs. combined systematic), and definitions of clinically significant cancer (most commonly Gleason Grade Group ≥ 2 , but not uniformly applied). These differences limit direct comparison across trials and should be considered when interpreting pooled findings or translating results to different healthcare contexts. Moreover, most trials report single-round outcomes; long-term data on interval cancer rates, repeat-

screening intervals, and cancer-specific mortality remain limited.

Policy and governmental interest

There is growing (though cautious) governmental interest in MRI-driven population-prostate cancer screening worldwide, driven by the potential to reduce diagnostic and therapeutic interventions and achieve net system cost savings. Policy momentum reflects emerging evidence, technological advances in MRI, the rise in metastatic disease observed in the US after recommendations against PSA screening and the persistence of opportunistic testing. The 2022 Council of the European Union (EU) cancer screening recommendation supports exploration of organised, risk-stratified screening with PSA as an entry test and MRI as a selective follow-up tool [48]. In Sweden, the Organised Prostate Cancer Testing (OPT) programme, implemented regionally since 2020, applied such pathways; by 2024, most regions had adopted OPT, generating real-world data on participation, MRI utilisation, and outcomes [49]. At the EU level, the PRAISE-U project (EU4Health, 2023–2026) is piloting PSA-plus-MRI algorithms across member states to evaluate feasibility, implementation, cost-effectiveness and psychosocial impact [50]. In parallel, the UK TRANSFORM trial will enrol up to 300,000 men to compare MRI-first and risk-adapted pathways with standard PSA-based screening [51].

Collectively, these initiatives position MRI (particularly within risk-adapted, stage-gated strategies) as a central component of future organised prostate cancer screening in Europe, although barriers to population-level implementation remain.

Barriers to widespread adoption

Although initial evidence from recent trials supports the clinical promise of MRI-based prostate cancer screening, important logistical, economic, and infrastructural barriers must still be addressed before widespread implementation.

Cost-effectiveness and healthcare economics

Although MRI-first screening achieves the highest detection rate of csPCa, its use as a primary strategy raises cost-effectiveness concerns due to increased biopsy rates and overdiagnosis of indolent disease [39]. European health-economic studies generally support MRI as a reflex rather than a first-line test [52, 53], but reliance on microsimulation rather than long-term empirical data limits extrapolation to population programmes. A systematic review reported a median incremental cost-effectiveness ratio (ICER) of $\sim$ €56,000 per quality-adjusted life year (QALY) for MRI-inclusive pathways

Table 4 ESUR Prostate MRI Working Group perspectives and suggestions on MRI-based prostate cancer screening

	Key points
Rationale	• PSA-based PCa screening is associated with suboptimal cancer detection rates (CDR), substantial overdiagnosis, and overtreatment of indolent disease, with inconsistent mortality reduction across settings. • MRI-based screening reduces unnecessary biopsies, increases detection of clinically significant csPCa and decreases overdiagnosis, offering a more favourable benefit-harm balance.
MRI acquisition, interpretation, and reporting	• MRI should be acquired according to PI-RADS technical requirements and checked for image quality using PI-QUAL v2 criteria. • An abbreviated bpMRI protocol is preferred and should include small-field-of-view axial T2-weighted imaging (with optional coronal and/or sagittal planes), DWI and ADC maps. • Patient preparation (e.g. enemas, antispasmodic agents) can be considered to improve image quality and reduce equivocal or non-diagnostic scans, taking into account additional patient and operational burden. • The PI-RADS scoring system should be used to ensure standardised interpretation and reporting of MRI findings. • A PI-RADS ≥ 4 threshold should be considered as the positivity cutoff to reduce overdiagnosis and unnecessary biopsies. • Centre accreditation, quality assurance and quality control (QA/QC) programmes, reader training and certification are recommended to support effective delivery of MRI for prostate cancer screening.
Implementation strategies	• PSA-first strategies, with MRI used as a reflex test, may provide greater cost-effectiveness and scalability for population-level implementation. • MRI-first pathways maximise detection of csPCa but can result in a high proportion of negative examinations, increased unnecessary biopsies, and substantial demands on MRI capacity. • There is insufficient evidence to support MRI-based screening exclusively in high-risk populations (e.g. BRCA mutation carriers).
Areas of development	• AI-accelerated MRI acquisition, applied to abbreviated bpMRI protocols, may further reduce scan times. • AI-assisted interpretation might be considered to help reduce radiologist workload and potentially improve diagnostic accuracy. • AI tools for assisted interpretation must be trained and prospectively validated in screening populations before clinical implementation.

PSA prostate-specific antigen, *bpMRI* biparametric magnetic resonance imaging, *csPCa* clinically significant prostate cancer, *PI-QUAL* Prostate Imaging Quality, *PI-RADS* prostate imaging reporting and data system, *DWI* diffusion weighted imaging, *ADC* apparent diffusion coefficient, *BRCA* breast cancer gene, *AI* artificial intelligence

[54], with strong sensitivity to MRI costs; for example, a German analysis suggested MRI-first would be cost-effective only if per-scan costs fell to around €120, below current reimbursement in many systems [55]. Additional uncertainty concerns assumptions about health-state utilities and repeated screening rounds. The PROSA randomised trial included a prospective health technology assessment from the Italian payer perspective, reporting an ICER of €2,201.75 per csPCa detected and €8,468 per QALY gained (assuming 0.26 QALYs per case), both below conventional willingness-to-pay thresholds (€20,000–€50,000) [44].

Infrastructure demands and equitable offer in low-resource settings

MRI is resource-intensive, requiring costly equipment, specialised infrastructure, and expert radiologists. Even in

high-income countries (25–30 scanners per million inhabitants), capacity is strained by growing diagnostic demand, and scaling to population-based screening would require a major expansion of scanners and workforce, which is unlikely in the short to medium-term [56]. Constraints are greater in low-resource settings (< 1 scanner per million), risking widened inequalities in cancer detection and outcomes. These constraints require distinguishing between implementation models appropriate for different resource settings. In high-resource healthcare systems with adequate MRI capacity and trained radiologists, MRI could play a central role in screening. On the other hand, in lower-resource settings, full population-level MRI screening is not currently feasible, and efforts should focus on improving PSA triage accuracy and equitable access to diagnostic pathways, and on implementing risk-adapted strategies, as supported by

current trial evidence. Any future screening programme must incorporate equity considerations from the outset.

Participants-centred demands

Prospective trials show high compliance with MRI and biopsy, suggesting imaging itself is not a major barrier [57]. Biopsy adherence may be higher in MRI-based pathways than PSA-only strategies [5], indicating greater acceptance when imaging guides decisions. Nonetheless, biopsy anxiety, waiting times, and uncertainty about results remain important concerns, highlighting the need for counselling, personalised information, and shared decision-making support [58].

Potential harms in the screening setting

Although MRI improves the benefit-harm balance compared with PSA-only screening, MRI-based screening may lead to potential harms. False-positive MRI findings (PI-RADS ≥ 3 or ≥ 4 lesions that prove benign on biopsy) may lead to unnecessary biopsies, even though the rate is lower than that of PSA-based strategies [44]. Equivocal lesions (PI-RADS 3) are common, particularly in younger men, and generate diagnostic uncertainty, repeat imaging, and patient anxiety [59]. Furthermore, even MRI-based strategies carry a risk of overdiagnosis, particularly of MRI-visible intermediate-grade (Gleason Grade Group 2) cancers that may never cause symptoms during a man's lifetime; a higher biopsy threshold (PI-RADS ≥ 4) may help mitigate this risk [60, 61]. Finally, MRI may detect extraprostatic incidental findings of limited or no clinical relevance, which can nevertheless trigger additional investigations, follow-up imaging, costs, and patient anxiety [62]. These potential harms should be clearly communicated to participants in any screening programme and incorporated into shared decision-making.

Efficacy and epidemiology metrics

Established screening programmes rely on metrics spanning completeness, adequacy, accuracy, and safety [63]. Recently proposed harm-to-benefit ratios can be considered within the broader accuracy domain [33]; however, the remaining domains remain largely underexplored in prostate cancer screening. From an epidemiological perspective, important uncertainties also remain, particularly regarding how to adequately capture overdiagnosis, which can only be reliably quantified through long-term randomised trials. Moreover, interpretation of screening outcomes is complicated by the reliance on modelling approaches, as opportunistic testing in control groups complicates mortality estimates in ongoing trials. A reduction in overall PCa incidence compared with systematic biopsy-based strategies has been proposed as a key endpoint to ensure MRI screening

does not simply shift overdiagnosis toward small MRI-visible intermediate-grade lesions that would otherwise remain clinically insignificant [34].

Innovations and future directions

Role of artificial intelligence

Multiple AI applications have recently emerged that could be integrated into MRI-based prostate cancer screening pathways. Deep learning-based reconstruction algorithms, increasingly available on commercial MRI systems, could substantially reduce acquisition time, potentially enabling abbreviated protocols with scan times under 10 min, an important prerequisite for screening [20].

Beyond technical optimisation, the main focus is AI-assisted diagnosis. The PI-CAI study showed that AI can improve MRI diagnostic accuracy, primarily by increasing specificity, potentially reducing the number of unnecessary biopsies compared with radiologist assessment [64]. This advantage would be particularly relevant in screening, where disease prevalence is low and minimising false positives is critical. In general, AI may reduce uncertainty, reporting time, and biopsy rates, especially for less experienced readers [65]. This benefit has also been demonstrated in screening populations, where combining a less experienced reader with AI achieved the highest diagnostic performance compared with expert reading as a reference [66]. Proposed implementation models include decision support for lesion detection and characterisation; use as a second reader in double-reading strategies; triage or high-confidence filtering to exclude clearly negative examinations and reduce workload; and, potentially, standalone screening [67]. However, robust evidence is lacking to determine which approach offers the greatest benefit. More importantly, most AI systems have been developed in secondary diagnostic cohorts with higher disease prevalence and older patients, and their performance may therefore be suboptimal in screening populations, particularly younger men with different prostate MRI appearances [30]. Dedicated training and validation in screening cohorts are required before routine adoption. Overall, AI should be considered a promising yet investigational tool in the screening context; its integration into routine screening pathways should await prospective validation in population-based screening cohorts. As AI-assisted MRI screening gains attention, ethical considerations must also be addressed. Equity of access is a key concern, as high-quality MRI screening could become concentrated in well-resourced centres, potentially widening health disparities.

Risk-adapted strategies

Although MRI-based strategies reduce overdiagnosis compared with systematic biopsy, risks of overmedicalization

from false-positive findings or incidental extraprostatic abnormalities persist. Risk-adapted strategies aim to improve efficiency by targeting individuals with higher baseline risk. Targeted MRI screening has been proposed for men with a family history, Afro-Caribbean ancestry, and carriers of pathogenic germline genetic variants. In the IMPACT study, BRCA2 carriers had a higher incidence of prostate cancer, were diagnosed at a younger age, and had a higher rate of clinically significant tumours, supporting earlier and more systematic screening in this group [68]. While BRCA2 remains the best-established high-risk gene, increased prostate cancer risk has also been associated with variants in other cancer predisposition genes (including BRCA1, ATM, CHEK2 and mismatch repair genes) [69]. Current guidelines increasingly recognise the role of germline genetic testing in prostate cancer, but recommendations remain heterogeneous, particularly for localised disease and screening populations [70].

Early data suggest that MRI-based screening may be valuable in genetically predisposed men. In carriers of pathogenic germline variants, MRI-based approaches have shown higher sensitivity for clinically significant prostate cancer than PSA-based screening alone, supporting their potential role in early detection [71]. Beyond rare monogenic variants, polygenic risk scores may further refine risk stratification. The ProGRESS study showed that integrating polygenic risk, family history, and genetic ancestry identified clinically meaningful gradients in the risk of any, metastatic, and fatal prostate cancer [72]. Similarly, BARCODE1 demonstrated that MRI and biopsy in men with a polygenic risk score in the highest decile detected prostate cancer in 40% of screened participants, including a substantial proportion of clinically significant disease [73].

However, because most prostate cancer deaths occur in men without identifiable risk factors, screening cannot be limited to high-risk subgroups alone and requires more refined stratification. Growing interest also surrounds circulating biomarkers as non-invasive tools to refine risk beyond. For example, microRNAs have shown potential for predicting clinically significant disease [74], and a prospective integrated pathway combining clinical variables, MRI biomarkers, and microRNAs achieved the greatest net benefit, avoiding ~20% of biopsies at low-grade disease [75].

Overall, while AI, risk stratification and novel biomarkers may further refine MRI-driven screening, additional evidence from population-based trials is needed before widespread implementation can be justified.

Perspectives and suggestions from the ESUR Screening and MRI Pathway Prostate MRI Working Group on MRI-based screening, based on current evidence, are provided in Table 4.

Conclusion

Prostate MRI has the potential to address key limitations of PSA-based PCa screening by improving detection of clinically significant disease while reducing harms associated with overdiagnosis of indolent tumours and unnecessary biopsies. Further research is needed to define the most effective and sustainable strategies for integrating prostate MRI into real-world screening pathways.

Abbreviations

AI	Artificial intelligence
AUA	American Urological Association
bpMRI	Biparametric MRI
ciPCa	Clinically insignificant PCa
csPCa	Clinically significant PCa
EAU	European Association of Urology
ERSPC	European Randomised Study of Screening for Prostate Cancer
EU	European Union
mpMRI	Multiparametric MRI
MRI	Magnetic resonance imaging
PCa	Prostate cancer
PI-QUAL	Prostate Imaging Quality
PI-RADS	Prostate Imaging Reporting and Data System
PPV	Positive predictive value
PSA	Prostate-specific antigen
QA/QC	Quality assurance/quality control
QALY	Quality-adjusted life year

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- Review

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