



UNIVERSITY OF LEEDS

This is a repository copy of *What Is the Negative Predictive Value of Multiparametric Magnetic Resonance Imaging in Excluding Prostate Cancer at Biopsy? A Systematic Review and Meta-analysis from the European Association of Urology Prostate Cancer Guidelines Panel.*

White Rose Research Online URL for this paper:  
<http://eprints.whiterose.ac.uk/114729/>

Version: Accepted Version

---

**Article:**

Moldovan, PC, Van den Broeck, T, Sylvester, R et al. (21 more authors) (2017) What Is the Negative Predictive Value of Multiparametric Magnetic Resonance Imaging in Excluding Prostate Cancer at Biopsy? A Systematic Review and Meta-analysis from the European Association of Urology Prostate Cancer Guidelines Panel. *European Urology*, 72 (2). pp. 250-266. ISSN 0302-2838

<https://doi.org/10.1016/j.eururo.2017.02.026>

---

© 2017 European Association of Urology. Published by Elsevier B.V. This manuscript version is made available under the CC-BY-NC-ND 4.0 license  
<http://creativecommons.org/licenses/by-nc-nd/4.0/>

**Reuse**

Unless indicated otherwise, fulltext items are protected by copyright with all rights reserved. The copyright exception in section 29 of the Copyright, Designs and Patents Act 1988 allows the making of a single copy solely for the purpose of non-commercial research or private study within the limits of fair dealing. The publisher or other rights-holder may allow further reproduction and re-use of this version - refer to the White Rose Research Online record for this item. Where records identify the publisher as the copyright holder, users can verify any specific terms of use on the publisher's website.

**Takedown**

If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing [eprints@whiterose.ac.uk](mailto:eprints@whiterose.ac.uk) including the URL of the record and the reason for the withdrawal request.



[eprints@whiterose.ac.uk](mailto:eprints@whiterose.ac.uk)  
<https://eprints.whiterose.ac.uk/>

Study	Study design	Period	Population	Pt Nb	Mean/Median* age (years)	Mean/median* PSA (ng/mL)	Mean/median* prostate volume (cm³)	Magnetic field strength	MR pulse sequences	Endo-rectal coil	MR score	Definition of positive MRI	Reference standard
Hauth 2015	Prospective	2011-2013	FB	94	64 [43-83]	9 [3-31]	51 [17 - 140]	1.5T	T2WI/DWI DCEI/MRSI	No	PI-RADS V1	≥3	11-13 core TRUS SBx+ TBx
Lamb 2015	Retrospective	2013-2013	FB & PNB	173	NR	NR	NR	1.5T	T2WI/DWI	NR	NR	NR	12 core TRUS SBx
Brock 2015	Prospective	2013-2014	PNB	168	64* [IQR 59-70]	9.2* [IQR 6.7-13.4]	55.4* [IQR 42-80]	3T	T2WI/DWI/ DCEI	No	PI-RADS V1	NR	12/24 core TRUS SBx + TBx
Grenabo Bergdahl 2015	Prospective	2013-2014	FB & PNB	83	69.3* [IQR 69-69.6]	1.6* [IQR 0.9-2.7]	NR	3T	T2WI/DWI/ DCEI/MRSI	No	PI-RADS V1	≥3	10 core TRUS SBx + TBx
Wang 2015	Prospective	2002-2009	FB & PNB	586	70 [26-91]	11.11* [0.02-9794]	NR	1.5T	T2WI/DWI/DCEI/ MRSI	Yes	PI-RADS V1	≥3	TRUS SBx
Pepe 2015	Prospective	2011-2014	PNB	100	64*	8.6* [4.2-10]	NR	3T	T2WI/DWI/ DCEI/MRSI	No	PI-RADS V1	≥4	TPBx + TBx
Panebianco 2015	Prospective	2011-2014	FB (61.62%) & PNB (38.34%)	925 (1140 total cohort)	NR	NR	NR	3T	T2WI/DWI/ DCEI	Yes	PI-RADS V1	NR	14 core TRUS SBx; 45 core sat TPBx + TBx
Radtke 2015	Prospective	2013-2013	FB (63.3%) & PNB (36.7%)	294	64* [60-71]	7.3 (6.0)	47 (37.5)	3T	T2WI/DWI/ DCEI	No	PI-RADS V1	PI-RADS ≥2; PI-RADS ≥3; PI-RADS ≥4; PI-RADS =5;	24 core TPBx + TBx
Itatani 2014	Retrospective	2004-2007	NR	193	68.9 (8.4); 70* [47-89]	11.8 (15.9); 7.9* [1.22 – 159]	NR	1.5T	T2WI/DWI/ DCEI	No	1-5 scale (Likert)	≥3	12-14 core TRUS SBx
Porpiglia 2014	Prospective	2011-2013	PNB	170	65* [60-70]	6.9* [5.2-9.8]	42* [36-48]	1.5T	T2WI/DWI/ DCEI	Yes	Dichotomous	Positive: at least 2/3 MR seq. with suspicious findings	18-24 core TRUS SBx (volume dependent)
Thompson 2014	Prospective	2012-2013	FB (88%) & PNB (12%)	150	62.4* [IQR 55.0-66.4]	5.6* [IQR 4.5 - 7.5]	40* [IQR 30-57]	1.5 T (47%) & 3T (53%)	T2WI/DWI/ DCEI	No	PI-RADS V1	≥3	Median of 30 TPBx (volume dependent)
Pokorny 2014	Prospective	2012-2013	FB	223	63* [IQR 57 – 68]	5.3* [IQR 4.1 - 6.6]	41* [IQR 30 - 59]	3T	T2WI/DWI/ DCEI	No	PI-RADS V1	≥3 (primary); ≥4;	12 core TRUS SBx+ TBx
Petrillo 2014	Prospective	2009-2010	NR	136	NR	NR	NR	1.5T	T2WI/ DWI/ MRSI	Yes	1-5 scale (Likert)	≥3	12–16 core TRUS SBx (volume +PSA dependent)
Javali 2014	Retrospective	2002-2011	NR	140	Control: 62.4(10.5); Study: 62.9(12,1)	Control: 6.8 (2.3); Study: 6.87 (2.6)	Control: 44 (14.2); Study: 43 (18.4)	1.5T	T2WI/MRSI	Yes	Dichotomous	Cit/[Cho + Cr] < 1.2	6-core TRUS SBx (n=69), 12-core TRUS SBx (n=119)
Abd-Alazeez 2014	Prospective	2007-2011	FB	129	62* [41-82]	5.8* [1.2-20]	40* [16-137]	1.5T & 3T	T2WI/DWI/DCEI	No	PI-RADS V1	≥3 (primary); ≥4;	20 core TPBx
Abd-Alazeez 2014	Retrospective	NR	PNB	54	64* [39-75]	10* [2-23]	53* [19-136]	1.5T & 3T	T2WI/DWI/DCEI	No	PI-RADS V1	≥3 (primary); ≥4;	≥20 core TPBx + TBx (n=15)
Matsuoka 2014	Prospective	2007-2012	NR	135	67* [50-80]	7.0* [2.9-19.8]	25.4* [12.7-90.2]	1.5T	T2WI/DWI/	No	1-5 scale (Likert)	≥ 3	14 core TRUS SBX
Junker 2013	Retrospective	2011-2013	PNB	73	62 (7.4)	7.0* [5.1-12.9]	45* [34-61]	3T	T2WI/DWI/DCEI	No	PI-RADS	PI-RADS≥ 10 and ≥ 11 for all PCa; PI-RADS≥ 13 for significant PCa	10 core TRUS SBx + TBx
Busetto 2013	Prospective	2010-2012	PNB	163	66.4 (5.3)	6.8 (1.6)	NR	3T	T2WI/DWI/DCEI/ MRSI	Yes	NR	NR	10 core TRUS SBx + TBx
Rais-Bahrami 2013	Prospective	2007-2012	NR	583	61.3 (8.4)	9.9 (13.1)	NR	3T	T2WI/DWI/DCEI/ MRSI	Yes	1-4 scale (Likert)	≥2 ≥3	12 core TRUS SBx+ TBx
Kuru 2013	Prospective	2010-2011	FB (51%) & PNB(49%)	347	65.3 [42-82]	9.85 [0.5-104]	48.7 [9-180]	3T	T2WI/DWI/DCEI	No	1-3 scale (Likert)	≥2	12-36 core TRUS SBx (volume dependent) + TBx
Ferda 2013	Prospective	NR	NR	164	[49 - 74]	[4,2 - 123]	NR	3T	T2WI/DWI/DCEI/ MRSI	No	NR	In house	TRUS SBx
Ganie 2013	NR	2007-2009	PNB	87	NR	NR	NR	1.5T	T2WI/MRSI	Yes	MRSI Cho/Cit ratio	In house	6 core TRUS SBx + MRI TBx
Vinet 2013	Prospective	2009-2011	FB	69	NR	5,2* [3,2 - 28]	NR	1.5T (35 pts) & 3T (34 pts)	T2WI/DWI/DCEI	No	1-5 scale (Likert)	≥ 3	12 core TRUS SBx + TBx
Numao 2013	Prospective	2006-2010	FB	351	65* [59-70]	6.3* [4.9-9.1]	32* [24-42]	1.5T	T2WI/DWI/DCEI (no DCEI in 42 pts)	No	1-5 scale (Likert)	≥3	3D 26 core (12 TRUS SBx +14 TPBx -203 pts); 3D 14-core (6TRUS

													SBx +8TPBx - 102 pts); TPBx 14core (46 pts)
<b>Belas 2012</b>	Prospective	2010-2011	FB	71	66* [47-76]	7* [4 - 10]	45* [15-150]	1.5T	T2WI/DWI/DCEI	No	TZ: 0-4 scale PZ: 0-10 scale	TZ: >2 PZ: >6	12 core TRUS SBx + TBx
<b>Ibraheim 2012</b>	Prospective	2008-2009	FB	100	65.03 (7.13)	26.3 (24.2)	60.09 (28.7)	1.5T	T2WI/DWI	No	NR	In house	12 core TRUS SBx
<b>Sciarra 2012</b>	Prospective	2008-2011	PNB	84	64.09[46-76]	7.07 [4.2-15.5]	NR	3T	T2WI/DWI/DCEI/ MRSI	Yes	NR	NR	10 core TRUS Bx + TBx
<b>Portalez 2012</b>	Prospective	2011	PNB	129	64.7 [47-79]	9.6 [2.7-40]	51.1 [12-192]	1.5T	T2WI/DWI/DCEI	Mixed	1-5 scale (Likert) PI-RADS	Likert ≥ 3 PI-RADS ≥ 9	10-12 core TRUS SBx + TBx
<b>Watanabe 2012</b>	Prospective	2004-2008	NR	1448	72 (7.5)	NR	NR	1.5T	T2WI/DWI	No	NR	ADC value ≤1.35x10 <sup>-3</sup> mm <sup>2</sup> /s	8 core TRUS SBx + TBx
<b>Tamada 2011</b>	Retrospective	2006-2009	NR	50	70 [40-84]	6.84* [4.06-9.94]	NR	1.5T	T2WI/DWI/DCEI	No	NR	In house	12 core TRUS SBx
<b>Choi 2011</b>	NR	2009-2010	NR	51	67.16 [56-90]	14.16 [1.02-38.9]	42.98 [13.8-77.3]	3T	T2WI/DWI	NR	NR	NR	10-12 core TRUS SBx + TBx
<b>Iwazawa 2011</b>	Retrospective	2008-2009	NR	178	68.8 [41-86]	20.51 [4.04-568.5]	NR	1.5T	T2WI/DWI/DCEI	NR	1-4 scale (Likert)	NR	10-12 core TRUS SBx (TBx included in SBx chart)
<b>Rouse 2011</b>	Prospective	2005-2007	PNB	114	63.6 [41-83]	13.4 [0-228]	NR	1.5T	T2WI/DWI/DCEI	NR	1-5 scale (Likert)	≥3	TRUS SBx
<b>Haffner 2011</b>	Prospective	2005-2009	FB	555	64* [47-83]	6.75* [0.18-100]	46* [15 - 200]	1.5T	T2WI/DCEI	No	1-5 scale (Likert)	≥3	10 core TRUS SBx + TBx
<b>Panebianco 2010</b>	Prospective	2007-2009	PNB	150	61.2 [46-78]	9.42 (3.91)	41.17 (7.47)	1.5T	T2WI/DCEI/MRSI	Yes	NR	In house	10 core TRUS SBx (TBx included in SBx chart)
<b>Roy 2010</b>	Not specified	2011-2009	FB (53%) & PNB (47%)	103	63 [52 - 78]	7*	NR	3T	T2WI/DWI/ DCEI	Yes	NR	NR	8 core TRUS SBx + TBx
<b>Testa 2010</b>	Not specified	2007-2007	PNB	54	63.9 [52-76]	11.4 [3-42]	59.3 [30-150]	1.5T	T2WI/MRSI	Yes	1-3 scale (Likert)	≥2	12 core TRUS SBx + TBx
<b>Sciarra 2010</b>	Prospective	2007-2009	PNB	110	63.5 [49-74]	NR	NR	1.5T	T2WI/DCEI/MRSI	Yes	NR	In house	10 core TRUS SBx + TBx
<b>Kitajima 2010</b>	Prospective	2008-2009	NR	53	69* [56-84]	11.1* [4.2-112.1]	NR	3T	T2WI/DWI/DCEI	No	1-5 scale (Likert)	≥3	20 core TPBx
<b>Labanaris 2010</b>	Prospective	2004-2008	PNB	260	NR	NR	NR	1T	T2WI/DWI/DCEI	Yes	Dichotomous	In house	18 core TRUS SBx
<b>Kumar 2009</b>	NR	NR	NR	61	65.3 (9.3)	16.5 [0.21-155]	NR	1.5T	T2WI/MRSI	Yes	NR	(Cit/(Cho+Cr) ≤1.2	TRUS Bx
<b>Schumueching 2009</b>	NR	NR	FB & PNB	67	68	11.5	NR	1.5T	T2WI/DCEI	No	NR	NR	20 core Bx
<b>Ben Cheick 2009</b>	Retrospective	2005-2008	PNB	93	63.2 [52-74]	9.63 [1.6-40]	NR	1.5T	T2WI/DCEI	No	Dichotomous	In house	12 core TRUS SBx + TBx
<b>Cirillo 2008</b>	Prospective	2004-2006	PNB	54	65.5 (5.2)	10.8 (7.5)	NR	1.5T	T2WI/MRSI	Yes	Dichotomous	In house	10 core TRUS SBx + TBx
<b>Kumar 2007</b>	Prospective	2003-2005	NR	83	NR	NR	NR	1.5 T	T2WI/ MRSI	Yes	NR	NR	12 core TRUS SBx + TBx
<b>Squillaci 2005</b>	Prospective	2004-2005	NR	65	NR	NR	NR	1.5 T	T2WI/DCEI/MRSI	No	1-3 scale (Likert)	≥2	10 core TRUS SBx + TBx
<b>Hara 2005</b>	Prospective	2003-2004	FB	90	67.2 (NR)	NR	NR	1.5T	T2WI/DCEI	No	1-3 scale (Likert)	≥2 =3	14 core TRUS SBx

**Table 1:** Baseline characteristics of included studies

FB: first biopsy; PNB: previous negative biopsy; Pt: Patient; Nb: number; MR: magnetic resonance; MRI: magnetic resonance imaging; T2WI: T2-weighted imaging; DWI: diffusion-weighted imaging; DCEI: dynamic contrast-enhanced imaging; MRSI: magnetic resonance spectroscopic imaging; NR: not reported; Bx: biopsy; TRUS SBx: Transrectal ultrasound-guided standard biopsy; TPBx: transperineal template biopsy; TBx: targeted biopsy.

Figures between parenthesis correspond to standard deviations; intervals between brackets correspond to full ranges or inter-quartile ranges when specified (IQR).