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Prevalence and associations of general practitioners' ordering of "non-symptomatic" prostate-specific antigen tests: A cross-sectional analysis

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Summary

Aims: Testing for asymptomatic prostate cancer with prostate specific antigen (PSA) is of uncertain benefit. Most relevant authorities recommend against screening, and for informed patient choice. We aimed to establish the prevalence and associations of "non-symptomatic" PSA-testing of men aged 40 or older by early-career general practitioners (GP registrars).

Methods: A cross-sectional analysis from the ReCEnT cohort study of registrars' consultations, 2010-2014 (analysed in 2016). Registrars record 60 consecutive consultations each 6-month training term. The outcome factor was ordering an "asymptomatic" PSA test (a PSA ordered for an indication that was not prostate-related symptoms or prostatic disease monitoring). Independent variables were patient, registrar, practice, consultation and educational factors.

Results: A total of 856 registrars contributed details of 21,372 individual consultations and 35,696 problems/diagnoses of males 40 or older. Asymptomatic PSAs were ordered for 1.8% (95%CI: 1.7-2.0%) of consultations and for 1.1% (95%CI: 1.0-1.2%) of problems/diagnoses. Multivariable associations of asymptomatic PSA testing (compared with problems/diagnoses for which a PSA was not ordered) included patient age (OR 2.32 [95%CI: 1.53-3.53] for 60-69 years compared with 40-49), patient ethnicity (OR 0.40 [95%CI: 0.19-0.86] for non-English speaking background), the patient being new to both the registrar and practice (ORs 1.46 [95%CI: 1.08-1.99] and 1.79 [95%CI: 1.03-3.10]), the number of problems/diagnoses addressed (OR 1.44 [95%CI:

1.25-1.66] for each extra problem) and more pathology tests being ordered (OR 1.88 [95%CI: 1.79-1.97] for each extra test).

Conclusion: GP registrars frequently order "asymptomatic" PSA tests. Our findings suggest that non-compliance with current guidelines for PSA screening may be relatively common and that targeted education is warranted.

1 | INTRODUCTION

Prostate cancer and testing for prostate cancer are major public health issues. Prostate cancer is responsible for 12.8% of male cancer deaths in Australia[1] and is the second leading cause of cancer death in men in Australia,[1] the United Kingdom[2] and the United States,[3] and third leading cause of male cancer deaths in Canada.[4] It is the seventh leading cause of fatal disease burden (years of life lost) in Australian males.[5] With ageing populations, the proportion of deaths as a result of prostate cancer is expected to increase appreciably.

Diagnostic testing of asymptomatic men for prostate cancer is thus an attractive option. Prostate-specific antigen (PSA) testing provides a means for such testing. PSA, though, has modest sensitivity and specificity resulting in poor positive predictive value in screening populations.[6]

The evidence for positive health outcomes for PSA testing of asymptomatic men is not persuasive.[7] There is evidence from observational studies of reduction in prostate-specific mortality.[8] In RCTs, however, while there is some evidence for reductions in prostate-specific mortality,[9,10] there is also contrary evidence of no benefit.[11-13] Systematic reviews and meta-analyses (in 2010[14] and 2011[15]) have not demonstrated reductions in prostate-specific mortality.[14,15] There have been continued positive findings of analyses (with longer follow-up) in one included trial[9,10] subsequent to these systematic reviews. There is, however, no evidence of a reduction in overall mortality in any trial.[10,12,14,15] The evidence, as well as being inconsistent, has considerable methodological caveats.[14] A meta-analysis adjusting for the major methodological issue, protocol non-compliance, found no significant reduction in prostate-specific mortality.[16]

PSA testing is also not without harms.[15] Potential harms are both non-treatment-related (anxiety and stress,[17] postdiagnosis suicide and cardiovascular events,[18] diagnostic biopsy complications such as sepsis[19]) and treatment-related harms (incontinence, erectile dysfunction and bowel disease,[20-22] and psychiatric morbidity[17]). Harms may occur in cancers that may never have proved problematic if left undiagnosed,[23] reflected in the evidence for "active monitoring" in clinically localised prostate cancer.[24,25] There are also economic implications[26]—PSA testing having been identified as a "low-value service" in primary care.[27]

In considering the uncertain evidence around PSA testing of asymptomatic men, the majority of relevant professional and scientific bodies recommend against routine PSA screening and against active promotion of PSA testing.[2,4,6,28-31] Instead, most advise that men should be appraised of the evidence in the area and invited to make their own supported decision regarding testing.[2,6,28,29,31] A shared decision-making is optimal.[31,32]

What's known

Prostate cancer screening using PSA testing is not recommended by most relevant professional bodies. Rather, testing of asymptomatic patients should be at patient request and informed by careful patient counselling. There is some evidence, however, that compliance by general practitioners with these principles may be suboptimal. Patient, clinician and consultation factors associated with PSA testing of asymptomatic patients are not well-defined.

What's new

In this study, the frequency with which early-career general practitioners order asymptomatic PSA tests and the associations of this PSA ordering (including patient age, consultation duration, number of concurrently ordered pathology tests) suggest that PSA ordering is often not congruent with current consensus guidelines.

In Australia, the Royal Australian College of General Practitioners (RACGP) recommends that general practitioners (GPs) need not raise this issue. Instead, testing should only be done if "the man specifically asks for it".[29] Furthermore, testing should involve informed decision-making: "if men ask about prostate screening they need to be fully informed of the potential benefits, risks and uncertainties".[29,33] Shared decision-making should also fulfil GPs' "medico-legal responsibilities".[29]

Despite this advice to GPs, in a survey of Australian males, of those who had a PSA in the past 12 months, 46% reported that their GP suggested the test as a part of a routine check-up and 15% reported that their GP "just conducted the test".[34] Understanding the PSA testing behaviours of Australian GPs is of importance in addressing this apparent guideline-practice incongruence. The PSA testing behaviours of early-career GPs and in-training GPs (in Australia, GP "registrars") is of particular interest. These clinicians are at a career stage when they are establishing practice patterns. Within a training programme, they will be exposed to the emerging evidence and current clinical guidelines in this sometimes controversial area (noting that in a recent study of UK GPs only 23% were aware of the latest PSA screening evidence).[35] Registrars operate clinically within a workplace-based apprenticeship-like model (with a designated clinical supervisor) but with considerable clinical autonomy—including test-ordering rights equivalent to more senior colleagues.

In this study, we aimed to establish the prevalence and associations of "non-symptomatic" PSA testing by GP registrars.

2 | METHODS

This analysis was a cross-sectional analysis of data from the longitudinal Registrar Clinical Encounters in Training (ReCEnT) study.

2.1 | ReCEnT

ReCEnT is an ongoing multisite cohort study. Participants are registrars enrolled with five of Australia's 17 GP Regional Training Providers (RTPs) across five of Australia's six states.

The detailed methodology has been described previously.[36] Briefly, registrars undertake data collection once in each of three 6-month training terms (or per 12-month term for part-time registrars) as an integral part of their educational programme.[37] In one RTP, some registrars undertaking a non-compulsory fourth GP-based term also contributed data. Informed consent is obtained for registrars' de-identified data to be used for research purposes.

Initial data collection includes registrars' demographic data and characteristics of the practice in which they are working. Data are recorded by each registrar for each training term.

Registrars also record detailed data of 60 consecutive clinical consultations per term via a paper-based case report form. Data collection is performed approximately midway through the term. As data collection is intended to reflect a "normal" week of general practice, consultations in a specialised clinic, eg, vaccination clinic, are excluded. Only office-based (not home visits or nursing home visits) consultations are recorded.

The in-consultation data encompasses four broad areas: patient demographics, diagnoses/problems managed, investigations/management (including referral and follow-up) and educational training aspects (whether the registrar sought in-consultation advice or information from their clinical supervisor or from other sources, or generated learning goals).

Registrars receive face-to-face and printed orientation to the study and instruction on data recording via the case report form.

In this analysis, only data relating to male patients aged 40 or older were included.

2.2 | Outcome factor

The outcome factor for this analysis was ordering of a diagnostic PSA test for an asymptomatic patient. The diagnosis/problem for which each PSA was ordered was considered in order to exclude PSAs ordered for symptomatic patients or for patients with pre-existing prostate disease (eg, prostate cancer, prostatitis, benign prostatic hypertrophy) being monitored for disease activity/progression. "Symptomatic" was defined as symptoms plausibly related to the prostate. We included PSAs ordered as a follow-up to an abnormal PSA in our analysis, as we considered these still likely to be part of the process of diagnostic testing of asymptomatic patients. Hereafter, unless otherwise specified, "PSA test" will refer to a PSA performed on an asymptomatic patient not being monitored for existing prostatic disease. Problems/diagnoses managed are coded according to the International Classification of Primary Care, second edition classification system (ICPC-2).[38] The ICPC-2 problems/diagnoses deemed prostate-related and excluded from analysis are listed in Table S1.

2.3 | Independent variables

Independent variables were related to registrar, patient, practice and consultation.

Registrar factors were age, gender, training term, place of medical qualification (Australia/international), worked at the practice during a previous term, the RTP with which the registrar was enrolled and full-time/part-time status.

Patient factors were gender, Indigenous (Aboriginal or Torres Strait Islander) status, new patient to the practice and new patient to the registrar.

Practice factors were rurality/urbanicity, practice size (number of GPs), socioeconomic status, and if the practice routinely bulk-bills (ie, there is no financial cost to the patient for the consultation). Practice postcode was used to define the Australian Standard Geographical Classification-Remoteness Area (ASGC-RA)[39] classification (the degree of rurality) of the practice location and to define the practice location's Socio-economic Index for Area (SEIFA) Relative Index of Disadvantage.[40]

Consultation factors were duration of consultation, the number of diagnoses/problems dealt with, if the problem/diagnosis was new or existing, if pathology or imaging was ordered, if follow-up was organised and if specialist referral was made. Further educational consultation factors were if the registrar sought clinical advice or information during the consultation (from their supervisor/trainer, from a specialist or other health professional, or from electronic or hard-copy resources) and if the registrar in the consultation generated personal learning goals to be pursued later.

2.4 | Statistical analysis

This was a cross-sectional analysis of patient consultations from the longitudinal ReCEnT study. Analysis was performed on nine rounds of data from 2010 to 2014. Individual RTPs contributed from one to nine rounds of data, depending on when they joined the project. Analysis was performed in July, 2016.

The proportion of problems/diagnoses for which a PSA was ordered was calculated, with 95% confidence intervals, adjusted for clustering. The proportions of PSAs ordered for particular problems/diagnoses were calculated after combining similar ICPC-2 codes into clinically congruent categories.

To test associations of a registrar ordering a PSA, simple and multiple logistic regression were used within a generalised estimating equations (GEE) framework to account for clustering of patients within trainees. An exchangeable correlation structure was assumed.

All covariates with a *P*-value less than .20 in the univariate analysis were included in the multiple regression model. Covariates which had a small effect size and were no longer significant (at $P < 0.05$) in the multivariate model were removed from the final model as long as the covariate's removal did not substantively change the resulting model.

Analysis was limited to consultations with male patients aged 40 years or older.

Statistical analyses were completed using STATA 13.1 (StataCorp, College Station, TX, USA) and SAS v9.4 (SAS Institute Inc., Cary, NC, USA). Predictors were considered statistically significant if the *P*-value was <.05.

2.5 | Ethics approval

Ethics approval is by the Human Research Ethics Committee, University of Newcastle, Reference H-2009-0323.

3 | RESULTS

A total of 856 individual registrars contributed 1828 registrar-rounds of data (including details of 21 372 individual consultations and 35 696 problems/diagnoses with male patients aged 40 or older). The response rate was 95.2%.

The demographics of the participating registrars and practices are presented in Table 1.

3.1 | Prevalence of PSA-ordering and problems/diagnoses for which PSA ordered

Any PSA (including symptomatic PSAs) was ordered in 2.5% [95% CI: 2.3%-2.7%] of all registrar consultations with men aged 40 or older. Of these, 74.2% [95% CI: 70.1%-78.0%] were classified as asymptomatic PSAs, which equates to asymptomatic PSAs being ordered in 1.8% [95% CI: 1.6%-2.1%] of all consultations with men aged 40 or older. By age group, this was 1.4% of all consultations for men aged 40-49, 2.5% for ages 50-59, 2.4% for ages 60-69 and 1.2% for ages 70+. The intraclass correlation coefficient for asymptomatic PSA testing within registrars was 0.0068.

Asymptomatic PSAs were ordered for 401 problems/diagnoses (1.1% [95% CI: 1.0%-1.3%] of all problems/diagnoses in men aged 40 or older). Any PSA test comprised 3.1% [95% CI: 2.7%-3.3%] of total tests ordered in this patient group. Asymptomatic PSAs comprised 2.3% (95% CI: 2.0-2.5) of total tests in this patient group.

Seventy-two asymptomatic PSAs (18.0%) were in patients aged 70 or older and 77 (19.2%) were in patients aged 40-49.

The 10 most common problems/diagnoses for which an asymptomatic PSA was ordered are presented in Table 2.

3.2 | Associations of PSA-ordering

Univariate associations of a problem/diagnosis in an asymptomatic man aged 40 or older involving ordering a PSA test are presented in Table 3.

TABLE 1 Participating registrar, registrar-term and practice characteristics: Australian GP registrars 2010-2014

Variable	Class	n (%) or Mean (SD)
Registrar variables (n = 856)		
Registrar gender	Male	294 (34.4)
	Female	562 (65.7)
Graduated as a doctor in Australia	No	182 (21.5)
	Yes	664 (78.5)
Registrar-term or practice-term variables (n = 1828)		
Registrar training term	Term 1	765 (41.8)
	Term 2	536 (29.3)
	Term 3	452 (24.7)
	Term 4	75 (4.1)
Registrar age (years)	Mean (SD)	32.9 (6.7)
Registrar works fulltime	No	397 (22.2)
	Yes	1393 (77.8)
Does the practice routinely bulk bill	No	1499 (82.6)
	Yes	316 (17.4)
Number of GPs working at the practice	1-5 (small practice)	603 (33.7)
	6-10 + (large practice)	1184 (66.3)
Rurality of practice	Major City	1057 (57.8)
	Inner Regional	520 (28.5)
	Outer regional, remote or very remote	251 (13.7)
SEIFA Index (decile) of practice	Mean (SD)	5.4 (2.9)

SEIFA, Socio-economic Indexes For Areas.

TABLE 2 Most common problems/diagnoses for which 'asymptomatic' PSA test was ordered: Australian GP registrars 2010-2014

Category	n	%
Check-up (non-prostate-specific)	121	30.25
Health maintenance	65	16.25
Hypertension	32	8.0
Check-up prostate	29	7.25
Blood screen/test	27	6.75
Health screening	23	5.75
Follow-up abnormal PSA	17	4.25
Cardiovascular disease or risk	9	2.25
Diabetes mellitus	9	2.25
Hyperlipidaemia	6	1.5

The multiple logistic regression models for this PSA test-ordering are presented in Table 4.

Significant multivariable associations with a problem/diagnosis involving ordering a PSA test in men aged 40 or older (compared with problems/diagnoses for which a PSA was not ordered) included patient

TABLE 3 Characteristics associated with Australian GP registrars' PSA-testing 2010-14 (for asymptomatic patients not being monitored for prostatic disease)

		PSA test ordering		
Variable	**Class**	**No (n = 35 295)**	**Yes (n = 401)**	***P***
Patient age group	40-49	8355 (24%)	77 (19%)	<.001
	50-59	8773 (25%)	133 (33%)	
	60-69	8346 (24%)	119 (30%)	
	70+	9821 (28%)	72 (18%)	
NESB	No	31290 (93%)	368 (96%)	.033
	Yes	2178 (7%)	14 (4%)	
Patient/practice status	Existing patient	16903 (49%)	107 (27%)	<.001
	New to registrar	15616 (46%)	240 (62%)	
	New to practice	1687 (5%)	43 (11%)	
Registrar gender	Male	16595 (47%)	193 (48%)	.67
	Female	18700 (53%)	208 (52%)	
Registrar FT or PT	Part-time	7072 (20%)	85 (21%)	.47
	Full-time	27453 (80%)	314 (79%)	
Term	Term 1	14878 (42%)	203 (51%)	.003
	Term 2	10244 (29%)	113 (28%)	
	Term 3	8733 (25%)	71 (18%)	
	Term 4	1440 (4%)	14 (3%)	
Worked at practice previously	No	24702 (71%)	295 (75%)	.055
	Yes	10067 (29%)	100 (25%)	
Qualified as a doctor in Australia	No	8630 (25%)	91 (23%)	.32
	Yes	26128 (75%)	302 (77%)	
Practice size	Small (1-5 GPs)	13040 (38%)	142 (36%)	.66
	Large (≥6 GPs)	21425 (62%)	252 (64%)	
Practice routinely bulk bills	No	29389 (84%)	346 (87%)	.11
	Yes	5761 (16%)	52 (13%)	
Rurality	Major city	18742 (53%)	221 (55%)	.59
	Inner regional	10475 (30%)	110 (27%)	
	Outer regional remote	6078 (17%)	70 (17%)	
Regional Training Provider (RTP)	RTP 1	12486 (35%)	157 (39%)	.56
	RTP 2	4922 (14%)	45 (11%)	
	RTP 4	3933 (11%)	41 (10%)	
	RTP 5	13554 (38%)	153 (38%)	
	RTP 6	400 (1%)	5 (1%)	
New problem seen	No	17746 (55%)	147 (40%)	<.001
	Yes	14472 (45%)	221 (60%)	
Sought help any source	No	30546 (87%)	370 (92%)	<.001
	Yes	4749 (13%)	31 (8%)	
Imaging ordered	No	32672 (93%)	380 (95%)	.098
	Yes	2623 (7%)	21 (5%)	
Learning goals generated	No	30145 (85%)	352 (88%)	.15
	Yes	5150 (15%)	49 (12%)	
Follow-up ordered	No	19114 (54%)	171 (43%)	<.001
	Yes	16181 (46%)	230 (57%)	

(Continues)

TABLE 3 (Continued)

Variable	Class	PSA test ordering		
		No (n = 35 295)	Yes (n = 401)	*P*
Specialist referral ordered	No	30850 (87%)	383 (96%)	<.001
	Yes	4445 (13%)	18 (4%)	
Aboriginal or Torres Strait	No	32904 (99%)	378 (99.5%)	.45 (exact)
Islander	Yes	345 (1%)	2 (0.5%)	
Registrar age	Median (Q1, Q3)	31 (28, 37)	30 (28, 35)	
	Mean (SD)	33 (7)	32 (6)	.001
Socio-Economic Index For Area	Median (Q1, Q3)	5 (3, 8)	5 (3, 8)	
	Mean (SD)	5 (3)	5 (3)	.22
Consultation duration	Median (Q1, Q3)	16 (12, 24)	18 (13, 24)	
	Mean (SD)	19 (10)	20 (10)	.027
Number of problems	Median (Q1, Q3)	2 (1, 3)	2 (2, 3)	
	Mean (SD)	2 (1)	2 (1)	<.001
Number of pathologies ordered	Median (Q1, Q3)	0 (0, 0)	6 (3, 7)	
	Mean (SD)	0 (1)	5 (3)	<.001

NESB, non-english speaking background.

age (OR 2.32 for age 60-69 compared to age 40-49), patient ethnicity (OR 0.40 for non-English speaking background), the patient being new to both the registrar and practice (ORs 1.46 and 1.79, respectively), the problem being new (OR 1.49), the number of problems addressed in the consult (OR 1.44 for each extra problem), more pathology tests being ordered at the consultation (OR 1.88 for each extra test) and with earlier training term (OR 0.58 for Term 3 compared to Term 1).

4 | DISCUSSION

4.1 | Major findings

We found that PSA testing of asymptomatic men was relatively common in the practice of Australian GP registrars, occurring in 1.8% of consultations with men aged 40 and older (and for 1.1% of problems/diagnoses). Registrars order more pathology tests, overall, than established Australian GPs.[41] Our findings regarding registrars' PSA testing practice, however, cannot be directly compared with studies of established Australian GPs. In a study of established GPs,[42] PSA was requested for 0.6% of problems/diagnoses—but the denominator in this calculation included consultations with female patients and with patients of all ages, and the numerator included PSAs ordered for symptomatic or disease-monitoring reasons.

A notable finding was that 37.2% of PSAs were ordered for patients outside a putative target age group of age 50-69. The American Cancer Society suggests average risk men be appraised of their choices regarding PSA testing from age 50[6] as does the US Preventive Services Task Force,[31] while the Canadian Task Force strongly recommends that men younger than 55 not be screened with PSA.[4] The Canadian Task Force and US Preventive Services Task Force also recommend that men 70 years of age and older not be screened.[4,31] In Australia, where our study was conducted, the Prostate Cancer Foundation recommends men 70 years or older who wish to be tested should be advised that the harms of PSA testing may be greater than the benefits in men of their age.[28]

4.2 | Associations of PSA ordering

A number of the associations of PSA ordering found in this study are of clinical relevance. The association with being more likely to be ordered if other tests are ordered (OR 1.88 for each additional test) suggests that PSAs are often being ordered as part of a "panel" of tests. The association of PSA testing with an increased number of problems being seen in the consultation (OR 1.44 for each additional problem) may suggest that a PSA (and, possibly other concurrent "screening" or "routine" tests) are being ordered as an "add on" in a patient seen primarily for another problem/diagnosis. This suggestion is also supported by the problems/diagnoses for which PSAs are ordered (Table 2). PSAs ordered for a problem/diagnosis of hypertension, cardiovascular disease, diabetes or hyperlipidaemia is consistent with the PSA being an "add on".

We would have expected an association of PSA testing with increased consultation duration (given the strong guidelines recommendations for detailed counselling). Instead, we found a non-significant trend for shorter consultation times (OR 0.98 for each additional consultation minute; $P = .064$). It is difficult to reconcile our findings with the guideline imperative to proceed to PSA testing only once the patient has raised the issue and been fully informed of the pros and cons of testing and given scope to discuss this fully with the GP. Rather, our findings are more consistent with evidence (from patient surveys) of Australian GPs'[34] and United States healthcare providers[43,44] often ordering PSA testing without adequate counselling.

The associations with the patient being new to the practice and being new to the registrar suggest that PSA testing may be part of a

TABLE 4 Associations of Australian GP registrars' PSA-testing 2010-2014 (asymptomatic patients not being monitored for prostatic disease): logistic regression

		Univariate		Adjusted	
Variable	**Class**	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***
Patient age group	50-59	1.65 (1.21, 2.26)	.0015	1.85 (1.20, 2.84)	.005
Referent: 40-49	60-69	1.56 (1.15, 2.11)	.0045	2.32 (1.53, 3.53)	<.001
	70+	0.80 (0.56, 1.14)	.2105	1.48 (0.91, 2.40)	.11
NESB	Yes	0.54 (0.31, 0.95)	.0332	0.40 (0.19, 0.86)	.018
Patient/practice status	New to practice	4.04 (2.77, 5.89)	<.0001	1.79 (1.03, 3.10)	.038
	New to registrar	2.49 (1.98, 3.12)	<.0001	1.46 (1.08, 1.99)	.015
Term	Term 2	0.79 (0.61, 1.02)	.0758	0.87 (0.59, 1.28)	.48
Referent: Term 1	Term 3	0.56 (0.41, 0.77)	.0004	0.58 (0.38, 0.90)	.014
	Term 4	0.59 (0.31, 1.13)	.1113	0.97 (0.46, 2.05)	.93
Worked at practice previously	Yes	0.79 (0.62, 1.01)	.0554	0.95 (0.65, 1.39)	.78
Practice routinely bulk bills	Yes	0.77 (0.56, 1.06)	.1142	0.72 (0.46, 1.15)	.17
New problem seen	Yes	1.83 (1.46, 2.29)	<.0001	1.49 (1.12, 1.99)	.007
Sought help any source	Yes	0.53 (0.37, 0.76)	.0004	0.79 (0.48, 1.31)	.37
Imaging ordered	Yes	0.69 (0.45, 1.07)	.0981	0.34 (0.17, 0.66)	.002
Learning goals generated	Yes	0.80 (0.58, 1.09)	.1502	0.77 (0.49, 1.21)	.26
Follow-up ordered	Yes	1.63 (1.32, 2.01)	<.0001	0.79 (0.59, 1.07)	.12
Specialist referral ordered	Yes	0.32 (0.19, 0.51)	<.0001	0.59 (0.33, 1.04)	.07
Registrar age		0.97 (0.95, 0.99)	.0012	0.98 (0.95, 1.00)	.067
Consultation duration		1.01 (1.00, 1.02)	.0268	0.98 (0.96, 1.00)	.064
Number of problems		1.42 (1.30, 1.55)	<.0001	1.44 (1.25, 1.66)	<.001
Number of pathologies ordered		1.83 (1.77, 1.89)	<.0001	1.88 (1.79, 1.97)	<.001

NESB, non-english speaking background.

routine, often "baseline", testing. Again, taken together with the above associations, there is a strong inference in these findings that PSA testing may be driven more by GP factors than (as is recommended) by patient request. This is consistent with US findings of 74% of PSA testing being physician-initiated.[45]

The significant association with a registrar being in Term 3 (compared with Term 1) suggests a possible education/training/practice experience effect on rational test-ordering (the lack of effect for Term 4 should be treated with caution—the relatively few registrars contributing data from this non-compulsory term are a selected and very different group to registrars in the earlier terms).

The association of PSA testing with not being of non-English speaking background may reflect an appreciation by GPs and patients of epidemiological factors (men of South Asian, Chinese, Asian and Hispanic backgrounds have appreciably lower incidence of prostate cancer).[46-48] It may also reflect cultural factors of ethnic differences in barriers to PSA screening.[49]

4.3 | Strengths and limitations

The strength of this study is the inclusion of a large number of clinical consultations with men within the age-range for which PSA is usually ordered, together with the contemporaneous recording of a large number of co-variates. This has allowed us to adjust our findings for a wide range of potential confounding factors. The tight linking in our data of test ordered with indication for that ordering has allowed us with confidence to include only asymptomatic PSAs (rather than investigative or disease-monitoring PSAs). The high-response rate and inclusion of data from five Australian states across all rurality classifications from major city to very remote provide our findings with good generalisability to Australian GP registrars' practice.

The limitation of this study is that we do not have contextual data around decisions to order a PSA. We do not have data on patient request. We also do not have documentation of family history of prostate cancer (which could, especially, influence decisions of testing in men aged less than 50 years). The likely minor effects of these factors and the effect sizes of our findings, however, do make our conclusions (that much testing is not consistent with current guidelines) quite robust. Another consideration is that a patient may have been appropriately counselled regarding the pros and cons of PSA testing at a previous consultation and returned, having made a decision, to have the test ordered (or had had adequate counselling prior to a previous PSA). Again, the association with other tests also being ordered

and, especially, the associations of the patient not having been seen in the practice or by the registrar previously and with the problem being a "new" presentation suggest that this would not be a common occurrence.

A further limitation is in the cross-sectional nature of the analysis—our findings regarding decreasing PSA ordering in Term 3 are an association that cannot be causally attributed to increased time in training.

4.4 | Implications of findings for policy and practice

Our findings suggest that PSA tests are frequently ordered outside the age groups in which the benefit-to-harm ratio is least problematic should lead to this aspect of PSA-testing decision-making being a focus for educational strategies for GP registrars. Our findings of an association with decreased consultation time, adding weight to previous concerns regarding lack of adequate counselling prior to PSA testing and the medicolegal implications of less than optimal counselling should also prompt GP educational focus on the importance of informed patient choice concerning PSA testing. Public education of men regarding the issues around appropriate testing is also indicated.

5 | CONCLUSIONS

GP registrars frequently order PSA tests on asymptomatic patients for non-disease-monitoring purposes. Our findings suggest that noncompliance with current guidelines for PSA screening may be relatively common and that targeted education (of GPs and patients) is warranted.

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AUTHORS' CONTRIBUTIONS

Parker Magin, Amanda Tapley, Simon Morgan, Mieke van Driel (this analysis—wider cohort study also Kim Henderson, Nigel Catzikiris, Katie Mulquiney, Neil Spike, Andrew Davey, Rohan Kerr): research design. Parker Magin, Amanda Tapley, Andrew Davey, Simon Morgan, Kim Henderson, Nigel Catzikiris, Katie Mulquiney, Neil Spike, Rohan Kerr: acquisition of data. Elizabeth Holliday, Jean Ball, Amanda Tapley: analysis. Parker Magin, Amanda Tapley, Elizabeth Holliday, Jean Ball: drafting paper. Andrew Davey, Simon Morgan, Mieke van Driel, Kim Henderson, Nigel Catzikiris, Katie Mulquiney, Neil Spike, Rohan Kerr: revising critically. All authors: approval of final version.

DISCLOSURE

None.

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

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