


Associations between socioeconomic factors and PSA testing in a population-based organised testing programme and routine healthcare: a register-based study of 50-year-old men

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ABSTRACT

Objective Population-based, organised prostate cancer testing (OPT) programmes were started in Sweden in 2020. The influence of socioeconomic factors on prostate cancer testing in this setting is not known. We examined associations between socioeconomic factors and (1) participation in OPT and (2) unorganised prostate-specific antigen (PSA) testing.

Methods and analysis Region Västra Götaland's OPT programme invited 21 174 men aged 50 years in 2020–2021. Regional data on unorganised testing in 2013–2014 of men aged 50–52 years were retrieved from Western Sweden Study of Opportunistic Prostate Cancer Screening database. Data on income, education, cohabitation and country of birth were collected from Statistic Sweden. Univariable and multivariable Poisson regression was used to calculate incidence rate ratios (IRRs) with CIs for PSA testing by socioeconomic category.

Results Participation in OPT was associated with all investigated socioeconomic factors; multivariable IRRs: low versus non-low income 0.63 (95% CI 0.58 to 0.68), single versus non-single household 0.78 (95% CI 0.75 to 0.81), low versus average education 0.84 (95% CI 0.78 to 0.90) and non-Nordic versus Nordic country of birth 0.88 (95% CI 0.84 to 0.92). Unorganised PSA testing was negatively associated with low income 0.83 (95% CI 0.78 to 0.90) and single household 0.87 (95% CI 0.82 to 0.92), but not with low education 1.00 (95% CI 0.92 to 1.08) or non-Nordic country of birth 0.98 (95% CI 0.91 to 1.06).

Conclusion Socioeconomic factors influenced PSA testing among 50-year-old men, both in an organised testing programme and in unorganised, clinical testing. An active offer of testing is not enough to achieve socioeconomic equality in the early detection of prostate cancer.

INTRODUCTION

Prostate cancer is the second most common cancer in men worldwide.¹ A European randomised trial showed that screening for prostate cancer can reduce disease-specific mortality but at the cost of significant overdiagnosis and overtreatment.^{2–3} All national

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Associations have been reported between socioeconomic factors and participation in established screening programs for other cancers and in screening trials for prostate cancer. Whether similar associations exist also in population-based organised prostate cancer testing programmes is not known.

WHAT THIS STUDY ADDS

⇒ This study shows that in Sweden, low education, low income, living alone and being born in a non-Nordic country are associated with lower participation rates among 50-year-old men in an organised prostate cancer testing programme. In unorganised testing, prior to the implementation of the organised testing programme, low income and living alone were associated with reduced rates of having a prostate-specific antigen test, whereas low education and being born in a non-Nordic country were not.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ An active offer of testing is not enough to achieve socioeconomic equality in the early detection of prostate cancer. The influence of socioeconomic factors on participation rates must be considered when designing, implementing and developing a screening programme for prostate cancer. Special measures are needed to minimise socioeconomic inequity in current pilot projects and future screening programmes for prostate cancer.

healthcare authorities except Lithuania, therefore, recommend against prostate cancer screening programmes. In recent years, prostatic MRI for men with a raised initial serum prostate-specific antigen (PSA) test has been shown to reduce overdiagnosis and overtreatment⁴ and is now recommended in European guidelines for prostate cancer diagnosis.⁵

The Swedish Board of Health and Welfare in 2018 recommended against PSA-based screening but recognised that the widespread unorganised testing is ineffective and resource-consuming. They, therefore, encouraged the regional healthcare providers to organise the testing for prostate cancer to make it more efficient, improve knowledge and reduce healthcare inequity.⁶ Such regional, population-based, organised prostate cancer testing (OPT) programmes have been since 2020 stepwise implemented in Sweden. In December 2022, the European Commission released a new recommendation for cancer screening that included an evaluation of the feasibility of screening for prostate cancer with a stepwise approach.⁷ The Swedish OPT programmes align well with this recommendation. No similar programme has yet been started elsewhere, but preparations are ongoing in several countries.^{8,9}

Men with lower socioeconomic status present with more advanced prostate cancer and have higher prostate cancer-specific mortality.¹⁰ A Swedish study showed that men with short formal education were less likely to have a PSA test and, if they had a raised PSA, to have a prostate biopsy.¹¹ Another study showed that men with lower income were less likely to receive curative treatment for intermediate and high-risk disease, and more likely to have positive surgical margins at prostatectomy.¹² Previous studies of established screening programmes for breast, cervix and colon cancer show that participation is strongly associated with socioeconomic factors.¹³ A Swiss study of breast cancer screening suggests that organised screening, compared with unorganised referral for mammography, increases participation in women with lower socioeconomic status.¹⁴ A Swedish randomised trial reported that prostate cancer screening reduced cancer-specific mortality more among men with low education than among men with high education.¹⁵ A shift from the current, unorganised PSA testing to population-based, organised screening may thus reduce socioeconomic inequity in the early detection of prostate cancer, but this has not yet been evaluated.

Data from the Swedish OPT programmes are prospectively registered and form a unique source of information. The aim of this study was to use regional and national register data to investigate how individual-level socioeconomic factors affect participation in OPT. We also wanted to establish the association between socioeconomic factors and unorganised PSA testing in men of similar age in the years prior to the start of the OPT programme.

MATERIALS AND METHODS

The OPT programme

The OPT infrastructure and diagnostic pathway have been previously reported in detail.¹⁶ In brief, the Region Västergötland (RVG) OPT project since 2020 actively invites all 50-year-old men in the region. The public was informed in local and regional newspapers, on social media, at bus stops, and through a broadcasted live information and

question session. A nationally standardised information text about the benefits and harms of PSA-based prostate cancer testing is included in a three-page invitation letter, described in detail elsewhere.¹⁷ This information was at the time of this study translated into English, Dari, Persian, Arabic and Somali and was made available as a video with sound and sight interpretation. Geographically selected testing facilities at public hospitals and primary care centres, were available for the men to obtain a PSA test. The number of facilities increased from 27 to 36 over the study period. Information about the testing facilities was included in the invitation letter and available on a website. The distance to the nearest facility was usually less than 5 and never more than 25 km. The PSA blood sample was specifically labelled to link it with OPT participation. The men could use their invitation letter to obtain a PSA test within 30 days. They could extend this time if they contacted the OPT office. The OPT PSA test was free of charge, but men who had an MRI scan, with or without a subsequent urology appointment, were charged 300 Swedish kronor (approximately €25).

OPT: population and data sources

This study included all men invited in 2020 and 2021 to the RVG OPT programme. Data about participation (obtaining an OPT PSA test) were obtained from the regional OPT database at Regional Cancer Centre West. After approval from the Swedish Ethical Review Authority, socioeconomic data for all invited men were collected from Statistics Sweden's Longitudinal integrated database for health insurance and labour market studies (LISA, by its Swedish acronym).

Unorganised PSA testing: population and data sources

Data for the unorganised, pre-OPT PSA testing were collected from the Western Sweden Study of Opportunistic Prostate Cancer Screening (WSOP) database. WSOP includes all men aged over 18 years who were a resident in RVG at any time between 1 January 1995 and 31 December 2014.^{18,19} WSOP includes the date and result of all PSA tests and prostate biopsies obtained in RVG, the date of any prostate cancer diagnosis and linked data from several national registries including the LISA database and the Swedish Cancer Register. This study included men who were 50–52 years old in 2013–2014 and did not have any previous prostate cancer diagnosis. The 51-year-old men and 52-year-old men were included to increase the statistical power. For men with more than one PSA test during the study period, only the first PSA test was included in the analysis. The assay used for PSA analysis was the same in the unorganised setting and in OPT. During the studied years, the Swedish Board of Health and Welfare recommended that PSA testing of men without symptoms should be done only after informed decision-making, including the presentation of the national standardised information about potential benefits and harms of PSA testing (this recommendation still applies).

Socioeconomic categorisation

The analysed socioeconomic factors were education, individual income, cohabitational status and country of birth. Educational level was defined as the highest completed education and categorised as primary school (<11 years), secondary school (11–12 years) or tertiary education (high school/university, >12 years). Income was categorised as low (<50% of median income, the standard definition used by Statistics Sweden) or not low ($\geq 50\%$ of median income). For the OPT population, both adjusted gross income and disposable income were analysed. The WSOP database does not include data on disposable income, so for the pre-OPT population, only adjusted gross income was analysed. Cohabital status was categorised as single-person or non-single-person household, and country of birth as Nordic (Sweden, Norway, Denmark, Finland or Iceland) or non-Nordic.

Statistical analysis

The outcome measure in the OPT population was participation, defined as having a PSA result within the OPT programme; in the unorganised, pre-OPT population it was having a PSA result obtained in RVG between 1 January 2013 and 31 December 2014 without a previous prostate cancer diagnosis. Univariable and multivariable incidence rate ratios (IRRs) with 95% CIs for these outcomes were calculated with Poisson regression, using the most common category in the source population as a reference. Interactions between education and family type versus the other socioeconomic factors were described with cross-tabulation. The unorganised, pre-OPT population was analysed to establish the testing patterns prior to the OPT. No statistical comparison between the OPT and pre-OPT populations was done because the reasons for accepting an offer for OPT and for having a PSA test in the pre-OPT period (eg, obtaining medical care for lower urinary tract symptoms) were quite different (ie, a null hypothesis was deemed inappropriate). A post hoc descriptive analysis of the PSA testing results was conducted to explore the differences between testing in the OPT versus the pre-OPT setting.

Patient and public involvement

1. At what stage in the research process were patients/public first involved in the research and how?
Patient organisations and public representatives were engaged in the writing of the OPT information letter and the development of informational material.
2. How were the research question(s) and outcome measures developed and informed by their priorities, experience and preferences?
Socioeconomic equity is highlighted as an important aspect in the recommendations from both the European Commission and the Swedish Board of Health and Welfare. Both these organisations represent the public.
3. How were patients/public involved in the design of this study?

No patient or public representative was involved.

4. How were they involved in the recruitment and conduct of the study?
Not applicable.
5. Were they asked to assess the burden of the intervention and time required to participate in the research?
Not applicable.

RESULTS

Participation in the organised testing programme

In 2020 and 2021, 21 174 men aged 50 years were offered to participate in the OPT programme, of whom 7871 (37.2%) participated by having a PSA test within the programme. The PSA reading was over the cut-off of 3 ng/mL for 2.2% of the men (95% CI 1.9% to 2.5%). The proportion of men with PSA ≥ 3 ng/mL per socioeconomic category is shown in online supplemental table 1.

OPT participation rates ranged from 20.5% in men with low disposable income to 43.5% in men with tertiary education (table 1). Low education, low income, non-Nordic country of birth and living in a single-person household were all negatively associated with the participation rate (table 1). Income was the factor with the strongest association on both univariable and multivariable analysis (multivariable IRR 0.63, 95% CI 0.58 to 0.68). Cross-tabulation showed that single men with low income (16.9%) were the least likely and non-single men with tertiary education (46.3%) the most likely to participate in OPT (online supplemental tables 2 and 3).

Unorganised PSA testing prior to the organised testing programme

A total of 32 989 men who in 2013–2014 were aged 50–52 years and had no prostate cancer diagnosis were identified in the WSOP database. Of these men, who were not invited to PSA testing but should be tested on clinical suspicion of prostate cancer and could be tested on their own initiative in the absence of symptoms, 4670 (14.2%) had one or more PSA tests taken in these years. The first PSA reading was over the cut-off 3 ng/mL for 5.7% of the men (95% CI 5.0% to 6.4%). The proportion of men with PSA ≥ 3 ng/mL per socioeconomic category is shown in online supplemental table 1.

The proportion of men having a PSA test ranged from 11.8% in men with low income to 15.1% in men not living in a single-person household (table 2). In this pre-OPT setting, only income and cohabitational status were significantly associated with PSA testing (table 2). Like in the OPT setting, income was the factor with the strongest association on both univariable and multivariable analysis (multivariable IRR 0.83, 95% CI 0.78 to 0.90). Cross-tabulation showed that single men with low income (11.2%) were the least likely and non-single men with secondary education (15.4%) the most likely to have a PSA test (online supplemental tables 4 and 5).

Table 1 Associations between socioeconomic factors and participation in an organised prostate cancer testing programme in Region Västra Götaland, Sweden, among 50-year-old men

Variable	Number of invited men	Proportion participating (%)	Univariable Poisson regression		Multivariable Poisson regression	
			Incident rate ratio (95% CI)	P value	Incident rate ratio (95% CI)	P value
Education level						
Primary	2234	26.4	0.74 (0.69 to 0.80)	<0.001	0.84 (0.78 to 0.90)	<0.001
Secondary	10537	35.7	1		1	
Tertiary	7979	43.5	1.22 (1.18 to 1.26)	<0.001	1.17 (1.13 to 1.21)	<0.001
Country of birth						
Nordic	16701	39.2	1		1	
Non-Nordic	4465	29.9	0.76 (0.72 to 0.80)	<0.001	0.88 (0.84 to 0.92)	<0.001
Household						
More than one person	13222	41.9	1		1	
Single person	7869	29.5	0.71 (0.68 to 0.73)	<0.001	0.78 (0.75 to 0.81)	<0.001
Disposable income						
<50% of median	2773	20.5	0.52 (0.48 to 0.56)	<0.001	0.63 (0.58 to 0.68)	<0.001
≥50% of median	18292	39.8	1		1	
Adjusted gross income						
<50% of median	3897	23	0.57 (0.53 to 0.60)	<0.001	Not included	
≥50% of median	17 168	40.5	1			

DISCUSSION

This is the first study to report associations between socioeconomic factors and participation in a population-based, OPT programme. We found that among 50-year-old Swedish men, those with low education, low-income, non-Nordic country of birth and living in a single-person

household were less likely to participate in the organised programme. Participation ranged from 20.5% in men with low disposable income to 43.5% in men with high education. The proportion of men of similar age who had a PSA test before the start of the OPT programme was lower (14.3%), and the range of testing across socioeconomic

Table 2 Associations between socioeconomic factors and unorganised prostate-specific antigen (PSA) testing in Region Västra Götaland, Sweden, among men aged 50–52 years 6–7 years before the start of the organised testing programme

Variable	Total number of men	PSA tested men (%)	Univariable Poisson regression		Multivariable Poisson regression	
			Incidence rate ratio (95% CI)	P value	Incidence rate ratio (95% CI)	P value
Education level						
Primary	5263	13.7	0.97 (0.90 to 1.05)	0.404	1.00 (0.92 to 1.08)	0.934
Secondary	16855	14.1	1		1	
Tertiary	10600	14.6	1.03 (0.97 to 1.09)	0.314	1.00 (0.95 to 1.06)	0.917
Country of birth						
Nordic	23374	14.4	1		1	
Non-Nordic	4945	13.2	0.92 (0.86 to 0.99)	0.023	0.98 (0.91 to 1.06)	0.614
Household						
More than one person	17043	15.1	1		1	
Single person	11269	12.7	0.84 (0.79 to 0.89)	<0.001	0.87 (0.82 to 0.92)	<0.001
Adjusted gross income						
<50% of median	7269	11.8	0.79 (0.74 to 0.85)	<0.001	0.83 (0.78 to 0.90)	<0.001
≥50% of median	21043	14.9	1		1	

groups was smaller (11.8%–15.1%). The invitation to the OPT increased PSA testing in all analysed socioeconomic groups, as compared with the analysed pre-OPT period. Unorganised PSA testing in the pre-OPT period was associated with high income and not living alone, but not with education or country of birth.

Socioeconomic factors and participation in prostate cancer screening trials

The overall participation rate among 50-year-old men after a first invitation to the Swedish regional OPT programme was 37%. This is in between the reported rates from randomised screening trials: 12% in the first round of the German PROBASE trial, which invited 45-year-old men,²⁰ and 59% in the first round of the Swedish Gothenburg-1 trial, which invited men aged 50–69 years.²¹ Participation in prostate cancer screening trials is often defined as participating at least once during a longer period, which is not comparable to our results from a first invitation to the youngest individuals in the target group. In a pilot study of OPT in the southernmost part of Sweden, younger men were less likely to participate: 38% of 50-year-old men participated compared with 44% of 56-year-old men and 45% of 62-year-old men.²² Several other factors may influence participation such as being invited to a research trial as opposed to standard healthcare like the OPT programme, the information in the invitation and the use of reminders to non-participants. If a national screening programme was implemented, participation would likely be greater because of the healthcare authorities' recommendation of it, and because of subsequent greater general awareness of prostate cancer screening.

The association between socioeconomic factors and participation in prostate cancer screening trials has been reported only from a Finnish trial, in which low education and low income were associated with lower rates of overall participation by 13.7 and 13.6 percentage points, respectively.¹⁰ These differences are somewhat smaller than those that we observed in the Swedish OPT programme. Possible explanations include the different age groups and settings (screening trial vs informed decision in standard healthcare).

Socioeconomic factors and participation in established cancer screening programmes

Although the Swedish regional OPT programmes, including the one in RVG that formed the basis for the present study, are in many ways similar to a formal screening programme, there are some important differences. A formal screening programme is usually recommended by a healthcare authority; in contrast, the invitation letter to the RVG OPT programme makes it clear that the Swedish healthcare authorities do not recommend a national screening programme for prostate cancer, as the advantages do not clearly outweigh the harms, but that they advise that men should be informed and make a personal decision whether to obtain testing.

Established screening programmes for breast, cervix and colon cancer have reported socioeconomic gradients for participation.^{13 23–30} In Swedish breast cancer screening, the combination of low income and living alone was strongly associated with low participation,³¹ which we also observed in our study of prostate cancer testing. Other factors negatively associated with participation in that study include not owning one's home and having social assistance or benefits as the main source of income.³¹ None of these factors were included in our analysis. In most studies, low income, low education, living alone and being an immigrant are associated with lower participation. A meta-analysis of 66 studies reported ORs of attendance to breast cancer screening of around 2 for high versus low income, married/cohabiting versus unmarried/non-cohabiting and immigrant versus non-immigrant, but only 1.1 for high versus low education.²⁴ A global literature review of participation in colorectal cancer screening showed that the influences of socioeconomic factors and ethnicity are often not assessed; when assessed, participation gradients varied from moderate (66% vs 71%) to great (35% vs 61%) across socioeconomic and ethnic groups.²⁵

Measures to reduce socioeconomic inequality in cancer screening

Although socioeconomic inequality in cancer screening programmes is well documented, evidence for interventions aimed at improving equity is poor. Various interventions have been studied, such as media campaigns, text message reminders, increased frequency of screening invitations and adjusted reminders to non-participants.¹³ Poor language skills may be a barrier, but a recent randomised trial did not show greater participation in breast cancer screening when the invitation was translated into immigrants' original language.³² A study of healthcare interventions in Brazil suggests that socioeconomic inequality is greater in the implementation phase than when an intervention is established.³³ Frequent monitoring and evaluation of participation rates in different socioeconomic groups to define determinants of low participation is considered essential.²⁵

Unorganised PSA testing prior to the OPT

PSA testing was less common (14% vs 37%) and the gradients of PSA testing across different socioeconomic groups were smaller when the testing was unorganised compared with the subsequent organised testing programme. These results agree well with previous reports.^{11 12 34 35} The proportion of men with a raised PSA value was more than twice as high in the unorganised versus in the OPT setting. This suggests that many men in the pre-OPT period were PSA tested because of urinary tract symptoms, in contrast to the OPT programme to which men were actively invited, and therefore, less likely to have symptoms. Our results suggest that the influence of socioeconomic factors on obtaining medical care for symptoms differs from their

influence on participation in an organised screening programme after an invitation.

Strengths, weaknesses and limitations

Strengths of our study include that the investigated OPT and pre-OPT groups were both population-based and reasonably large and that OPT is part of standard health-care as opposed to a screening trial setting. Furthermore, the Swedish register of individual-level socioeconomic data has near-complete coverage and is highly accurate.³⁶ A potential weakness is the 7–8 years gap between the pre-OPT and OPT settings, but there were no changes in the healthcare organisation or PSA testing policy in these years, so we do not believe that the time gap affected the investigated socioeconomic gradients.

Limitations of generalisability include that we assessed associations between socioeconomic factors and participation in the implementation phase of an organised testing programme, so they may not mirror those in a well-established programme. They also include the narrow, young age group of 50 years. The influence of socioeconomic factors on screening participation may be different in older men, who more often have lower urinary tract symptoms and experience prostate cancer among friends and family members. It may also be different in healthcare systems that rely on primary care for referral to cancer screening. Home testing of PSA, which is currently being evaluated in some Swedish OPT projects, may also affect the socioeconomic differences in participation. Moreover, a future recommendation in favour of a national screening programme would probably increase the overall participation rate and may increase participation more in some socioeconomic groups than others. Furthermore, the studied OPT period coincided with the COVID-19 pandemic, which may have affected the results. Finally, Sweden is a country with relatively narrow socioeconomic gradients,³⁷ a public healthcare system and widespread unorganised PSA testing.¹⁸ The associations between socioeconomic factors, PSA testing and prostate cancer screening may be different in countries with wider socioeconomic gradients, an insurance-based healthcare system or less frequent PSA testing.

CONCLUSION

In Sweden, an OPT programme appeals more to 50-year-old men with higher than to those with lower educational levels or income. Men born in a Nordic country are also more likely to participate than those born in a non-Nordic country. The differences across socioeconomic groups were similar or smaller than previously reported from established cancer screening programmes. We also investigated unorganised, clinical PSA testing prior to the organised testing programme and found that testing rates were lower and socioeconomic gradients smaller than in the organised programme. An active offer of testing is clearly not enough to reduce socioeconomic inequality. Further research is needed to identify reasons

for socioeconomic differences and interventions that effectively counteract inequity. Our results are of particular importance because of the European Union's recent recommendation to stepwise implement organised screening for prostate cancer. A first step towards equity is to continuously evaluate socioeconomic differences in these new screening programmes.

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