Archives of Public Health

RESEARCH

Open Access

Are we there yet? Closing the gap of prostate cancer presentation disparities in Ireland

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Abstract

Introduction The Irish Prostate Cancer Outcomes Research (IPCOR) Study collected longitudinal data on men newly diagnosed with Prostate Cancer (PC). Understanding the nuances of disease presentation is essential, considering the high incidence of PC in Ireland. This study aims to characterise disease presentation features, identify factors related to socio demographic disparities in presentation following opportunistic screening, and shed light on potential inequality challenges within Ireland's healthcare structure.

Methods Data were collected on demographics, diagnosis, and treatment of 6,816 men newly diagnosed with PC across 16 hospitals in the Republic of Ireland from February 2016 to January 2020. A complete case analysis was carried out, complemented by a sensitivity analysis for addressing sites with high rates of missing values. Multivariable logistic regression was conducted to examine the association between various predictor variables and the initial presentation to the urology clinic subsequent to opportunistic screening.

Results A multivariable logistic regression model revealed that the type of hospital was a key determinant in post-opportunistic screening presentation, with patients in public hospitals 45.7% more likely to be presented following screening compared to those in private hospitals. Urban residents were 34% more likely to present following screening than rural ones. Age negatively influenced presentation following screening likelihood, decreasing by 3.4% yearly.

Discussion Our research has highlighted the key features of PC presentation in Ireland, revealing potential inequalities affecting mainly urban populations, middle socioeconomic groups, and individuals with inadequate healthcare coverage. While the differences we observed in various groups may appear subtle and may indicate the success of the Rapid Access Prostate Clinics, they are still significant in pinpointing specific populations that require special attention.

Conclusions By addressing these nuanced differences in access to healthcare, socioeconomic status, and urban versus rural residence and implementing tailored strategies, we can work towards closing disparity gaps in PC, ultimately leading to improved health outcomes and equity across all population segments.

Keywords Prostate Cancer, Disparities, Opportunistic screening

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Text box 1. Contribution to the literature

- This study provides a comprehensive national-level analysis of prostate cancer presentation disparities in Ireland, covering both rural and urban populations and public versus private healthcare sectors.
- By examining socio demographic factors, this study highlights the impact of healthcare access inequalities, particularly for middle socioeconomic groups and rural populations, on prostate cancer presentation following opportunistic screening.
- The findings suggest targeted interventions are needed to improve healthcare access, offering actionable insights for policymakers and healthcare providers.
- This study contributes to the broader global discussion on healthcare equity in cancer detection, particularly in countries with mixed public-private healthcare systems.

Introduction

Prostate cancer (PC) represents a significant global health burden and remains one of the leading causes of cancer-related morbidity and mortality in men, with nearly 1.4 million new cases reported annually worldwide and approximately 375 thousand deaths [1]. While advances in research and healthcare have improved early detection and treatment outcomes, a growing body of evidence suggests that PC is not uniform across varied populations [2]. Disparities in PC may arise from race and various social determinants of health, encompassing economic factors, education, social context, healthcare access, and living environment. Furthermore, these disparities can impact every stage of the disease continuum, from screening, referral, and diagnosis to care access, treatment outcomes, quality of life, and survival.

The use of prostate-specific antigen (PSA) screening for early PC detection remains controversial. It has been shown that PSA testing substantially reduces mortality rates [3]. Opportunistic screening for PC refers to the practice of testing for PC (usually through a PSA test) in men who visit healthcare providers for unrelated reasons, not following clinical findings and not as part of a screening program. While many high-income countries do not implement national screening programs, they allow men and their physicians to perform PSA screening per guideline recommendations. Despite recommendations emphasising shared decision-making and risk assessment before testing [4–6], many men undergo PSA testing without a thorough discussion with their physicians, leading to high rates of PSA testing with no medical benefit, medical harm with overdiagnosis and inequities [7]. In Ireland, there is no universal screening program, however, PSA testing rates are rising [8–10].

The Irish healthcare system operates in a mixed public-private setting. In Ireland, there are two primary categories for public health service benefits: Category I are granted free public health services through medical cards and have prescription copayments; Category II receive subsidised public hospital services and prescription medicines but must cover the full cost for primary care, usually out-of-pocket or through private insurance policies [11]. Alongside the public health providers, there are private providers in primary care and hospital-based care. In 2015, the General Practitioner (GP) card was introduced for children under six and people over 70. This allows for free GP visits but retains Category II benefits elsewhere. As of December 2021, 30.8% of the population had a medical card [12]. The percentage of people with a medical card has decreased significantly in the younger and older age groups, which can be attributed to the introduction of the GP card. Nearly half of the population (45.2%) has private health insurance, primarily for accessing private hospital care and reduced copayments for other services [12]. The main challenge of the Irish healthcare system remains cost barriers and long waiting times, especially for those without private insurance [11].

As PC incidence rates were rising in Ireland, with more than 2500 new cases per year in 2006 [13], and lack of standardisation in screening, and as part of the National Strategy for Cancer Control 2006 [14], the National Cancer Control Programme (NCCP) initiated in 2009 rapid access clinics within public hospitals specialising in lung, breast and prostate cancer. By 2012, there were eight rapid access prostate clinics (RAPCs) across Ireland. Patients younger than 70 years old with abnormal findings, including abnormal digital rectal examination (DRE) or PSA levels above the age-reference range, are streamlined and referred to RAPC by their GP. These clinics aimed to streamline referral pathways and enhance diagnosis while mitigating access and cost barriers [15]. The primary key performance indicator for these clinics is access, with 90% of referrals to the RAPC being offered an appointment within 20 working days from referral. Since the introduction of the RAPCs, there has been an increase in PC detection rates in Ireland, following a shift towards detecting lower-grade disease [16]. However, RAPCs did not diminish barriers and disparities completely, as a central part of early detection is screening. In parallel, the NCCP harmonised PSA screening guidelines to include risk stratification and shared decision-making strategies [17].

Previous reports highlighted the role of the healthcare provider and the socio economic status (SES) in disparities in the survival outcomes of men with PC in Ireland [18]. Regarding PC screening, an analysis of self-reported data from the TILDA study (2009–2011) showed that, after controlling for confounders, including self-reported health and socio economic status, PSA testing was significantly higher in men with private health insurance [19]. Another Irish study, using the SLÁN data (2007),

determined that SES was the primary determinant in differential uptake of PC screening [20].

The Irish Prostate Cancer Outcomes Research (IPCOR) Study collected comprehensive longitudinal data on men newly diagnosed with PC in Ireland from 2016 to 2020. Given the high incidence of PC in Ireland, reaching 3,466 new cases in 2016 [13], understanding the nuances of disease presentation is crucial. This analysis aims to characterise disease presentation features on timely data at a national level and identify factors related to socio demographic disparities in presentation following opportunistic screening, shedding light on potential challenges within Ireland's unique healthcare system.

Methods

From February 2016 to January 2020, IPCOR collected data on demographics, diagnosis, and treatment of 6,816 men newly diagnosed with PC across 16 hospitals in Ireland [21]. The data collection included a wide range of hospitals from both the public and private sectors. In the study's first two full years, 2016 and 2017, IPCOR registered 2,196 and 2,749 men, respectively, accounting for 63% and 74% of all PC cases diagnosed in Ireland, as reported by the National Cancer Registry Ireland (NCRI) [13]. The data collected included socio demographic variables such as age at diagnosis, county of residence, setting of residence (rural or urban), the type of hospital (public or private), the distance to the diagnosing hospital (calculated from the patient's residence), and SES quintile. The SES was determined based on addresses geocoded to the electoral division level and then categorised into deprivation quintiles. Clinical details on the disease at presentation were collected, including PSA level, stage at diagnosis using the International Society of Urological Pathology (ISUP) grading scale and the metastatic status at presentation by clinical exam, MRI, CT scan, PET scan or bone scan information within four months from the diagnosis. Additionally, the mode of disease presentation was documented, which could be incidental, following symptoms, or subsequent to opportunistic PSA screening.

Registered men were further invited to participate in a sub-study focused on patient-reported outcome measures (PROMs). In total, 873 men joined this sub-study, which provided details on health-related quality of life, self-reported demographics, comorbidities, and insights into healthcare financing, either via private medical insurance or public medical or GP cards.

We carried out a complete case examination for our analysis. To address missing values, our complete case analysis was complemented with a thorough examination of data completeness across all reporting sites, focusing on the extent of missingness for each variable and patterns of missingness. Based on this, we identified three sites with more than 100 patients and at least 35% absence of data in the primary outcome variable. These sites were excluded from a subsequent sensitivity analysis to assess the impact of this missing data.

We used the chi-squared test for between-group comparisons in categorical variables (metastatic disease, mode of presentation) and cumulative link model (CLM) regression for ordinal variables (PSA category, ISUP grade, SES). The Benjamini-Hochberg procedure [22] was employed to adjust for multiple comparisons. Multivariable logistic regression was conducted to examine the association between various predictor variables and the presentation subsequent to opportunistic screening. The predictors included in the model were chosen based on their prior evidence in the literature suggesting their potential association with the opportunistic screening outcome. These included age, setting of residence (rural or urban), the type of hospital (public or private), the distance to the diagnosing hospital and SES. Statistical significance was determined using a p-value threshold of 0.05. All tests were two-tailed. Data analysis was performed using R software version 4.2.1.

Results

Patient characteristics

Among the 6,816 men registered, the median age was 67, ranging from 31 to 94. Of these men, 67.9% were under 70 years of age. Most men (54.8%) lived in an urban setting, and the median distance to the diagnosing hospital was 39.1 km. Most men (62.2%) were diagnosed in a public hospital. The men were evenly distributed across SES quintiles, which suggests the cohort reflects the general population in Ireland. Of the 873 men in the PROMs sub-study, 61.5% reported having private medical insurance, while 33.6% reported holding a public medical card. The median PSA at diagnosis was 7.7 ng/mL. Elevated PSA (>4 ng/mL) was observed in 87.8% of men. Approximately one-third of the patients were diagnosed with ISUP grade 1 (33.5%), while 9.2% were diagnosed with ISUP grade 5. Only 4.7% of men were recorded with metastatic disease at presentation. Notably, 69.1% were diagnosed following opportunistic screening, and 7.6% were presented with symptoms. All baseline patient characteristics are detailed in Table 1.

In the analysis of self-reported responses of the 873 men in the PROMs sub-study, a significant association was observed between SES and healthcare financing mechanisms. Lower SES was strongly correlated with the possession of public medical cards, while higher SES was predominantly associated with private insurance (both $p<0.001$). Specifically, among the least deprived quintile, 12.3% reported having medical cards, and 31.5% had private insurance. In contrast, the most deprived quintile displayed a substantially higher reliance on medical

Table 1 Characteristics of patients, IPCOR cohort (2016–2020)

Characteristic	Overall (n = 6816)
Age at diagnosis, years	
Mean (SD)	66.7 (8.2)
Median (range)	67 (31–94)
> 70, *n*(%)	2092 (30.7)
≤ 70, *n*(%)	4626 (67.9)
> 50, *n*(%)	6550 (96.1)
≤ 50, *n*(%)	168 (2.5)
Missing, *n*(%)	98 (1.4)
Rural/Urban group, *n*(%)	
Rural	2901 (42.6)
Urban	3737 (54.8)
Unclassified	103 (1.5)
Missing	75 (1.1)
Distance to hospital, Km	
Mean (SD)	58 (61.7)
Median (range)	39.1 (0.2-353.5)
Missing	50 (0.7)
Hospital	
Public	4241 (62.2)
Private	2183 (32)
Unknown or Overseas	9 (0.1)
Missing	383 (5.6)
Deprivation index (SES*), *n*(%)	
1 – least deprived	1377 (20.2)
2	1176 (17.3)
3	1267 (18.6)
4	1355 (19.9)
5 – most deprived	1290 (18.9)
Unclassified	297 (4.4)
Missing	54 (0.8)
Private insurance, *n*(%)**	
Yes	537 (61.5)
No	332 (38)
Missing	< 5 (0.5)
Public medical card, *n*(%)**	
Yes	293 (33.6)
No	573 (65.6)
Missing	7 (0.8)
PSA at diagnosis, ng/mL, *n*(%)	
≤ 4	426 (6.3)
4–10	3928 (57.6)
10–20	1258 (18.5)
> 20	799 (11.7)
Missing	405 (5.9)
Metastatic disease, *n*(%)	
Yes	319 (4.7)
No	4392 (64.4)
Missing	2105 (30.9)
ISUP*** grade, *n*(%)	
1	2286 (33.5)
2	2020 (29.6)
3	978 (14.3)
4	694 (10.2)

Table 1 (continued)

Characteristic	Overall (n = 6816)
5	628 (9.2)
Missing	210 (3.1)
Mode of presentation, *n*(%)	
Opportunistic screening	4712 (69.1)
Symptoms	520 (7.6)
Incidental findings	256 (3.8)
Unknown	736 (10.8)
Missing	592 (8.7)

* SES – Socioeconomic status

** proportions from PROMs cohort ($n=873$); *** ISUP - International Society of Urological Pathology

This table summarises the demographic and clinical characteristics of men recruited in the IPCOR study in Ireland between February 2016 and January 2020

cards at 33.8%, while only 11.7% reported having private insurance.

Association between socio demographic variables and disease presentation features

Several factors emerged as significant in the univariable analysis assessing the association between socio demographic and provider characteristics and disease presentation features. These associations are broken down in Table 2. Patients living in urban areas presented with more advanced disease than patients living in rural areas. They had higher PSA (>20 ng/mL: 13.7% vs. 11.2% and ≤4ng/mL 6.4% vs. 6.8%, B-H adjusted p-value=0.033), higher metastatic rates (7.8% vs. 5.6%, $p=0.024$), higher stage (ISUP grade 1: 33.1% vs. 36.5% and ISUP grade 5: 10.4% vs. 8.5%, $p=0.015$). A statistically significant, though very small, higher proportion of urban men presented following opportunistic screening (86% vs. 85.4%, $p<0.001$). Patients diagnosed in public hospitals presented with more advanced disease. They had significantly higher PSA levels (>20 ng/mL: 13.8% vs. 9.9% and ≤4ng/mL 5.6% vs. 9.1%, $p<0.001$), higher metastatic disease rates (7.5% vs. 5.4%, $p=0.027$) and a higher proportion of presentation following opportunistic screening (86.8% vs. 84.2%, $p<0.001$). Patients diagnosed in private hospitals had higher percentages of incidental findings (6.4% vs. 3.6%, $p<0.001$).

We found an interesting non-linear pattern when examining the distribution of presentation features across SES quintiles. Patients from the least deprived and most deprived SES quintiles presented with higher PSA levels than those in the 2nd, 3rd and 4th quintiles (>20 ng/mL: 12.8%, 12.4%, 11%, 12.5%, and 14.2%, by SES quintile, $p=0.007$). Concordantly, patients in the least deprived and most deprived SES quintiles had slightly higher proportions of metastatic disease than those in the 2nd, 3rd and 4th quintiles (7.3%, 6.8%, 6%, 6.6%, and 7.4%, by SES quintile, $p=0.003$). The middle SES quintiles (2nd and 3rd) had reduced rates of diagnoses from opportunistic screening at 84.2% and 85.2%, respectively. In contrast, the least deprived quintile reported 86.6%, while the two lowest quintiles (4th and 5th) demonstrated closely aligned rates of 86.6% and 86.4%, respectively ($p=0.011$). These findings are visually represented in Fig. 1.

Factors influencing presentation following screening - multivariable logistic regression

We utilised a multivariable logistic regression model to examine factors influencing the outcome variable of presentation to the Urology clinic following opportunistic screening. The model was built using the following predictors - age at diagnosis, urban or rural setting, distance to hospital, SES, and type of hospital (public or private). The results are summarised in Table 3. The most notable finding was the significant impact of hospital type on presentation following screening. Patients treated in public hospitals were found to be 45.7% more likely to be presented following opportunistic screening compared to those in private hospitals, assuming other factors are held constant (odds ratio (OR)=1.457, $p<0.001$). Men from urban areas were about 34% more likely to present following screening than their rural counterparts (OR=1.34, $p<0.001$). Age at diagnosis showed a significant negative association with the likelihood of being presented following the screening, with the odds decreasing by 3.4% for each additional year of age (OR=0.966, $p<0.001$). Distance to the hospital was also significant in the model, suggesting that a longer distance to the hospital is associated with an increased likelihood of screening (OR=1.003, $p<0.001$). However, the difference is slight. SES did not demonstrate significant associations with screening in this model. An extended model, which included interaction terms between the urban or rural setting and distance to the hospital and between SES and provider's characteristics (public vs. private sector), demonstrates results similar to those of the primary model. The extended model is summarised in supplement Table 3S.

Table 2 Univariable analysis of selected prostate cancer presentation features and socio demographic covariates, IPCOR cohort (2016–2020)

Characteristic	Overall (*n* = 6816)	Rural (*n* = 2901)	Urban (*n* = 3737)	*p*-value	Private (*n* = 2183)	Public (*n* = 4241)	*p*-value	SES 1 - least deprived (*n* = 1377)	SES 2 (*n* = 1176)	SES 3 (*n* = 1267)	SES 4 (*n* = 1355)	SES 5 - most deprived (*n* = 1290)	*p*-value
PSA at diagnosis, ng/mL, *n*(%)													
≤ 4	426 (6.3)	187 (6.8)	225 (6.4)	0.033	178 (9.1)	230 (5.6)	< 0.001	87 (6.8)	82 (7.5)	86 (7.2)	89 (7)	56 (4.5)	0.007
4–10	3928 (57.6)	1707 (62.3)	2118 (60.5)		1217 (61.9)	2514 (60.8)		773 (60.5)	665 (60.5)	740 (62.2)	797 (62.6)	745 (60.3)	
10–20	1258 (18.5)	540 (19.7)	678 (19.4)		375 (19.1)	817 (19.8)		254 (19.9)	216 (19.7)	233 (19.6)	229 (18)	259 (21)	
> 20	799 (11.7)	306 (11.2)	479 (13.7)		195 (9.9)	571 (13.8)		164 (12.8)	136 (12.4)	131 (11)	159 (12.5)	175 (14.2)	
Missing	405 (5.9)	161	237		218	109		99	77	77	81	55	
Metastatic disease, *n*(%)													
Yes	319 (6.8)	115 (5.6)	198 (7.8)	0.024	80 (5.4)	227 (7.5)	0.027	72 (7.3)	55 (6.8)	50 (6)	60 (6.6)	70 (7.4)	0.003
No	4392 (93.2)	1925 (94.4)	2354 (92.2)		1408 (94.6)	2788 (92.5)		913 (92.7)	749 (93.2)	777 (94)	852 (93.4)	871 (92.6)	
Missing	2105	861	1185		695	1226		392	372	440	443	349	
ISUP grade, *n*(%)													
1	2286 (34.6)	1026 (36.5)	1201 (33.1)	0.015	705 (33.2)	1440 (34.9)	0.119	431 (32)	439 (38.5)	428 (34.9)	446 (34)	427 (34.2)	0.048
2	2020 (30.6)	824 (29.3)	1141 (31.5)		635 (29.9)	1271 (30.8)		399 (29.6)	329 (28.9)	379 (30.9)	395 (30.2)	401 (32.2)	
3	978 (14.8)	423 (15.1)	527 (14.5)		331 (15.6)	616 (14.9)		221 (16.4)	147 (12.9)	175 (14.3)	223 (17)	170 (13.6)	
4	694 (10.5)	297 (10.6)	381 (10.5)		273 (12.9)	384 (9.3)		150 (11.1)	108 (9.5)	138 (11.2)	131 (10)	135 (10.8)	
5	628 (9.5)	239 (8.5)	377 (10.4)		178 (8.4)	419 (10.1)		146 (10.8)	117 (10.3)	107 (8.7)	115 (8.8)	114 (9.1)	
Missing	210	92	110		61	111		30	36	40	45	43	
Mode of presentation, *n*(%)													
Opportunistic screening	4712 (85.8)	1954 (85.4)	2631 (86)	< 0.001	1427 (84.2)	3125 (86.8)	< 0.001	968 (86.6)	775 (84.2)	858 (85.2)	948 (86.6)	929 (86.4)	0.011
Symptoms	520 (9.5)	240 (10.5)	268 (8.8)		158 (9.3)	345 (9.6)		96 (8.6)	102 (11.1)	96 (9.5)	95 (8.7)	102 (9.5)	
Incidental findings	256 (4.7)	94 (4.1)	159 (5.2)		109 (6.4)	130 (3.6)		54 (4.8)	43 (4.7)	53 (5.3)	52 (4.7)	44 (4.1)	
Unknown	736	370	342		280	305		137	133	145	143	134	

This table presents the univariable analysis results examining the association between socio demographic factors (rural/urban residence, hospital type, and socio economic status) and prostate cancer presentation features (PSA levels, metastatic disease, ISUP grade, and mode of presentation)

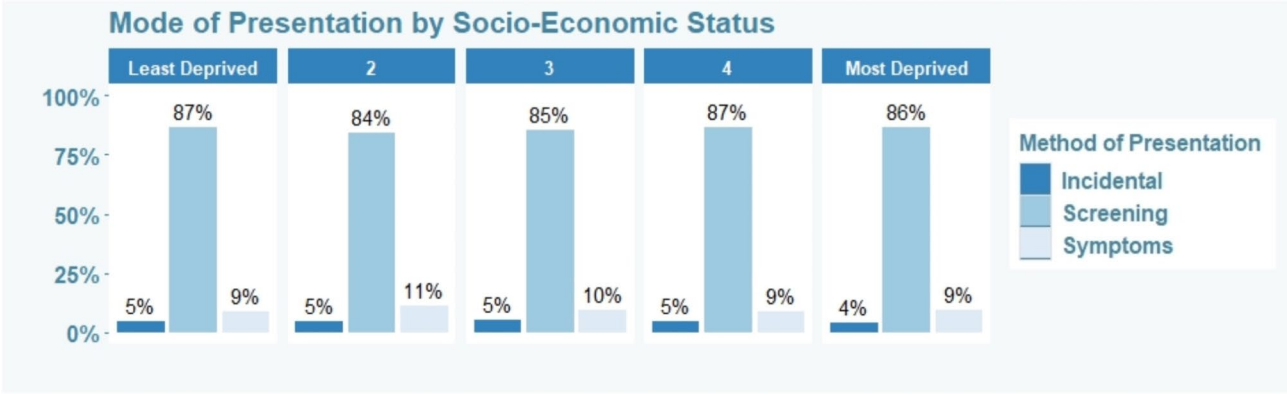

Fig. 1 Socioeconomic status and mode of prostate cancer presentation, IPCOR cohort (2016–2020). *Note* This figure illustrates the relationship between socioeconomic status and the mode of prostate cancer presentation, including opportunistic screening, symptoms, and incidental findings, among patients registered in the IPCOR study from 2016 to 2020

Table 3 Multivariable logistic regression model for presentation following opportunistic screening, IPCOR cohort (2016–2020)

Variable	Odds Ratio	CI 95%	p-value
(Intercept)			< 0.001
Age at diagnosis (per year)	0.9664	0.9584–0.9744	< 0.001
Rural/Urban (Urban)	1.3398	1.1470–1.5652	< 0.001
Distance to Hospital (per Km)	1.0025	1.0011–1.0039	< 0.001
Socioeconomic Status (SES) - L*	1.0016	0.8471–1.1844	0.984
Socioeconomic Status (SES) - Q*	1.1299	0.9738–1.3110	0.106
Socioeconomic Status (SES) - C*	0.8870	0.7680–1.0245	0.103
Hospital Type (Public)	1.4570	1.2704–1.6710	< 0.001

* SES.L – Linear effect; SES.Q – Quadratic effect; SES.C – Cubic effect; CI – Confidence Interval

This table presents the results of the multivariable logistic regression analysis identifying factors associated with presentation to the clinic following opportunistic screening for prostate cancer, including age, rural/urban setting, distance to hospital, socioeconomic status, and hospital type

Missing values and sensitivity analysis

The findings from the sensitivity analysis aligned with those from the complete case analysis and are presented in Tables 1S and 2S in the supplementary materials. PSA levels and opportunistic screening rates remain higher in the urban setting, the public sector, and the middle SES quintiles. The effect of urban setting, public sector and SES on metastatic presentation and ISUP grade was borderline or non-significant. This consistency suggests that, despite the notable level of missing data at specific sites, the overall conclusions drawn from our study remain robust and reliable.

Discussion

In this study, we aimed to characterise PC disease presentation features nationally in Ireland, specifically focusing on identifying factors associated with socio demographic disparities in presentation subsequent to opportunistic screening. While our analysis did reveal some statistically significant associations, it is important to note that these associations may not necessarily translate into clinical significance. Nevertheless, our study adds considerable value to existing research by providing timely and comprehensive nationwide information, encompassing both public and private sectors. This wide-ranging approach ensures a more representative and holistic understanding across different healthcare settings.

Our findings indicate that patients in urban areas are diagnosed with more advanced PC, marked by higher PSA levels, increased metastatic rates, and higher ISUP grades compared to those in rural areas. Despite slightly higher rates of presentation following opportunistic screening in urban areas, these findings suggest that urban patients may be diagnosed at later stages. This may stem from multiple factors. One explanation could be related to urban healthcare systems being burdened by longer wait times, particularly in the public sector, leading to delays in both diagnosis and treatment. Studies from countries such as Australia and the U.S. have similarly identified urban populations facing access issues due to healthcare system overloads despite their proximity to services [23]. Although urban residents may engage in opportunistic screening, they still face access issues. Further exploration into these factors is necessary to fully understand the mechanisms driving urban-rural disparities. Future research should focus on how environmental stressors, healthcare access, and rural-urban screening differences influence PC diagnosis.

Additionally, we observed a non-linear pattern in disease presentation across different SES groups, with middle SES groups showing lower rates of opportunistic screening, implying poorer access to screening. This might be caused by financial and structural barriers limiting their access to healthcare services. Ireland's two-tiered public-private healthcare system may explain this anomaly. While men in the 2nd and 3rd SES quintiles may not afford private insurance, they also may not be eligible for social medical coverage [24]. These men may avoid opportunistic screening since GP visits are costly. Our multivariable analysis, which accounted for dependencies between different socioeconomic and demographic variables, found that presentation following screening is more likely in public and urban settings. Public hospitals equipped with structured pathways, such as the RAPCs, facilitate efficient referral and diagnostic processes. Urban settings typically offer better access to healthcare facilities and resources. Conversely, age is negatively associated with presentation following screening, suggesting that older men are less likely to undergo screening. This may be due to comorbidities, reduced healthcare-seeking behaviour, or potential biases caused by screening recommendations for older populations.

Previous studies have extensively investigated the relationship between socio demographic or socio economic factors and PC presentation and outcomes, providing a valuable foundation for contextualising our findings. Weiner et al. utilised SEER data to investigate disparities in PC presentation [25]. Their research highlighted the independent associations between lower SES, race/ethnicity, the absence of private insurance coverage, and a higher likelihood of presenting with metastatic de-novo disease. Our study similarly identifies SES as a significant factor in PC presentation, particularly noting a U-shaped trend across different SES quintiles. In a separate study, Foley et al. examined PC cases in Tasmania [26], revealing that men from remote areas who lived in lower socio economic regions are diagnosed at an older age and present with more clinically aggressive PC features. Contrarily, our study found that patients in urban areas were diagnosed with more advanced PC than those in rural areas. While our study also identified SES as a key factor in more advanced PC presentation, the relationship we revealed is more complex. We can attribute the different findings to the unique Irish social and healthcare features.

In the Irish context, a 2023 report by the National Cancer Registry examining cancer disparities in Ireland, spanning the years 2004 to 2018, provided a detailed exploration of inequalities, also focusing on PC [27]. This report follows a 2016 report which covered the years 2008-2012 [28]. These reports revealed significant differences in the stage at diagnosis influenced by rural-urban status and socio economic deprivation. It was observed that urban patients were diagnosed at a more advanced stage in comparison to rural patients. Moreover, patients from the most socio-economically deprived backgrounds were less likely to be diagnosed at an earlier stage relative to those from the least deprived groups. Our study aligns with these findings, adding nuance to the relationship between SES and PC presentation. The Think-tank for Action on Social Change (TASC) report from 2022 focused on investigating the impact of socio-economic inequalities on access to cancer services in Ireland [29]. Although concentrating on specific cancers that show higher morbidity rates in disadvantaged and marginalised population groups, this report also sheds some light on PC disparities in Ireland. The report highlights that an individual's economic and social resources influence their cancer journey and outcomes. Social inequalities lead to various barriers, ranging from delayed access to primary care and financial burdens of treatment to psychological obstacles like stigma and the fear of financial hardship. Our study's observations on the socio economic disparities in opportunistic screening resonate with the TASC report's emphasis on barriers related to care access.

Our findings highlight the need for targeted interventions to improve access and encourage screening and have significant implications for the organisation of PC screening in Ireland. Implementing risk-based, tailored screening programs that consider SES and geographical location could enhance early detection and reduce advanced disease presentations. Public awareness campaigns should be increased to emphasise the importance of PC screening, especially targeting those in rural or deprived areas. Additionally, implementing policies aimed at reducing the financial burden of screening for men from middle or lower-SES backgrounds and enhancing accecability is crucial. These measures collectively aim to reduce disparities and improve overall health outcomes.

While our study has provided valuable insights into the factors influencing PC presentation, it is essential to acknowledge and address the limitations that may have impacted the interpretation and generalisability of our findings. One significant limitation of this study stems from its observational nature. As an observational study, we relied on the analysis of pre-existing data and the selection of patients from sites that participated in the study, not covering all men diagnosed with PC in Ireland. This lack of control can introduce confounding variables and biases that may affect the internal validity of our results. Therefore, caution should be exercised when interpreting causal relationships based on our observational findings. Another limitation of this study is the irregular distribution of missing data across various study sites, which could be attributed to the varying

data collection practices and clinical practices at each site. A sensitivity analysis was performed to mitigate this limitation, incorporating only sites with a low percentage of missing data. As noted earlier, the outcomes of this analysis were consistent with the complete case analysis, thereby supporting the validity of generalising the results at a national level.

Another notable limitation of our study is the lack of consideration of race or ethnicity as a potential factor influencing disparities in PC presentation. While a substantial body of literature examines racial inequality in PC outcomes, it is essential to acknowledge that our study did not collect race information. Thus, the investigation of racial disparities falls outside the scope of our research. While we recognise the significance of this factor, our study primarily focused on other socio demographic and socio economic aspects. It aimed to shed light on potential challenges within Ireland's healthcare system. Future studies specifically designed to examine racial disparities in PC are warranted to provide a more comprehensive understanding of this complex issue. Finally, it is crucial to note that our study focused primarily on disparities in the initial stage of PC presentation. It did not investigate potential disparities in subsequent stages of the patient journey, such as access to disease staging investigation, treatments or outcomes. This warrants further exploration in future research.

Conclusions

Our study has shed light on presentation features and screening for PC in Ireland, identifying potential disparities mainly targeting urban populations, middle socioeconomic groups, and those with inadequate healthcare coverage. While the differences we observed between various groups may appear subtle and may potentially indicate the success of the RAPC, they are still significant in pinpointing specific populations that require special attention. By addressing these nuanced differences in access to healthcare, socioeconomic status, and urban versus rural residence and implementing tailored strategies, we can work towards closing disparity gaps in PC, ultimately leading to improved health outcomes and equity across all population segments.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13690-024-01439-6.

Supplementary Material 1

Acknowledgements

The authors wish to express their sincere gratitude to the men who participated in the IPCOR project, as well as to the numerous hospitals and consultants involved, for their invaluable contributions. We also extend our thanks to the National Cancer Registry Ireland (NCRI) for their support and collaboration. Additionally, we are grateful to our funders for their generous support. Any opinions, findings, conclusions or recommendations expressed are those of the authors and not necessarily those of the Irish Cancer Society or Movember Foundation.

Author contributions

NG and CD contributed to the data analysis. NG, CD, SG, WW, and DG contributed to the interpretation of data. NG drafted the manuscript. All authors contributed to the concept and design of the manuscript, the revision of the manuscript, and the approval of the final version.

Funding

The Irish Prostate Cancer Outcomes Research Project, IPCOR14GAL, supported by the Irish Cancer Society and the Movember Foundation. NG is a Movember Janssen Newman Fellow in Prostate Cancer Outcomes Research.

Data availability

The IPCOR dataset is available for access through a federated model; full details are available through ipcor@ucd.ie.

Declarations

Ethics approval and consent to participate

Ethics approval was obtained from each of the individual hospitals participating in the IPCOR project. An ethical waiver was issued by University College Dublin LS-E-22-131-GALVIN to allow the use of the IPCOR dataset in University College Dublin. Patient consent was not required for the patient data, as this was carried out under the auspices of the National Cancer Registry Ireland (NCRI). The NCRI has permission under the Health (Provision of Information) Act 1997 to collect and hold data on all persons diagnosed with cancer in Ireland. The use of these data for research is covered by the Statutory Instrument, which established the Registry Board in 1991.

Competing interests

The authors declare no competing interests.

Received: 30 April 2024 / Accepted: 29 October 2024
Published online: 13 November 2024

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