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Socioeconomic inequality in prostate cancer diagnostics, primary treatment, rehabilitation, and mortality in Sweden

Ulf Strömberg[1,2] | Anders Berglund[3] | Stefan Carlsson[4,5] | Camilla Thellenberg Karlsson[6] | Mats Lambe[7] | Ingela Franck Lissbrant[8] | Pär Stattin[9] | Ola Bratt[10,11]

[1]School of Public Health and Community Medicine, Institute of Medicine, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden

[2]Department of Research and Development, Region Kronoberg, Växjö, Sweden

[3]EpiStat AB, Uppsala, Sweden

[4]Department of Molecular Medicine and Surgery, Karolinska Institutet, Stockholm, Sweden

[5]Department of Urology, Karolinska University Hospital Solna, Stockholm, Sweden

[6]Department of Diagnostics and Intervention, Oncology, Umeå University, Umeå, Sweden

[7]Department of Medical Epidemiology and Biostatistics, Karolinska Institute, Stockholm, Sweden

[8]Department of Oncology, Institute of Clinical Sciences, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden

[9]Department of Surgical Sciences, Uppsala University, Uppsala, Sweden

[10]Department of Urology, Institute of Clinical Sciences, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden

[11]Department of Urology, Sahlgrenska University Hospital, Gothenburg, Sweden

Correspondence
Ulf Strömberg, School of Public Health and Community Medicine, University of Gothenburg, PO Box 469, Gothenburg 405 30, Sweden.
Email: ulf.stromberg@gu.se

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Abstract

We designed a nationwide study to investigate the association between socioeconomic factors (household income and education) and different aspects of prostate cancer care, considering both individual- and neighbourhood-level variables. Data were obtained from Prostate Cancer data Base Sweden (PCBaSe), a research database with data from several national health care registers including clinical characteristics and treatments for nearly all men diagnosed with prostate cancer in Sweden. Four outcomes were analysed: use of pre-biopsy magnetic resonance imaging (MRI) in 2018–2020 ($n = 11{,}843$), primary treatment of high-risk non-metastatic disease in 2016–2020 ($n = 6633$), rehabilitation (≥2 dispensed prescriptions for erectile dysfunction within 1 year from surgery in 2016–2020, $n = 6505$), and prostate cancer death in 7770 men with high-risk non-metastatic disease diagnosed in 2010–2016. Unadjusted and adjusted odds and hazard ratios (OR/HRs) with 95% confidence intervals (CIs) were calculated. Adjusted odds ratio (ORs) comparing low versus high individual education were 0.74 (95% CI 0.66–0.83) for pre-biopsy MRI, 0.66 (0.54–0.81) for primary treatment, and 0.82 (0.69–0.97) for rehabilitation. HR gradients for prostate cancer death were significant on unadjusted analysis only (low vs. high individual education HR 1.41, 95% CI 1.17–1.70); co-variate adjustments markedly attenuated the gradients (low vs. high individual education HR 1.10, 95% CI 0.90–1.35). Generally, neighbourhood-level analyses showed weaker gradients over the socioeconomic strata, except for pre-biopsy MRI. Socioeconomic factors influenced how men were diagnosed with prostate cancer in Sweden but had less influence on subsequent specialist care. Neighbourhood-level socioeconomic data are more useful for evaluating inequality in diagnostics than in later specialist care.

KEYWORDS
diagnosis, mortality, prostate cancer, socioeconomic factors, treatment

What's new?

Socioeconomic factors influence individual cancer characteristics, as well as quality of cancer care and patient outcomes. Few studies on socioeconomic differences, however, have clearly described impacts specifically on prostate cancer care. Here, the authors investigated associations between aspects of care and education and household income among men with prostate cancer in Sweden. Analyses show that household income and education are significantly associated with use of pre-biopsy magnetic resonance imaging, primary treatment, sexual rehabilitation after surgery, and cause-specific mortality for high-risk non-metastatic prostate cancer. Covariate adjustments attenuated socioeconomic mortality gradients, suggesting that socioeconomic factors influence diagnostics more than later specialist prostate cancer care.

1 | INTRODUCTION

Socioeconomic inequity in the management of and outcomes for cancer patients has been reported across the world,[1–3] including in the Nordic countries.[4] To discriminate between justified differences in patient management that are based on differences in patient and cancer characteristics, and unjustified differences that are based on socioeconomic factors only, adjustment for detailed cancer characteristics and patient comorbidity is necessary. Few of the previous studies on socioeconomic differences in cancer care could, however, do this.[1–3,5,6] Moreover, most previous studies used either neighbourhood level or, less commonly, individual-level socioeconomic data. Whether associations based on either individual- or neighbourhood-level socioeconomic data are in agreement for assessment of inequalities in specific cancer care outcomes has not yet been systematically investigated.

We designed a nationwide register-based study to assess possible associations between socioeconomic factors and different aspects of prostate cancer care in Sweden. We had access to detailed cancer characteristics data, patient comorbidity data, and socioeconomic data on both individual and neighbourhood level. We chose to assess outcomes related to diagnostics, primary treatment, and rehabilitation, as well as prostate cancer-specific mortality in men with high-risk non-metastatic prostate cancer for whom treatment clearly affects mortality.[7] The aims were to assess inequality in prostate cancer care with and without adjustment for factors that rightfully should affect patient management and to compare individual- versus neighbourhood-level analysis of socioeconomic data.

2 | MATERIAL AND METHODS

2.1 | The Swedish healthcare system

Sweden has a public, tax financed, healthcare system available to all residents at low out-of-pocket cost. Patients are charged ~10 euro for a consultation with a general practitioner and 20–30 euro for a consultation in specialised care. The health insurance incrementally subsidises patients so that no-one pays more than 200 euro per year for healthcare consultations or 200 euro for prescribed drugs. While intraurethral and intracavernous treatments for erectile dysfunctions are reimbursed, phosphodiesterase inhibitors are not.

2.2 | Dataset

We used data from Prostate Cancer data Base Sweden (PCBaSe) version 5.0, a merged research database including clinical data in the National Prostate Cancer Register of Sweden (NPCR) and cross-linked with data from several other national health care registers and demographic databases by use of the unique personal identification number assigned to all permanent residents of Sweden.[8,9] NPCR has a completeness of 98% compared to the National Cancer Register[10] to which reporting of all incident cancers is mandated by law.

For all men with prostate cancer identified in the NPCR, socioeconomic characteristics at the time of diagnosis were retrieved on both individual and neighbourhood levels from Statistics Sweden. Individual-level data were obtained on household income and educational level. Household income was defined as the disposable income per household per consumption unit (Statistics Sweden applies the following weights: 1.0 for single or living alone, 1.51 for cohabiting couple, 0.6 for each additional adult, 0.52 for first child 0–19 years, and 0.42 for each additional child 0–19 years). To correspond with the neighbourhood-level socioeconomic variable on household income (see below), we categorised this individual-level variable as low, corresponding to first quartile of all households in Sweden, intermediate (second and third quartiles), or high (fourth quartile). Educational level was categorised based on number of school years according to the Swedish educational system: low: ≤9 years (compulsory school), intermediate: 10–12 years (secondary, non-compulsory) or high: >12 school years (high-school or university education, referred to as 'academic education').

Residential area at diagnosis and neighbourhood-level socioeconomic data were retrieved based on Statistics Sweden's small-area division of Sweden referred to as Demographic Statistical Areas, launched in 2018 to facilitate the monitoring of segregation and socioeconomic conditions. In 2018, the populations across the 5985 Demographic Statistical Areas in Sweden varied between 600 and 4300 individuals, with a median of 1600 people. We used the following neighbourhood-level variables, which have been suggested for studies in Sweden[11]: proportion of inhabitants with low household

income (first quartile of all households in Sweden), further categorised as national quintiles Q1 (lowest proportion = richest neighbourhoods) to Q5 (highest proportion = poorest neighbourhoods), and proportion of inhabitants aged 25–64 years with ≤12 school years, categorised as national quintiles Q1 (lowest proportion = highest educational level) to Q5 (highest proportion = lowest educational level). These data for the Demographic Statistical Areas were extracted from year 2018.[11]

We assessed associations of individual and neighbourhood-level socioeconomic indicators for four different aspects of prostate cancer care: diagnostics, primary treatment, rehabilitation, and cancer-specific mortality. These three first outcomes were chosen to represent distinctly different aspects of care, whereas cancer-specific mortality represents an end-point affected by many different parts. Cancer- and patient-related covariates for adjusted analyses were extracted from PCBaSe 5.0. The comorbidity burden in each man was assessed by use of the Charlson Comorbidity Index (CCI) based on International Classification of Diseases diagnosis codes retrieved from the National Patient Register for up to 15 years before the date of the prostate cancer diagnosis.[12]

Diagnostics: magnetic resonance imaging (MRI) before prostate biopsy (yes/no) among men aged <80 years with prostate-specific antigen (PSA) 3.0–19.9 ng/mL diagnosed with stage T1c prostate cancer between 1 January 2018 and 31 December 2020 (the implementation period after the national guidelines included a pre-biopsy MRI in December 2018).

Primary treatment: treatment with curative intent (surgery or radiotherapy, yes/no) among men aged <80 years with CCI 0–2 diagnosed with high-risk non-metastatic disease between 1 January 2016 and 31 December 2020.

Rehabilitation: at least two dispensed prescriptions of treatment for erectile dysfunction within 1 year from radical prostatectomy (yes/no) among men aged <70 years without registered comorbidity (CCI 0) diagnosed with low- or intermediate-risk cancer between 1 January 2016 and 31 December 2020.

Cancer-specific mortality was assessed for men aged <80 years with CCI 0–2 diagnosed with high-risk non-metastatic prostate cancer in between 1 January 2010 and 31 December 2015 (to achieve a minimum of 5 years' follow-up).

2.3 | Statistical methods

Logistic regression was employed to estimate associations of the diagnostic, primary treatment, and rehabilitation outcomes. Odds ratios (ORs) with 95% confidence intervals (CIs) were estimated, each representing the OR of the 'favoured' choice in the healthcare process (MRI before prostate biopsy, treatment with curative intent, repeated prescription of treatment for erectile dysfunction) between two specified categories of each socioeconomic variable. Both crude and adjusted ORs were calculated. We carefully pre-specified the covariates, considered as potential mediators/confounders, in the adjusted models. In the logistic regression models for the diagnostic outcome, adjustments were made for calendar year, age, and serum PSA value at the time of diagnosis. In the models for the treatment outcome, pre-specified adjustments were made for year, age, CCI, clinical local tumour stage (T), regional lymph node stage (N), Gleason score, and PSA value at the time of diagnosis. In the models for the rehabilitation outcome, adjustments were made for age, T stage, Gleason score, number of positive biopsy cores, PSA value, and the healthcare region of residence at time of diagnosis (Swedish has six such regions: South, South-East, West, Mid, Stockholm/Gotland, and North).

Cox regression was employed to estimate associations of the cause-specific mortality outcome with individual- and neighbourhood-level socioeconomic variables. Hazard ratios (HRs) with 95% CIs were estimated. Both crude and adjusted HRs were estimated. Adjustments were made for the covariates year, age, CCI, T stage, Gleason score, PSA value, and healthcare region.

Adjusted ORs and HRs were estimated from two multivariable models. First, we adjusted the association between a socioeconomic variable and a given outcome by including the covariates specified above into the model. These adjusted ratios are referred to as 'Adjusted 1'. Second, we added the other socioeconomic variable to the model, including both individual-level variables (income and education) to the individual-level analysis and analogously for the neighbourhood-level analysis. These adjusted ratios are referred to as 'Adjusted 2'.

We used the Akaike information criterion for quantifying the relative suitability of the statistical models for a given outcome.

3 | RESULTS

A total of 32,751 men were included, 11,843 for the analyses of diagnostics, 6633 for primary treatment, 6505 for rehabilitation, and 7770 for cause-specific mortality. The results of these analyses are reported separately. Descriptive statistics for patients included in the analyses and crude proportions of patients having the outcome are presented in Tables S1–S4. Individual and neighbourhood socioeconomic characteristics are cross-tabulated in Table S5.

3.1 | Diagnostics: Use of MRI before biopsy

In the population under study, 4838 out of 11,843 men (41%) underwent MRI before biopsy in 2018–2020. This proportion varied from 35% to 47% across the socioeconomic strata in the individual-level analyses and from 35% to 51% in the neighbourhood-level analyses (Table S1).

In adjusted logistic regression analyses, the OR of a pre-biopsy prostate MRI was lower in men with lower household income and in those with shorter education, regardless of whether the socioeconomic categorisation was based on individual or neighbourhood-level data (Figure 1). The adjusted models (Adjusted 1) based on individual data yielded a somewhat greater adjusted OR for low versus high household income (0.53, 95% CI 0.47–0.60) than for low versus high education (0.65, 95% CI 0.58–0.72). The adjusted neighbourhood-level models (Adjusted 1) showed marked gradients of

ORs by increasing proportion of inhabitants with low household income (Q5 vs. Q1: adjusted OR 0.49, 95% CI 0.43–0.57), and of inhabitants aged 25–64 years without academic education (Q5 vs. Q1: adjusted OR 0.49, 95% CI 0.39–0.51). The models adjusted for both individual-level socioeconomic factors or both neighbourhood-level factors (the Adjusted 2 models) yielded somewhat weaker but still statistically significant OR estimates.

3.2 | Primary treatment with curative intent of high-risk non-metastatic disease

Of 6633 men who fulfilled the inclusion criteria, 5463 (82%) received treatment with curative intent (radical prostatectomy or radiotherapy) in 2016–2020. This proportion varied from 75% to 89% across the socioeconomic strata in the individual-level analyses and from 79% to 84% in the neighbourhood-level analyses (Table S2). The unadjusted ORs for receiving treatment with curative intent were significantly lower in men with lower individual income or education, as well as in men residing in more socioeconomically disadvantaged neighbourhoods (Figure 2). In the Adjusted 2 models, the individual socioeconomic differences remained statistically significant (low vs. high household income OR 0.66 [95% CI 0.52–0.83]; low vs. academic education OR 0.66 [95% CI 0.54–0.81]), whereas the neighbourhood-level differences did not.

3.3 | Rehabilitation: Treatment for erectile dysfunction after radical prostatectomy

Of 6505 patients aged <70 years without registered comorbidity who in 2016–2020 underwent radical prostatectomy for a low- or intermediate-risk cancer, 3263 (50%) had at least two dispensed prescriptions of treatment for erectile dysfunction within 1 year from surgery. This proportion varied slightly by individual household income (44%–52%) and education (44–51), and to a smaller extent with neighbourhood-level income or education (Table S3). The Adjusted 2 models revealed a statistically significant association for individual-level education only: low versus academic education, OR 0.82 (95% CI 0.69–0.97; Figure 3).

3.4 | Cancer-specific mortality of men with high-risk non-metastatic disease

The clinical characteristics of 7770 men diagnosed with high-risk non-metastatic disease in 2010–2015 are described in Table S4. Eight hundred and eight men died from prostate cancer during follow-up. The unadjusted analyses showed statistically significantly higher HRs for prostate cancer death in men with shorter education (low vs. high, HR 1.41, 95% CI 1.17–1.70) and in those with lower household income (low vs. high, HR 1.66, 95% CI 1.35–2.04), but no significant association remained after adjustments for cancer and patient characteristics (Figure 4). The analyses based on neighbourhood-level socioeconomic data revealed no statistically significant difference (Figure 4).

3.5 | Model fit

The adjusted models fit the data pronouncedly better than the unadjusted models (Table S6). We also point out that the models on diagnostics (use of MRI before biopsy) with neighbourhood-level socioeconomic indicators fit the data better than the corresponding models with individual-level socioeconomic indicators (Table S6). In contrast, the models on the other outcomes (treatment, rehabilitation, and survival) with individual-level socioeconomic indicators fit the data better than the corresponding models with neighbourhood-level socioeconomic indicators (Table S6).

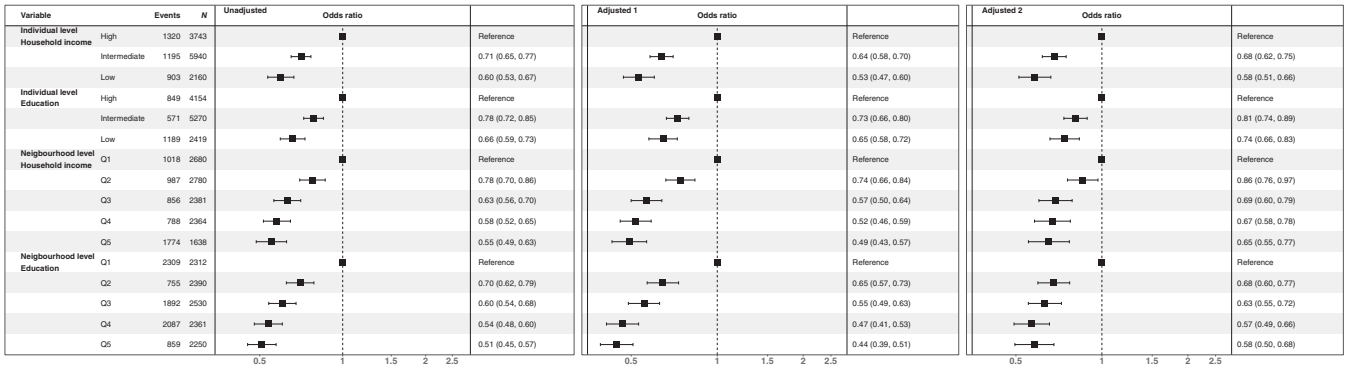

FIGURE 1 Associations between individual and neighbourhood-level socioeconomic variables and the likelihood of having an magnetic resonance imaging (MRI) scan before the diagnostic prostate biopsy among men aged <80 years with prostate-specific antigen (PSA) 3.0–19.9 ng/mL who were diagnosed with stage T1c prostate cancer during the implementation period 2018–2020 in Sweden (the national guidelines included MRI before biopsy in 2019). *Left panel*, unadjusted odds ratios with 95% confidence intervals. *Middle panel*, odds ratios adjusted for calendar year, age, and PSA value at the time of diagnosis (Adjusted 1). *Right panel*, odds ratios adjusted for these covariates and the other individual/neighbourhood-level socioeconomic variable (Adjusted 2).

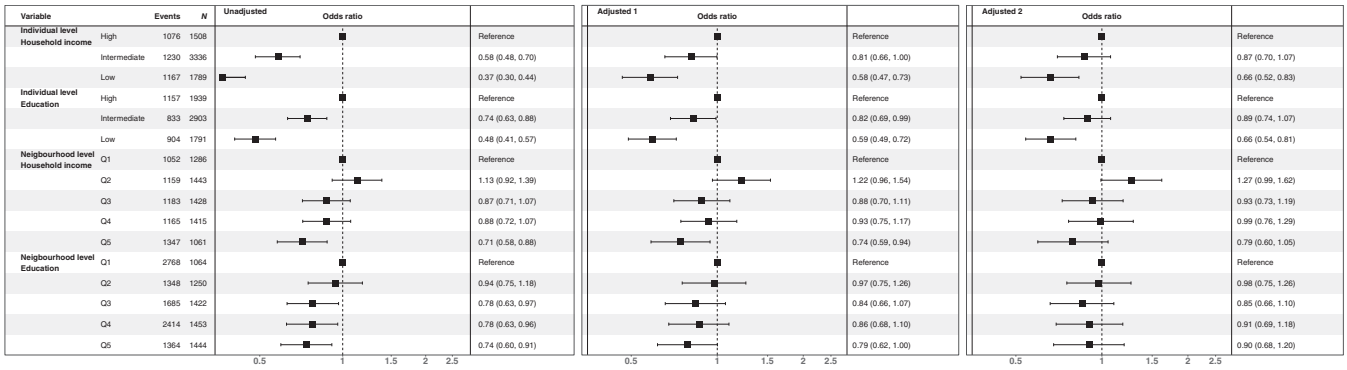

FIGURE 2 Associations between individual and neighbourhood-level socioeconomic variables and the likelihood of having radical treatment of the primary tumour (surgery or radiotherapy) among men aged <80 years with Charlson Comorbidity Index (CCI) 0–2 diagnosed with high-risk non-metastatic disease in 2016–2020. *Left panel*, unadjusted odds ratios with 95% confidence intervals. *Middle panel*, odds ratios adjusted for calendar year, age, CCI, T stage, N stage, Gleason score, and prostate-specific antigen value at the time of diagnosis (Adjusted 1). *Right panel*, odds ratios adjusted for these covariates and the other individual/neighbourhood-level socioeconomic variable (Adjusted 2).

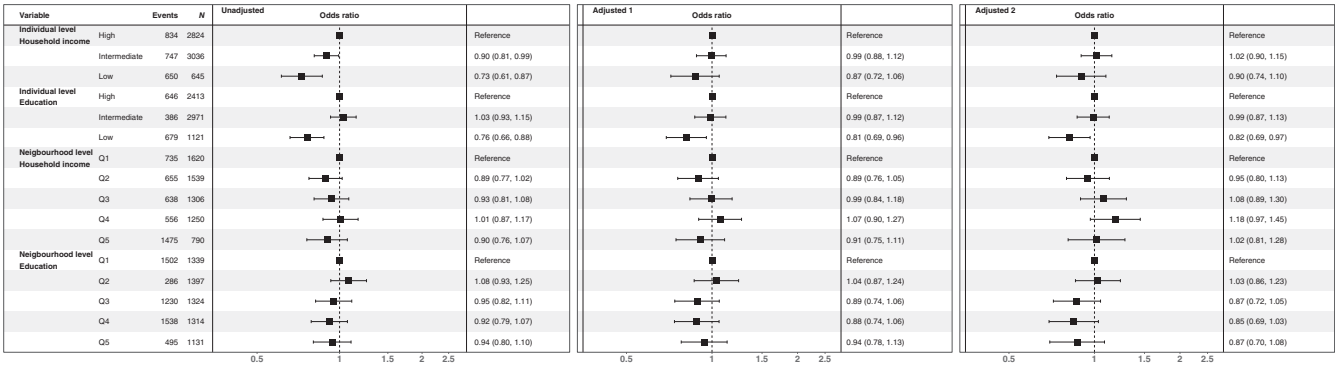

FIGURE 3 Associations between individual- and neighbourhood-level socioeconomic variables and having at least two dispensed prescriptions of treatment for erectile dysfunction within 1 year from radical prostatectomy among men aged <70 years without registered comorbidity. *Left panel*, unadjusted odds ratios with 95% confidence intervals. *Middle panel*, odds ratios adjusted for age, T stage, Gleason score, number of positive biopsy cores, prostate-specific antigen value, and healthcare region at the time of diagnosis (Adjusted 1). *Right panel*, odds ratios adjusted for these covariates and the other individual/neighbourhood-level socioeconomic variable (Adjusted 2).

4 | DISCUSSION

We conducted a nationwide register study to explore associations between socioeconomic factors (household income and education) and prostate cancer care in Sweden, using detailed cancer characteristics data, patient comorbidity data, and socioeconomic data on both individual and neighbourhood level. The outcomes included aspects specifically related to diagnostics, primary treatment, and rehabilitation, as well as an overarching cause-specific mortality outcome.

Crude differences across strata of individual and neighbourhood-level socioeconomic categories were greatest for pre-biopsy MRI. The unadjusted analyses with individual socioeconomic data revealed significant socioeconomic gradients for all four outcomes; after adjustment for cancer and patient characteristics, statistically significant differences remained for the intervention-specific outcomes but not for cause-specific mortality. On unadjusted neighbourhood-level data analysis, only differences in pre-biopsy MRI and primary treatment were significant and only pre-biopsy MRI remained statistically significant after adjustment.

We estimated HRs also after adjustments for cancer characteristics, age, and comorbidity (Adjustment 1). Some of these covariates may be mediators of the influence of socioeconomic factors on cancer outcomes, some may be confounders, and some may be both a mediator and a confounder. For example, a higher cancer-specific mortality in men with low income could be mediated by that these men are less likely to obtain screening and medical care for early cancer symptoms, and therefore are more likely to be diagnosed with advanced cancer than men with higher income. Comorbidity may act as both a mediator and a confounder: a mediator because the severe comorbidity may be a contraindication to effective cancer treatment; a confounder because chronic diseases may also restrict the chances of obtaining academic education. Age is a confounder because it is associated with both cancer-specific survival and educational level (younger Swedish men are more likely to have a high education than older men [Statistics Sweden]).

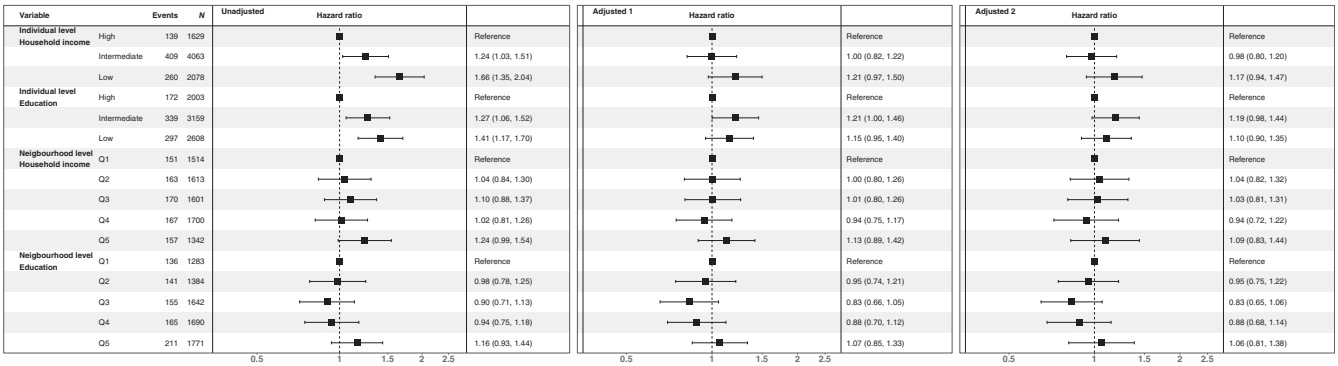

FIGURE 4 Associations between individual and neighbourhood-level socioeconomic variables and cancer-specific survival in men aged <80 years with Charlson Comorbidity Index (CCI) 0–2 diagnosed with high-risk non-metastatic prostate cancer in 2010–2015. *Left panel*, unadjusted hazard ratios with 95% confidence intervals. *Middle panel*, hazard ratios adjusted for year, age, CCI, T stage, Gleason score, prostate-specific antigen value, and healthcare region at the time of diagnosis (Adjusted 1). *Right panel*, hazard ratios adjusted for these covariates and the other individual-/neighbourhood-level socioeconomic variable (Adjusted 2).

The attenuation of the HRs in the adjusted analyses thus indicates that men with low income or education had more unfavourable prognostic characteristics at the time of diagnosis, but that their results from management did not substantially differ from men with high income and education with similar cancer characteristics, age, and comorbidity. Adjustment for relevant covariates is clearly essential to evaluate whether poorer survival in socioeconomically unfavoured cancer patients are predominately mediated by delayed diagnosis leading to worse tumour characteristics at the time of diagnosis and that they have a higher comorbidity burden, or disparity in choice of treatment related to their socioeconomic status as such.

Few previous studies have investigated the influence of socioeconomic factors on cancer-related outcomes for such a wide span of clinical outcomes on a nationwide level with adjustment for so many cancer characteristics based on both individual- and neighbourhood-level socioeconomic analysis. In a systematic review of socioeconomic differences in cancer care in the Nordic countries published in 2022,[1] all but 3 of 98 included studies were based on individual socioeconomic data only. The three exceptions that used both neighbourhood level and individual data were conducted by same Swedish research group and included patients with prostate,[13] lung,[14] and cervical cancer[15] diagnosed between 1990 and 2008. The risk of prostate cancer death was higher in men residing in deprived neighbourhoods (three categories, OR for high vs. low deprivation: 1.64), in men with low family income (four categories, OR for low vs. high income: 1.49), and in men with short education (three categories, OR for low vs. long education: 1.23).[13] These results are difficult to compare with ours because men with all stages were merged without adjustment for cancer characteristics.

Only one of the Nordic studies adjusted for as many cancer-related characteristics as we did: a regional Swedish study of almost 10,000 women diagnosed breast cancer in 1993–2003.[16] Based on a different analytic approach, precluding a direct comparison, adjusted HRs for breast cancer death were similar to our findings for prostate cancer death. Another Swedish study of 74,643 men with prostate cancer (all stages) found evidence of socioeconomic gradients for eight clinical outcomes, but no adjustment for cancer characteristics was done.[17]

In addition to the studies included in the Nordic systematic review,[1] we could identify three other studies that used both individual and neighbourhood-level socioeconomic characteristics to assess cancer outcomes, all conducted by the same research group and based on a single population from England and Wales.[18–20] They used individual-level data from a longitudinal census study of a 1% random sample of the population and applied them to people diagnosed with common malignancies in 2008–2016 without adjustment for cancer characteristics. Small differences in net mortality and excess mortality by income and education were observed, with similar results on both individual and neighbourhood-level socioeconomic data analysis.[19,20] Differences in outcomes and analyses preclude direct comparison with our findings.

A systematic review published in 2022 summarised socioeconomic differences in prostate cancer treatment.[5] Most reviewed studies were of men with localised disease. Men with intermediate- and high-risk cancer were analysed together with men with low-risk cancer, for whom surveillance is now considered the best option. In contrast, we chose to study men younger than 80 years with high-risk cancer only, for whom radical treatment is the main option. None of the studies in the systematic review adjusted for as many cancer characteristics as we did. Despite this, most of the ORs for treatment of men with low versus high income or education were smaller in the systematically reviewed studies than the corresponding ORs in our study.

Our comparison between individual and neighbourhood-level socioeconomic data analysis showed that individual-level analysis resulted in more pronounced gradients across the socioeconomic strata than neighbourhood-level analysis, except for diagnostics (pre-biopsy MRI) where neighbourhood-level results agreed well with individual-level results in showing a wide socioeconomic gradient. Previous Swedish studies have shown that neighbourhood level

analysis can be valuable for revealing socioeconomic differences in early detection of cancer.[21,22] For prostate cancer, population-based studies have addressed influence of socioeconomic characteristics (education) on early detection by individual rather than neighbourhood level analysis.[23–25] We were unable to find other population-based studies investigating the influence of income or education on the use of pre-biopsy MRI, but racial and geographical disparities have been reported from the United States.[26–28]

In many countries, individual-level data are not available for the entire population, so neighbourhood-level data are more commonly used for the assessment of socioeconomic inequity in cancer care.[6] For example, the Index of Multiple Deprivation for small neighbourhood areas was used to evaluate disparities in cancer incidence and mortality in England between 2001 and 2016.[29] Considerably higher incidences of prostate cancer were observed in the deprived than in the non-deprived areas, but there was no significant difference in prostate cancer mortality.

In the Nordic countries and in some other countries, individually unique identifiers (personal identification numbers) provide an opportunity to cross-link diagnosis-specific quality registries to population registries to obtain individual-level socioeconomic data.[1,8] This approach is time consuming and requires consideration of the General Data Protection Regulation (GDPR). Even if collection of individual socioeconomic data is feasible for research, neighbourhood data are preferable for surveillance of healthcare inequities because of easier access.[30] Our results support that neighbourhood-level socioeconomic data are appropriate for surveillance of healthcare inequalities in the diagnostic phase of prostate cancer, but not for assessing inequalities in later specialist management. We encourage further studies on socioeconomic inequality in early detection of prostate cancer with neighbourhood-level socioeconomic data.

Neighbourhood-level data represent proportions of residents in defined geographical areas with a specified individual socioeconomic characteristic, such as academic education. The geographical areas are often, as in our study, grouped in quintiles. It must be kept in mind that some people with apparently advantaged individual-level socioeconomic status reside in areas belonging to the most deprived quintile and vice versa. As an example, in our neighbourhood level analysis on pre-biopsy MRI as many 18% of the men diagnosed with prostate cancer living in a neighbourhood within the lowest quintile of education had an academic education. Neighbourhood-level socioeconomic characteristics should, however, not be viewed merely as a proxy for individual socioeconomic characteristics. Neighbourhood contexts possess specific social attributes that can affect lifestyle and health behaviours,[31] so individual and neighbourhood-level socioeconomic variables reflect different aspects of inequity.[18] If both individual- and neighbourhood-level socioeconomic data are available, researchers may consider using both in their analysis.

Strengths of our study include the use of data retrieved from high-quality population-based registers containing detailed individual-level information, the availability of socioeconomic data both on neighbourhood and individual levels, and the assessment of four different outcomes reflecting a wide range of cancer care. The generalisability of our results may, however, be limited to affluent countries with similar public healthcare systems. Moreover, compared to many other countries, the Swedish society is characterised by relatively small population differences in income and education[4]; the socioeconomic gradients in cancer care outcomes are probably more pronounced in countries with greater socioeconomic population differences.

5 | CONCLUSIONS

This nationwide Swedish register study explored associations between socioeconomic factors (household income and education) and prostate cancer care outcomes. Using individual-level socioeconomic data, significant socioeconomic gradients were observed for all four outcomes, spanning from diagnostics to cause-specific mortality. After adjustment for detailed cancer characteristics, age, and comorbidity, statistically significant socioeconomic gradients remained for all outcomes except cancer-specific mortality. This indicates that men with low income or education had more unfavourable prognostic characteristics at the time of diagnosis, but that their results from management did not substantially differ from men with high income and education with similar cancer characteristics, age, and comorbidity. Our comparison between individual and neighbourhood-level socioeconomic data analysis showed that individual level analysis resulted in more pronounced gradients across the socioeconomic strata than neighbourhood level analysis, except for diagnostics (pre-biopsy MRI) where neighbourhood level results agreed well with individual level results. No significant association was found on neighbourhood level analysis for sexual rehabilitation or cancer-specific mortality. This suggests that neighbourhood-level socioeconomic data are more useful for evaluating inequality in diagnostics than in later specialist cancer care.

AUTHOR CONTRIBUTIONS

Ulf Strömberg and Ola Bratt: Guarantors of the article. Specific author contributions—**Ulf Strömberg:** Conceptualization; methodology; data curation; investigation; visualisation; funding acquisition; writing—original draft; review and editing. **Anders Berglund:** Conceptualization; methodology; formal analysis; data curation; visualisation; writing—review and editing. **Stefan Carlsson:** Conceptualization; writing—review and editing. **Camilla Thellenberg Karlsson:** Conceptualization; writing—review and editing. **Mats Lambe:** Conceptualization; writing—review and editing. **Ingela Franck Lissbrant:** conceptualization; writing—review and editing. **Pär Stattin:** conceptualization; data curation; writing—review and editing. **Ola Bratt:** Conceptualization; methodology; data curation; investigation; visualisation; funding acquisition; writing—original draft; review and editing. The work reported in the article has been performed by the authors, unless clearly specified in the text.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

DATA AVAILABILITY STATEMENT

Data used in our study was extracted from the Prostate Cancer data Base Sweden (PCBaSe), which is based on the National Prostate Cancer Register (NPCR) of Sweden and linkage to several national health-data registers. The corresponding author can facilitate access to the data that support the findings of our study upon reasonable request. For detailed information (registration forms, manuals, etc.), please see www.npcr.se/in-english.

ETHICS STATEMENT

The study was approved by the Swedish Ethical Review Authority (reference number: 2022-01944-02).

ORCID

Ulf Strömberg https://orcid.org/0000-0002-6373-1973

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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