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Abstract

Background: Socioeconomic inequalities exist in each cancer-related aspect globally, but the evidences were relatively fragmented and unsystematic, even within high-income countries with more in-depth data. We aim to assess disparities in cancer stage at diagnosis, treatment, and mortality by socioeconomic status (SES) in Finland to assess inequalities in the whole cancer journey.

Methods: All Finnish residents aged 30 years or older and newly diagnosed with cancer between 2000 and 2020 were included in this study, and information including date of diagnosis, cancer type, stage, and treatments, was extracted from the Finnish Cancer Registry. Mortality, SES (education and income) and other demographic characteristics was extracted from the Population Register. Odds ratios (OR) of diagnosed with early stage or later stage, and receiving specific treatment or not across SES groups were estimated using adjusted logistic regression models. The differences of mortality in low and high SES groups were shown in hazard ratios (HR) estimated using adjusted Cox models.

Finding: Totally 377,986 Finnish residents were newly diagnosed with cancer (191,341 men and 186,645 women) between 2000 and 2020. Systematic disparities were observed in stage at diagnosis, treatment and mortality in overall cancers and subtypes of cancers, such as prostate, breast, melanoma, and uterine cancer. Patients with high education had 10–16% higher probabilities of being diagnosed with early-stage cancer than people with low education for overall cancer types in both men (OR=1.14, 95% CI=1.11–1.16) and women (OR=1.11, 95% CI=1.10–1.13). Patients with high education had 12–18% higher probabilities to receive surgery (men: OR=1.18, 95% CI=1.15–1.20; women: OR=1.18, 95% CI=1.15–1.21) comparing with patients with low education. Patients with high education had consistently around 20% lower mortality comparing to patients with low education for overall cancers (men: HR=0.79, 95% CI=0.77–0.81; women: HR=0.80, 95% CI=0.78–0.82). Similar patterns were observed across groups with different levels of income.

Conclusions: Systematic disparities throughout the cancer journey exist across SES groups in Finland, with low SES people often disadvantaged in cancer stage at diagnosis, treatment, and mortality.

Keywords: Socioeconomic inequalities; Education; Income; Stage at diagnosis, Treatment; Mortality

Introduction

Cancer is a complex disease with disparities at individual, societal and national level[1,2]. Social inequalities in cancer diagnosis, treatment and survival have been studied and reported globally in recent decades[3–16], even if the results are mostly fragmented and unsystematic. Disparities have been observed not only between countries but also within high-income countries, despite their investments in social security systems, widely accessible high-quality health care and health insurances[17–21]. The European Union (EU) launched the "Europe's Beating Cancer Plan" in 2022, one of its key objectives of which is to reduce cancer disparities across the EU[22]. In addition to promoting healthy lifestyles, equal access to health care services and early cancer detection across socioeconomic status (SES) groups is essential to achieve this goal. Detailed knowledge of disparities in cancer stage at diagnosis, treatment received, and survival is urgently needed.

In countries with universal health care systems, people with higher SES are shown to be more likely to receive cancer diagnosis at earlier stages, undergo more comprehensive or radical treatments, and have better overall survival rates[9,23–25]. Studies from Nordic countries found systematic socioeconomic inequality in cancer stage, treatment, and survival in breast cancer, lung cancer, colorectal cancer and Non Hodgkin Lymphoma[26]. However, prior studies have investigated either general patterns of overall cancer or focused on specific cancer sites and treatments, and no single study systematically investigated the disparities in stage at cancer diagnosis, cancer treatment, and mortality outcomes simultaneously. Consequently, current knowledge about cancer-related disparities is fragmented, and a more comprehensive understanding of inequalities throughout the whole cancer journey is needed. To achieve this, it is essential to simultaneously investigate diagnosis, treatment, and survival across both all-cause cancers and specific cancer types covering the entire population of target country.

In the context of Finland, previous studies have primarily focused on disparities in survival across SES groups for prostate, breast and colorectal cancers, while there is no available evidence on differences in stage at diagnosis, treatments and survival, covering overall cancers or important cancer types, such as lung cancer and melanoma on national level[27–33]. Thanks to the exhaustive Finnish register data covering the entire population over decades, it is possible to track the complete cancer history and survival outcome of individuals, enabling research on SES disparities in the cancer journey without the limitations of self-report bias or loss to follow-up. This study aims to provide an integrated and detailed analysis of disparities across SES groups on various cancer-related aspects, contributing to a more cohesive and comprehensive understanding of these inequalities in Finland, and offer inspiring insights for mitigating existing cancer inequalities in European countries.

Materials and Methods

Study design

This study was based on the total residents in Finland who were aged 30 years or older between 2000 and 2020. Information on gender, educational level, income, marital status and origin background was extracted from the population register of Statistics Finland.

We identified primary cancer diagnoses between 2000 and 2020 with the information of cancer site (according to the International Classification of Diseases for Oncology edition 3rd, ICD-O-3), stage, and anti-cancer treatments (surgery, radiotherapy, chemotherapy and other therapies) in the Finnish Cancer Registry (1953–2021). Individuals diagnosed with cancer before year 2000 were excluded from the study. We analyzed overall cancer and five most common site-specific cancers separately, including breast, prostate, colorectal, melanoma, uterine, and lung cancers in men and women, grouping all other cancers into a residual category. We considered only the first cancer diagnosis for each individual during the follow-up.

Definition of key covariates

Educational level was based on the highest attained qualification before cancer diagnosis. We classified educational level according to International Standard Classification of Education (ISCED-2011) as low (ISCED 0-2), medium (ISCED 3-4), and high education (ISCED 5-8). Information of disposable personal income was based on the salary, entrepreneur and property income, and current transfers received after taxes. We adjusted personal income for inflation and calculated the five-year average before the year in which the individual was diagnosed with cancer. In the analysis, income was classified into low, medium and high based on terciles within five-year age groups. Other covariates included age at cancer diagnosis (linear, square, and quadratic terms), year of diagnosis, year of birth, marital status (married, widowed, divorced, and never married), origin (Finnish background: at least one parent born in Finland, foreign background: both parents born abroad), region of residence (totally 19 regions), and urbanization level of the municipality of residence (urban, semi-urban, and rural). For individuals diagnosed with cancer, all covariates were measured from the year preceding cancer diagnosis.

Statistical methods

The characteristics of cancer cases were shown in mean and standard deviation (SD), or counts and percentages. For overall cancer and five most common cancer types in men and women, we used logistic regression models to estimate the odds ratios (OR) of being diagnosed with early-stage compared to late-stage cancer for high and medium SES groups comparing with low SES groups, adjusted for age at cancer diagnosis, year of diagnosis, year of birth, marital status, origin, region of residence, and level of urbanization of the municipality of residence stratified by cancer types. For overall-cancer models, cancer type was adjusted as a dummy factor. Individuals with missing information of stage at diagnosis were excluded from the modeling. Logistic regression models were used to estimate the OR of receiving a specific treatment (surgery, chemotherapy, and radiation) compared with not receiving that treatment for high and medium SES groups comparing with low SES groups, adjusted for covariates and stage at diagnosis (samples with missing information of stage were included). Individuals with missing information of treatment were excluded from the modeling.

Cox proportional hazards regression was used to model hazard ratios (HR) for mortality across SES groups for overall cancer and site-specific subtypes. Cox models were adjusted for age at diagnosis, year of diagnosis, stage at diagnosis treatments, year of birth, marital status, origin, region of residence, and level of urbanization of the municipality of residence stratified by cancer types. For overall-cancer models, cancer type was adjusted. The follow-up time were cut at 10 years after cancer diagnosis or December 31, 2020, whichever came first.

In order to distinguish the individual effects of education and income, such that in the main analysis above, only education was reported (M1). In order to explore the confounding effects, we conducted sensitivity analyses by adjusting income in model (M2), and further adjusting their interactions in the model (M3) to examine how the main effect changed from the main model. Because a large proportion of cancer diagnoses and treatments had missing information in the registry, we conducted sensitivity analyses to look at the missing patterns by SES level using logistic regression models adjusted for the same covariates. All analyses were conducted using R (version 4.3.1)[34].

Results

Sample Characteristics

Table 1 describes the summary statistics for the total sample, and for men and women separately. There were in total 384,441 people newly diagnosed with cancer (194,283 men and 190,158 women) between 2000 and 2020. The average age at diagnosis was 66.4 (standard deviation, SD=12.4) years, with slightly older age for men (67.8, SD=11.3) than for women (65, SD=13.3). For education levels, 47.1%, 28.4%, and 24.5% of men were classified respectively with low, medium, and high education levels. Women had higher educational attainment with about 41.8%, 30.6%, and 27.6% respectively. Using terciles by age groups, there were about 25.3% men with low income, 36.7% with medium income, and 38.1% with high income; for women, the proportions were 30.3%, 32.9%, and 36.8% respectively. The most prevalent cancer types were prostate (42.7%) and colorectum (10.6%) cancer in men and breast (40.7%) and colorectum (10.1%) in women. Among all patients, 65.1% received surgery, with proportions differing by gender: 52.4% of men and 78.1% of women underwent surgery. Conversely, 20% of all patients did not receive surgical treatment, with higher proportions in men (29.7%) compared to women (10.2%). Information on surgical treatment was missing for 16.6% of patients overall, with missing data being more common among men (17.9%) than women (11.7%). During the study period, 51.3% of the patients died (57.1% men and 45.4% women). The number of different cancer cases and crude rate for different SES levels were shown in Supplementary Table 1 and 2.

Stage at Diagnoses

In Figure 1, for both men and women, higher SES was generally associated with higher odds of being diagnosed with early cancer stages. Men with higher education had higher likelihood of being diagnosed earlier for overall cancer (OR: 1.14, 95% CI: 1.11–1.16) and, consistently, for prostate cancer (OR: 1.24, 95% CI: 1.20–1.28), colorectal cancer (OR: 1.07, 95% CI: 1.00–1.15), and melanoma (OR: 1.23, 95% CI: 1.12–1.36)). For women, higher SES was similarly linked to early diagnosis in all-cause cancer for education (OR: 1.11, 95% CI: 1.10–1.13), with similar patterns showed for breast cancer (OR: 1.18, 95% CI: 1.15–1.20), melanoma (OR: 1.25, 95% CI: 1.13–1.37), and uterine cancer (OR: 1.24, 95% CI: 1.15–1.34). For lung cancer, higher educated women had lower likelihood to be diagnosed as early stage (OR: 0.79, 95% CI: 0.74–0.85). Similar patterns were observed across income levels (Supplementary Figure 1).

Treatment

In Figure 2, for both men and women, higher SES was generally associated with higher odds of being treated with surgery across different cancer stages. For men, higher education was consistently linked to greater odds of receiving surgery for overall cancer (OR: 1.18, 95% CI: 1.15–1.20). Similar trends were observed across specific cancer types. For prostate cancer, higher education (OR: 1.27, 95% CI: 1.23–1.31) was strongly associated with undergoing surgery. For lung cancer, education (OR: 1.18, 95% CI: 1.11–1.25) was also positively associated with surgical treatment. Colorectal cancer showed similar patterns, with higher education (OR: 1.14, 95% CI: 1.03–1.26linked to increased odds of surgery. Bladder cancer showed even stronger associations, as education (OR: 1.30, 95% CI: 1.09–1.55) significantly predicted higher likelihoods of surgery. In contrast, for melanoma, the association with surgery was weaker, with education showing no significant effect (OR: 0.96, 95% CI: 0.75–1.24). Similar patterns were observed across income levels for both men (Supplementary Figure 2).

For women, higher education was consistently linked to greater odds of receiving surgery for overall cancer (OR: 1.18, 95% CI: 1.15–1.21). Similar patterns were also observed across specific cancer types : uterine cancer (OR: 1.56, 95% CI: 1.38–1.75), lung cancer (OR: 1.48, 95% CI: 1.37–1.59), colorectal cancer (OR: 1.25, 95% CI: 1.14–1.37) and breast cancer (OR: 1.24, 95% CI: 1.15–1.34). No significant association were observed for melanoma (OR: 1.06, 95% CI: 0.77–1.47). Similar patterns were observed across income levels for women (Supplementary Figure 2).

For other therapies of cancer, as shown in Figures 3 and 4, men with high education were linked to higher rates of chemotherapy (OR 1.07, 95% CI: 1.05–1.10) and radiation therapy (OR 1.04, 95% CI: 1.02–1.06) for overall cancers. Women with high education were linked to a higher likelihood of receiving chemotherapy (OR 1.04, 95% CI: 1.02–1.05) but not radiation therapy. While stratified by cancer types, men with high education were linked to higher rates of chemotherapy for lung cancer (OR 1.31, 95% CI: 1.24–1.38) and colorectal cancer (OR 1.08, 95% CI: 1.02–1.16); and linked to higher rates of radiation therapy for prostate cancer (OR 1.12, 95% CI: 1.08–1.15) and melanoma (OR 1.17, 95% CI: 1.04–1.30). No significant association was observed between high education and chemotherapy or radiation therapy for specific cancer types in women. As shown in Supplementary Figures 3 and 4, opposite patterns were observed in men across income levels, while men with higher education were linked to lower rates of chemotherapy (OR 0.93, 95% CI: 0.92–0.95) and radiation therapy (OR 0.92, 95% CI: 0.91–0.94) for overall cancers and several cancer types. For women, higher income was associated with lower rate of radiation therapy for overall cancers (OR 0.95, 95% CI: 0.93–0.97) and melanoma (OR 0.77, 95% CI: 0.69–0.87). Higher income was not associated with chemotherapy in women for overall cancers, but associated with lung cancer (OR 1.11, 95% CI: 1.02–1.21) and melanoma (OR 0.82, 95% CI: 0.72–0.93).

Survival

In Figure 5, higher SES was generally associated with lower mortality in overall cancer. For men, higher education was consistently associated with lower mortality risk for all cancers combined (HR 0.79, 95% CI 0.77–0.81). This protective effect of higher education was observed in all site-specific cancer types prostate cancer (HR 0.73, 95% CI 0.70–0.76), colorectal cancer (HR 0.83, 95% CI 0.78–0.88), and bladder cancer (HR 0.81, 95% CI 0.73–0.90). Similar patterns were observed across income levels for men (Supplementary Figure 5).

For women, as with men, higher education was associated with reduced mortality risk for overall cancer (HR 0.80, 95% CI 0.78–0.82). This protective effect of higher education was observed in all site-specific cancer types. Higher education was particularly prominent for melanoma (HR 0.68, 95% CI 0.58–0.79), breast cancer (HR 0.73, 95% CI 0.69–0.77), uteri cancer (HR 0.77, 95% CI 0.69–0.86), colorectal cancer (HR 0.87, 95% CI 0.80–0.93) and lung cancer (HR 0.83, 95% CI 0.76–0.90). Similar patterns were observed across income levels for women (Supplementary Figure 5).

Sensitivity analysis

While education and income were adjusted in the model, as shown in M2 in Supplementary Figures 6–10, the main effects of education and income were relatively similar to when only one SES measure was included in the model (M1). Even when the interaction term for education and income was included in the model (M3), the main effects of education and income remained comparable to their effects in M1. These results indicate that education and income might be correlated with each other, but their main effects are mutually different from each other hence capturing different facets of individual SES.

For the sensitivity analysis of missing, information on stage at diagnosis was shown in supplementary Table 3. For overall cancer, high SES was associated with a lower chance of having missing information of stage among men (education OR: 0.95, 95% CI: 0.94–0.96; income OR: 0.91, 95% CI: 0.90–0.92) and women (education OR: 0.76, 95% CI: 0.66–0.87; income OR: 0.81, 95% CI: 0.76–0.88). For the sensitivity analysis of missing information on treatments (Supplementary Table 4), high SES was associated with a higher likelihood of missing treatment data for overall cancer for both men (education OR: 1.05, 95% CI: 1.03–1.06; income OR: 1.19, 95% CI: 1.17–1.21) and women (education OR: 1.05, 95% CI: 1.03–1.07; income OR: 1.13, 95% CI: 1.10–1.15).

Discussion

The findings indicate that men and women with higher SES (income and educational attainment) generally have improved cancer outcomes across diagnosis, treatment, and survival. Nevertheless, variations by cancer type and treatment type emerged. Women with higher SES were more likely to be diagnosed at an early stage with cancers of breast, melanoma, and uterus, a pattern that parallels findings for men, where higher SES also correlated with earlier diagnoses of prostate, colorectal, and melanoma cancers.

These findings align with a prior study that analyzed population-based cancer registry data from USA (1973–2001) on 26,844 matched cancer patients, which similarly found that lower education and income levels were associated with late-stage diagnoses, particularly for breast and prostate cancers[7]. Smaller clinical case studies have also observed similar patterns[5,6,23]. Our study, however, differs by utilizing the national Finnish cancer registry, representing all cancer patients in Finland to explore SES-related differences in cancer diagnosis. The differentials in the stage at which cancer is diagnosed might relate to accessibility, awareness, or participation in cancer screening programs in different SES groups. For breast cancer screening in the Netherlands, women with medium and high education had 50% and 80% higher chances to attend mammography screening than lower educated women[35] and similar patterns were observed in USA[36]. The case of prostate cancer is more complex. There are some debates about the benefits and costs of screening in general population, so that screening recommendations vary considerably by country, and evidence of overdiagnosis and overtreatment were reported in Europe. Regardless, screening uptake is lower among patients with low SES in different health care settings[37,38]. Although participation rates in colorectal cancer screening programs vary worldwide, population with low SES consistently have lower adherence within each country[39]. Similarly, significant persistent disparities exist between women with different levels of education across European countries[40].

For cancer treatment, women with higher SES were more likely to get treated, with particularly high odds in the case of uterine, breast, and colorectal cancers. For men, higher SES was similarly associated with greater likelihood of receiving treatment across all cancer stages, especially for prostate, lung, and bladder cancers. These findings are consistent with previous research on prostate[8], breast[23,41,42], and colorectal cancers[43], but differ from findings based on the Netherlands Cancer Registry, which reported no SES effect on the likelihood of surgery for breast cancer[14].

For survival, higher SES consistently associated with lower mortality across all cancer types for both men and women, with particularly significant results for prostate, breast, and colorectal cancers. These survival patterns are consistent with findings from studies in Southeast England across cancer types[13], in Canada for overall cancers[9], and for specific cancers like prostate[13], breast[23], and lung[21].

To our best knowledge, this is the first systematic study estimating SES differentials among cancer patients. Our research addresses this by examining patterns across the entire cancer journey, from diagnosis to treatment and survival outcomes. Moreover, our study benefits from the use of the Finnish Cancer Registry data, that stands out for its comprehensive coverage and high completeness with standard cancer topological and histological codes and detailed treatment information since 1952. This longitudinal data supports in-depth analyses on patterns of cancer diagnosis, treatments, and survival outcomes, not available in other contexts. Unlike studies using indirect SES measures, such as deprivation indexes[8], Medicaid enrollment and census tract poverty levels[42], postal code average income[14,23], and average household income at a neighborhood[43], our study uses direct patient level education and income data to explore treatment differentials, which was not fully in current literature.

Nevertheless, there are several limitations in this research that should be considered when interpreting the findings. One key limitation is the absence of data on mechanisms associated with cancer risk, such as lifestyle factors, environmental exposures, and biological susceptibilities. Additionally, the study does not account for the comorbidity of other chronic diseases for cancer risks and treatments. For example, patients with low SES might have more health conditions than high SES groups that can affect treatment decisions and efficacy, and survival chances. Another limitation, although common in many studies, relates to the measurement of SES. While personal income is used in this study, household income might be a better indicator of available material resources, but this is often unavailable for institutionalized individuals, who are typically older and at higher risk of cancer. Moreover, it is common that the stage at diagnosis and treatment have high proportion of missing information in registry data. We applied sensitivity analysis on missing information of cancer stage and treatments. Finally, the relationship between education and income is complex and not easy to disentangle. We performed sensitivity analyses to test whether educational attainment and income capture the same SES dynamics, first including both SES factors, and then including the interaction terms in the models. The results were relatively stable, but further investigation is needed.

The findings that higher SES correlates with earlier diagnosis, higher likelihood of treatment, and lower mortality, underscore the crucial role of SES in cancer treatment and, ultimately, survival. This evidence calls for policy interventions aimed at reducing SES-related disparities in the whole cancer journey. Potential mechanisms could be differences in screening programs and behaviors across SES. Lifestyle factors such as diet, exercise, smoking, and alcohol consumption are often correlated with SES and may significantly mediate the relationship between SES and cancer outcomes. This could include enhanced and targeted screening and early detection programs for lower SES population subgroups, improving access to quality treatment regardless of income or education level, promoting healthier life through education and community programs, and increasing cancer literacy through educational campaigns. Addressing these disparities has the potential not only to improve health outcomes for marginalized groups but also to contribute to the broader goal of equity in healthcare and to the overall improvement of public health, benefiting society as a whole in the long term.

Statements and Declarations

Ethical approval:

The use of data for this study was approved by the Statistics Finland Board of Ethics and the Social and Health Data Permit Authority Findata (permit numbers TK/3343/07.03.00/2023 and THL/499/14.06.00/2024). Statistics Finland pseudonymized the data prior to providing it to researchers.

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Competing Interests:

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions:

PL & XZ conceived the study. All authors contributed to the study conception and design. PM acquired the access to registry data. PL, XZ, LDB, KK MM (Moretti) and PM could access the registry data. PL organised the data and performed statistical analysis. All authors contributed in analysis and interpretation of data. XZ and PL wrote the first draft of the manuscript with the help of LDB and MM (Moretti). All authors edited and revised the manuscript for important intellectual content. MM (Myrskylä) and PM acquired funding and provided administrative and technical supporting.

Data sharing:

Due to data protection regulations of the national register holders providing the data, we are not allowed to make the data available to third parties. Interested researchers have the option to request data access by contacting the following register-holding public institutions:

- Statistics Finland (http://www.stat.fi/tup/mikroaineistot/index_en.html).
  Contact by email tutkijapalvelut(at)stat.fi.
- Findata (https://findata.fi/en/).
  Contact by email info(at)findata.fi.

The lead author (PL) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any deviations from the study as it was originally planned have been explained.

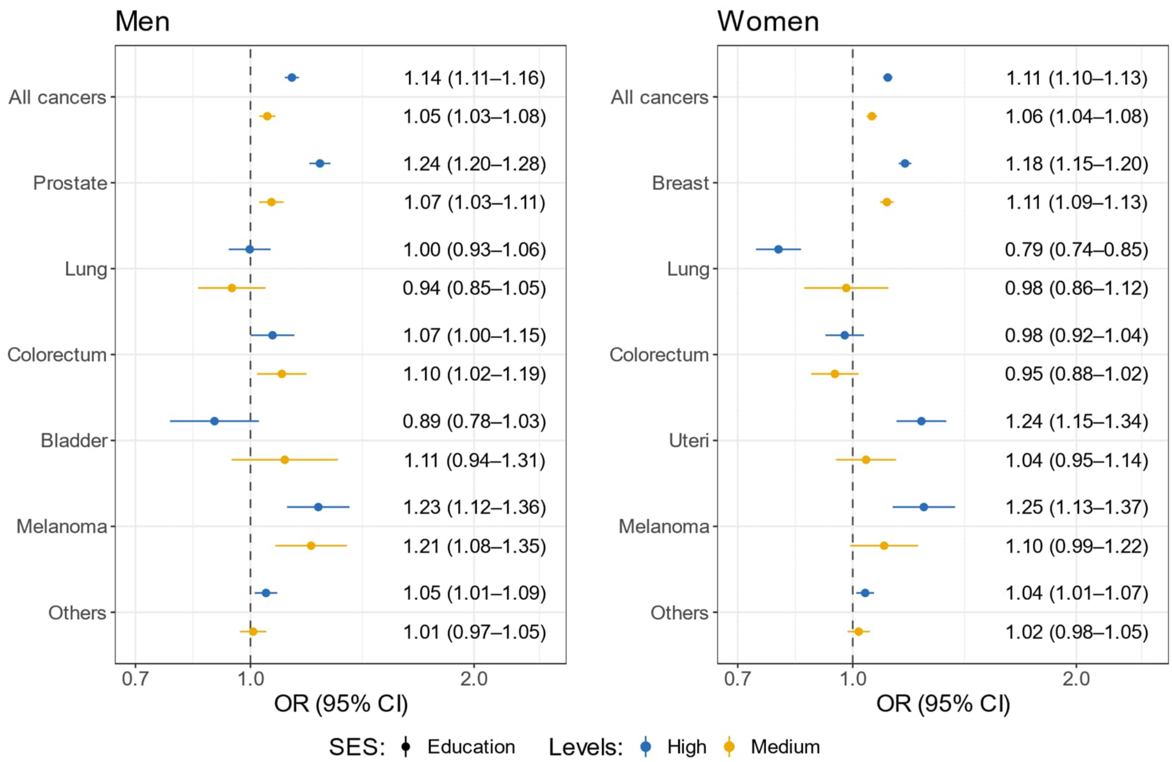
List of Tables and Figures

Table 1: Characteristics of the study population: newly diagnosed cancer cases during 2000-2020

	Total (N=384,441)	**Men** (N=194,283)	**Women** (N=190,158)
Marital status (N, %)			
Married	220,526 (57.36%)	128,135 (65.95%)	92,391 (48.59%)
Unmarried	49,032 (12.75%)	23,720 (12.21%)	25,312 (13.31%)
Divorced	58,367 (15.18%)	26,403 (13.59%)	31,964 (16.81%)
Widowed	56,516 (14.70%)	16,025 (8.25%)	40,491 (21.29%)
Education (N, %)			
Low	170,893 (44.45%)	91,500 (47.10%)	79,393 (41.75%)
Medium	113,395 (29.50%)	55,168 (28.40%)	58,227 (30.62%)
High	100,153 (26.05%)	47,615 (24.51%)	52,538 (27.63%)
Income (N, %)			
Low	106,728 (27.76%)	49,109 (25.28%)	57,619 (30.30%)
Medium	133,743 (34.79%)	71,212 (36.65%)	62,531 (32.88%)
High	143,970 (37.45%)	73,962 (38.07%)	70,008 (36.82%)
Origin background (N, %)			
Finnish	376,581 (97.96%)	190,723 (98.17%)	185,858 (97.74%)
Foreign	7,860 (2.04%)	3,560 (1.83%)	4,300 (2.26%)
Urbanization			
Urban	246,008 (63.99%)	119,876 (61.70%)	126,132 (66.33%)
Semi-urban	65,262 (16.98%)	34,269 (17.64%)	30,993 (16.30%)
Rural	73,171 (19.03%)	40,138 (20.66%)	33,033 (17.37%)
Age at diagnosis (mean, SD)	66.38 (12.38)	67.76 (11.25)	64.96 (13.29)
Cancer types (N, %)			
Bladder	8,349 (2.17%)	8,349 (4.30%)	NA
Breast	77,347 (20.12%)	NA	77,347 (40.68%)
Colorectum	39,782 (10.35%)	20,519 (10.56%)	19,263 (10.13%)
Lung	22,646 (5.89%)	14,818 (7.63%)	7,828 (4.12%)
Melanoma	19,164 (4.98%)	9,846 (5.07%)	9,318 (4.90%)
Others	120,768 (31.41%)	57,867 (29.78%)	62,901 (33.08%)
Prostate	82,884 (21.56%)	82,884 (42.66%)	NA
Uteri	13,501 (3.51%)	NA	13,501 (7.10%)
Cancer stage (N, %)			
Stage I-II	116,774 (30.38%)	70,206 (36.14%)	46,568 (24.49%)
Stage III-IV	126,854 (33.00%)	60,602 (31.19%)	66,252 (34.84%)

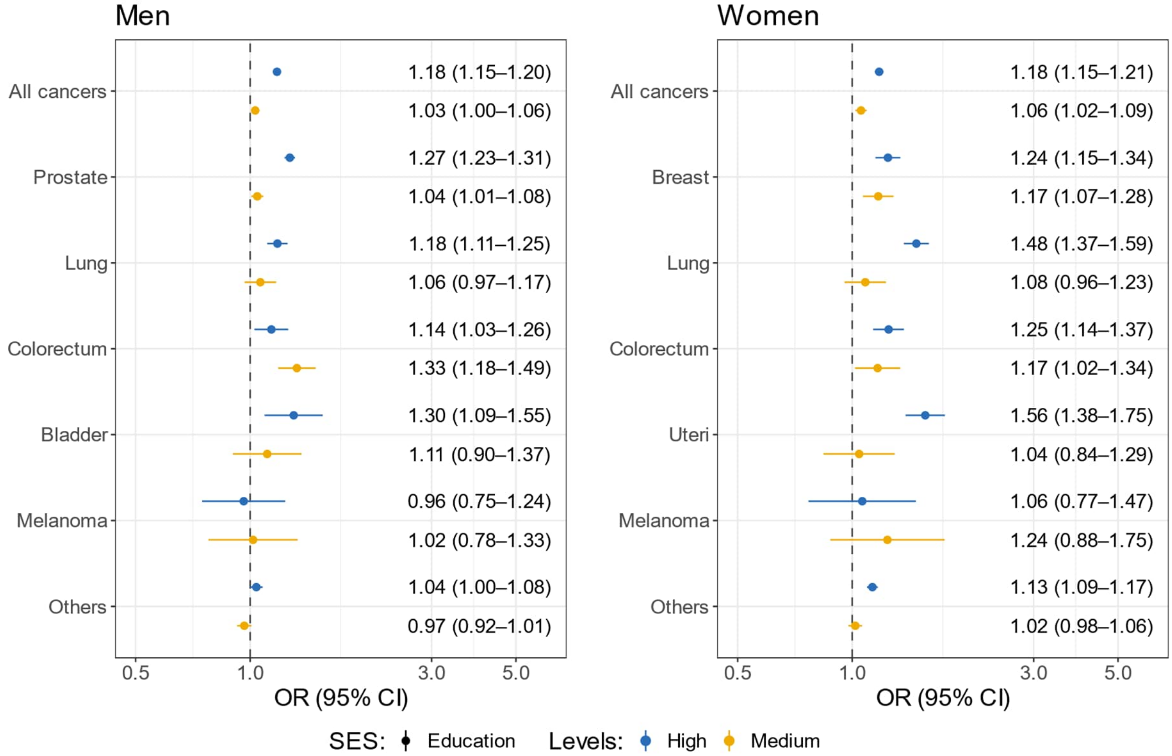
Missing	140,813 (36.63%)	63,475 (32.67%)	77,338 (40.67%)
Treatment: surgery			
No	77,203 (20.08%)	57,768 (29.73%)	19,435 (10.22%)
Yes	250,243 (65.09%)	101,819 (52.41%)	148,424 (78.05%)
Missing	56,995 (14.83%)	34,696 (17.86%)	22,299 (11.73%)
Treatment: radiation			
No	146,814 (38.19%)	73,656 (37.91%)	73,158 (38.47%)
Yes	173,937 (45.24%)	83,769 (43.12%)	90,168 (47.42%)
Missing	63,690 (16.57%)	36,858 (18.97%)	26,832 (14.11%)
Treatment: chemo			
No	167,500 (43.57%)	86,855 (44.71%)	80,645 (42.41%)
Yes	153,143 (39.84%)	70,428 (36.25%)	82,715 (43.50%)
Missing	63,798 (16.60%)	37,000 (19.04%)	26,798 (14.09%)
Number of deaths (N, %)	197,191 (51.29%)	110,885 (57.07%)	86,306 (45.39%)
Survival years (mean, SD)	6.20 (5.20)	5.85 (4.99)	6.56 (5.38)

Figure 1. Odds ratios (OR) of being diagnosed with early stage cancer (I-II) (ref. later stage (III-IV) cancer) across education groups



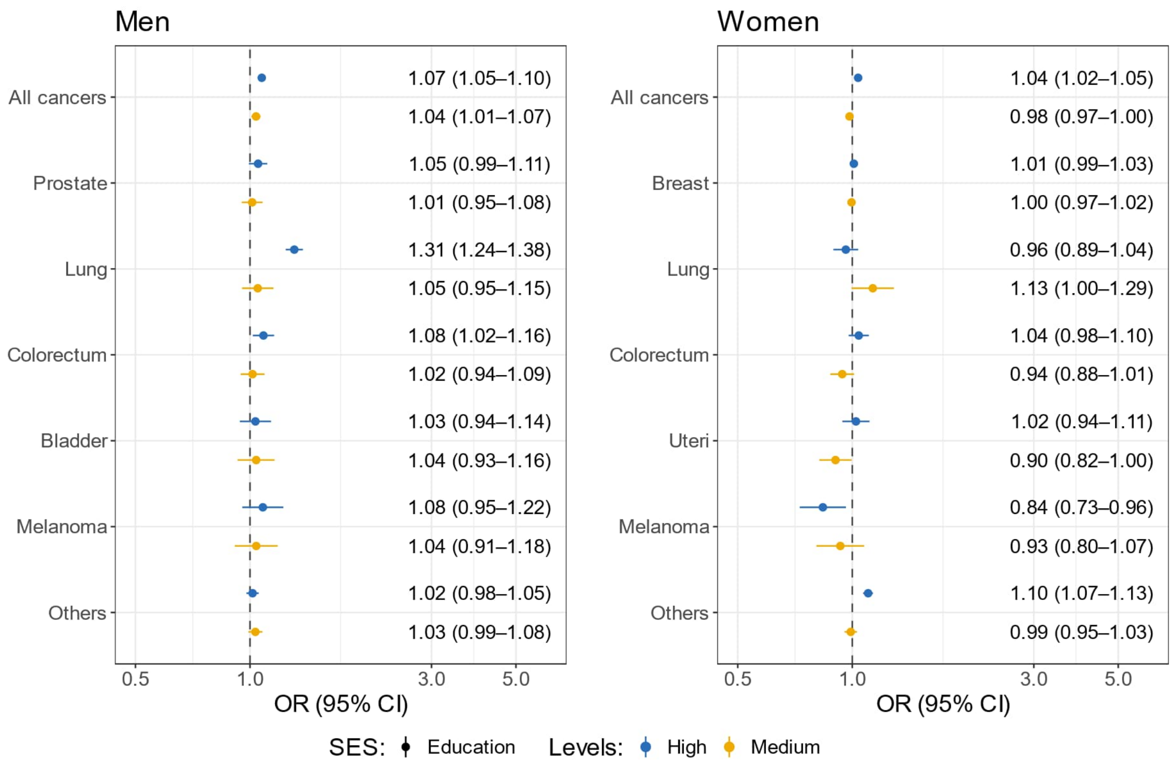
The models adjusted for age at cancer diagnosis, year at diagnosis, year of birth, marital status, origin, region of residence, urbanization of the region, and education level stratified by cancer types. For overall-cancer models, cancer type was adjusted as dummy factor. The dots with bars represent the odds ratios (ORs) and corresponding 95% confidence intervals (CIs) for being diagnosed with early-stage cancer among individuals with medium (yellow) and high (blue) education levels compared to those with lower education.

Figure 2. Odds ratios (OR) of being treated with surgery (ref. no surgery) across education groups



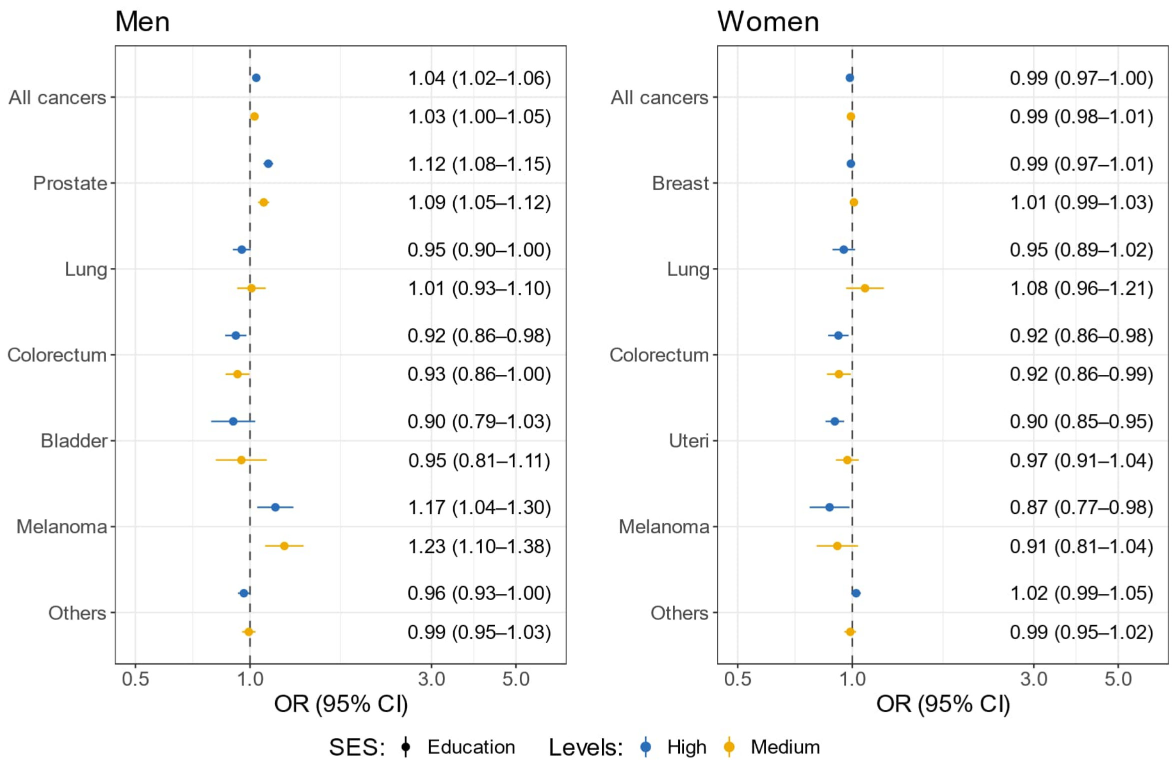
The models adjusted for stage at diagnosis, age at cancer diagnosis, year at diagnosis, year of birth, marital status, origin, region of residence, urbanization of the region, and education level stratified by cancer types. For overall-cancer models, cancer type was adjusted as dummy factor. The dots with bars represent the odds ratios (ORs) and corresponding 95% confidence intervals (CIs) for being treated with surgery among individuals with medium (yellow) and high (blue) education levels compared to those with lower education.

Figure 3. Odds ratios (OR) of being treated with chemotherapy (ref. no chemotherapy) across education groups



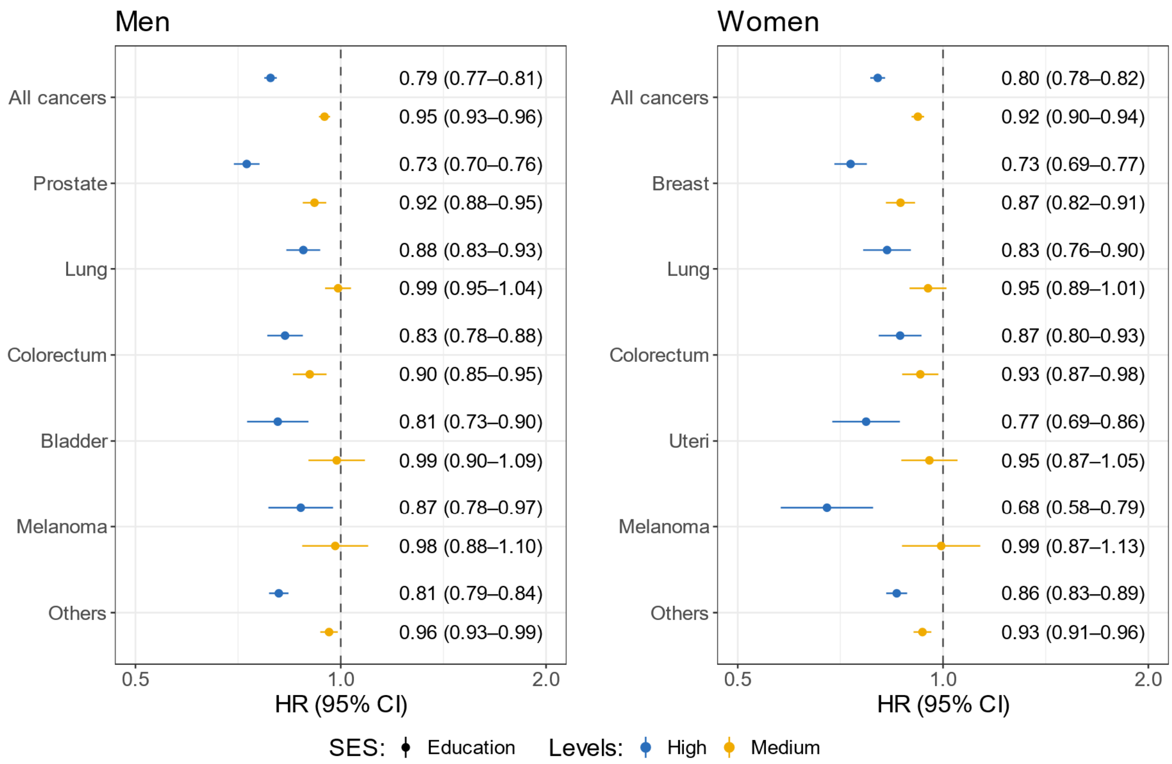
The models adjusted for stage at diagnosis, age at cancer diagnosis, year at diagnosis, year of birth, marital status, origin, region of residence, urbanization of the region, and education level stratified by cancer types. For overall-cancer models, cancer type was adjusted as dummy factor. The dots with bars represent the odds ratios (ORs) and corresponding 95% confidence intervals (CIs) for being treated with surgery among individuals with medium (yellow) and high (blue) education levels compared to those with lower education.

Figure 4. Odds ratios (OR) of being treated with radiation therapy (ref. no radiation therapy) across education groups



The models adjusted for stage at diagnosis, age at cancer diagnosis, year at diagnosis, year of birth, marital status, origin, region of residence, urbanization of the region, and education level stratified by cancer types. For overall-cancer models, cancer type was adjusted as dummy factor. The dots with bars represent the odds ratios (ORs) and corresponding 95% confidence intervals (CIs) for being treated with surgery among individuals with medium (yellow) and high (blue) education levels compared to those with lower education.

Figure 5. Hazard Ratio (HR) of all-cause mortality across education groups



The models adjusted for stage at diagnosis, treatment, age at cancer diagnosis, year at diagnosis, year of birth, marital status, origin, region of residence, urbanization of the region, and education level stratified by cancer types. For overall-cancer models, cancer type was adjusted as dummy factor. The dots with bars represent the odds ratios (ORs) and corresponding 95% confidence intervals (CIs) for mortality among cancer patients with medium (yellow) and high (blue) education levels compared to those with lower education.

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