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QUANTITATIVE RESEARCH

Trends in socio-economic inequalities in bladder cancer incidence in Canada: 1992–2010

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Abstract

Objectives Growing literature demonstrates widening socio-economic gradients in cancer incidence in different countries. However, few studies have measured the magnitude of socio-economic inequalities in the incidence of different types of cancers. This study aimed to evaluate socio-economic inequalities in bladder cancer incidence in Canada over time.

Methods Using data obtained from the Canadian Cancer Registry (CCR), the Canadian Census of Population (CCP), and the National Household Survey (NHS), we examined socio-economic inequalities of bladder cancer incidence among men and women in Canada from 1992 to 2010. Income- and education-related inequalities were measured using the concentration index (C) approach. We also analyzed the trends of income- and education-related inequalities over the study period.

Results There is an increasing trend in bladder cancer incidence in Canada. The estimated C suggested a higher incidence of bladder cancer among low socio-economic-status individuals. The results revealed that income-related inequality in bladder cancer incidence increased among the female population. Education-related inequality in the incidence of bladder cancer widened for both males and females in Canada.

Conclusion The concentration of bladder cancer in Canada is growing among the socio-economically disadvantaged population. Further studies are required to help elucidate causal relationships between socio-economic status and bladder cancer incidence in Canada.

Résumé

Objectifs L'élargissement des gradients socioéconomiques de l'incidence du cancer dans différents pays est de plus en plus attesté dans la littérature scientifique. Peu d'études ont toutefois mesuré l'ampleur des inégalités socioéconomiques dans l'incidence de différents types de cancers. Nous avons cherché à évaluer les inégalités socioéconomiques dans l'incidence du cancer de la vessie au Canada au fil du temps.

Méthode À l'aide des données du Registre canadien du cancer (RCC), du Recensement de la population canadienne (RPC) et de l'Enquête nationale auprès des ménages (ENM), nous avons examiné les inégalités socioéconomiques de l'incidence du cancer de la vessie chez les hommes et les femmes au Canada de 1992 à 2010. Nous avons mesuré les inégalités liées au revenu et au niveau d'instruction par la méthode de l'indice de concentration (C). Nous avons également analysé les tendances des inégalités liées au revenu et au niveau d'instruction sur la période de l'étude.

Résultats L'incidence du cancer de la vessie est en hausse au Canada. L'indice C estimatif indique une incidence supérieure du cancer de la vessie chez les personnes de faible statut socioéconomique. Selon les résultats que nous avons obtenus, les inégalités liées au revenu dans l'incidence du cancer de la vessie ont augmenté dans la population féminine. Les inégalités liées au niveau d'instruction dans l'incidence du cancer de la vessie se sont creusées chez les hommes et les femmes au Canada.

Conclusion La concentration des cancers de la vessie au Canada s'accentue dans les populations défavorisées sur le plan socioéconomique. Il faudrait pousser la recherche pour élucider les relations causales entre le statut socioéconomique et l'incidence du cancer de la vessie au pays.

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Mots-clés Inégalités · Revenu · Niveau d'instruction · Cancer de la vessie · Incidence · Tendances · Canada

Introduction

Despite major improvements in healthcare, there are still considerable inequalities in health worldwide that pose significant public health challenges (Marmot 2005). Many of these disparities can be attributed to differences in socio-economic status (SES), or one's socio-economic position in society (Chen and Miller 2013), which is commonly measured by social determinants of health such as education, income, and/or occupation status.

There is a global trend that people in the lower levels of social determinants are at a greater risk of having poorer health and health outcomes (Hajizadeh et al. 2016). There is an abundance of evidence that demonstrates this relationship for illnesses such as heart disease (Hawkins et al. 2012), lung disease (Sahni et al. 2017), poor mental health (Wang et al. 2010), cancer (Clegg et al. 2009), and many other diseases (Chen and Miller 2013; Evans and Kantrowitz 2002). Even more notable, lower SES is linked to an increase in all-cause mortality (Marmot 2005). These differences in health exist between countries of varying levels of development, as well as within countries, including Canada (Hajizadeh et al. 2016).

Recent data estimate that half of all Canadians will be diagnosed with cancer in their lifetime and that 25% of them will die from it, making cancer the most common cause of death in Canada (Canadian Cancer Society's Advisory Committee on Cancer Statistics 2017). Despite Canada's medical system providing universal healthcare for no direct cost to the patient, there is still evidence of socio-economic inequalities in both the incidence and mortality of cancers in Canada (Booth et al. 2010; Mackillop et al. 2000). Although it is generally assumed that lower SES correlates with an increase in the incidence of cancers, that relationship is not found for all cancers (Booth et al. 2010; Clegg et al. 2009; Mackillop et al. 2000). For example, lower SES is correlated with increased incidence of lung (Mackillop et al. 2000) and cervical (Clegg et al. 2009) cancers, whereas higher SES is correlated with increased incidence of prostate (Quaglia et al. 2013) and breast (Woods et al. 2006) cancers.

Bladder cancer is the ninth most common cancer worldwide and ranks 13th on the list of all cancer-related deaths globally (Sanli et al. 2017). In 2016, the overall global incidence of bladder cancer was approximately 437,000, with a prevalence of approximately 1,767,000, a respective 31.0% and 33.7% increase since 2006 (Abajobir et al. 2017). In Canada, bladder cancer is the fifth most common cancer, with approximately 8900 new cases (21.8 per 100,000) diagnosed in 2017, with approximately 6700 (36.3 per 100,000) of these cases in men and 2200 (9.8 per 100,000) in women (Canadian Cancer Society's Advisory Committee on Cancer Statistics 2017). The noticeable difference in incidence between men and women may be explained by bladder cancer's largest risk factor: smoking (Antoni et al. 2017; Mahdavifar et al. 2016; Wong et al. 2018). Men are frequently reported to have higher rates of tobacco smoking than women (Chavan et al. 2014; Sanli et al. 2017) and an estimated 50% of bladder cancer cases are attributed to smoking in various populations (Antoni et al. 2017; Mahdavifar et al. 2016). This is an important observation, as risks for bladder cancer mortality due to tobacco are second only to lung cancer and tobacco (Mahdavifar et al. 2016).

Some recent studies (Goy et al. 2008; Mahdavifar et al. 2016; Wong et al. 2018) have examined the association between SES and the incidence of bladder cancer. A review article showed that incidence of bladder cancer is highest in Europe and North America, two highly developed regions of the world, but also in Northern African and Western Asia, more likely due to *Schistosoma haematobium* infections (Antoni et al. 2017). A retrospective study in the United States found that a lower SES (measured by income and education quintiles) has a direct negative impact on the prognosis of bladder cancer (Weiner et al. 2018). A recent study that examined income-related inequalities demonstrated that individuals in the lowest quartile of income were more likely to present at later stages of bladder cancer with worse prognoses (Weiner et al. 2018). Another study demonstrated that individuals with the lowest levels of education had a twofold increase in the risk of developing bladder cancer compared with those in the highest level of education (Goy et al. 2008).

Although, to date, some studies have examined inequalities in incidence and mortality of bladder cancer in several countries (Antoni et al. 2017; Chavan et al. 2014; Wong et al. 2018), socio-economic inequalities in the incidence of bladder cancer in Canada are poorly understood. This study, for the first time, aimed to quantify socio-economic inequalities in bladder cancer incidence in Canada over time. Specifically, we aimed to measure income- and education-related inequalities in the incidence of bladder cancer in Canada from 1992 to 2010. Understanding the distribution of bladder cancer across socio-economic groups can better inform health professionals and policymakers on which subsets of the population may require more focus for therapy and/or preventive care.

Methods

Data and variables

Data for this study were obtained from three sources: the Canadian Cancer Registry (CCR), the Canadian Census of Population (CCP), and the National Household Survey (NHS). The CCR is a database composed of patients' basic demographic and cancer-specific data from provincial and territorial cancer registries (Surveys and Statistical Programs - Canadian Cancer Registry (CCR) 2018). The CCR was used to obtain new patient primary diagnoses of bladder cancer in all provinces (Alberta [AB], British Columbia [BC], Manitoba [MB], Newfoundland and Labrador [NL], New Brunswick [NB], Nova Scotia [NS], Ontario [ON], Prince Edward Island [PE], Quebec [QC], and Saskatchewan [SK]) in Canada from 1992 to 2010. NL and PE were combined due to low incidence, and the territories were excluded for the same reason. To specifically identify the bladder cancer patients in the CCR, we used code "C67" in the third revision of the International Classification of Diseases for Oncology (ICD-O-3). This code includes cases of carcinoma in situ for all provinces, excluding Ontario, as they do not report carcinoma in situ in their provincial registry; therefore, they were excluded from our analyses (Canadian Cancer Statistics 2017).

Geographically, we used Census Divisions (CD) to aggregate our data. A CD is defined as a group of neighbouring municipalities joined together for the purposes of regional planning and managing common services. Based on the 6-digit postal codes obtained from the CCR, we used the Postal Code Conversion File Plus (PCCF+) Version D software to find the CD associated with each bladder cancer diagnosis. After determining the CD of each patient, we calculated the number of new cases of bladder cancer in each CD.

The CCR does not collect SES of patients; thus, the CCP and NHS were used to obtain the demographic and socio-economic information for each CD identified in the CCR. Four CCPs were used: 1991, 1996, 2001, and 2006, referred to as census years (CY). The NHS 2011 was used as the CY 2011 did not contain sufficient socio-economic information for this study. Using the unique CD identifier, the CCR data were linked to CYs and the NHS as follows: cases detected in 1992–1993 were associated with CY 1991; cases detected in 1994–1998 were associated with CY 1996; cases detected in 1999–2003 were associated with CY 2001; cases detected in 2004–2008 were associated with CY 2006; and cases detected in 2009–2010 were associated with NHS 2011.

We used average equivalized household income and proportion of individuals with a bachelor's degree or above in each CD as measures of SES in our study. Income for each household was equivalized as per the Organisation for Economic Co-operation and Development (OECD) publications (OECD 2019) by dividing household income by the square root of household size.

Statistical analysis

Income- and education-related inequalities were measured using the concentration index (C). This measure is defined with reference to the concentration curve, a graph which represents the population ranked by SES variable (i.e., income or education) on the *x*-axis and the cumulative proportion of health outcome (i.e., incidence of bladder cancer) on the *y*-axis. The value of the C is determined by measuring the area between the concentration curve and the line of perfect equality (a line running at a 45° angle from the bottom-left corner to the top-right corner of the graph) then multiplying that value by 2. A negative (positive) value of the C indicates that the inequality is disproportionately affecting those on the lower (upper) end of the socio-economic variable being measured (World Bank 2019). As Ontario does not report cases of bladder carcinoma in situ in the CCR, the C for bladder cancer was calculated for males and females in Canada, excluding Ontario. We used the number of the population in each CD as a weight in all of the analyses to produce estimates that are representative of the Canadian population. The trend analyses were carried by plotting the C for each year on the *y*-axis against time on the *x*-axis (from 1992 to 2010). A negative coefficient for the time indicates that the C is decreasing over time and vice versa. All the analyses were performed in version 14 of the STATA software package (StataCorp, College Station, TX).

Results

Trends in bladder cancer incidence

Figure 1 illustrates the incidence of bladder cancer in males, females, and the total population of Canada (excluding Ontario) each year from 1992 to 2010. The

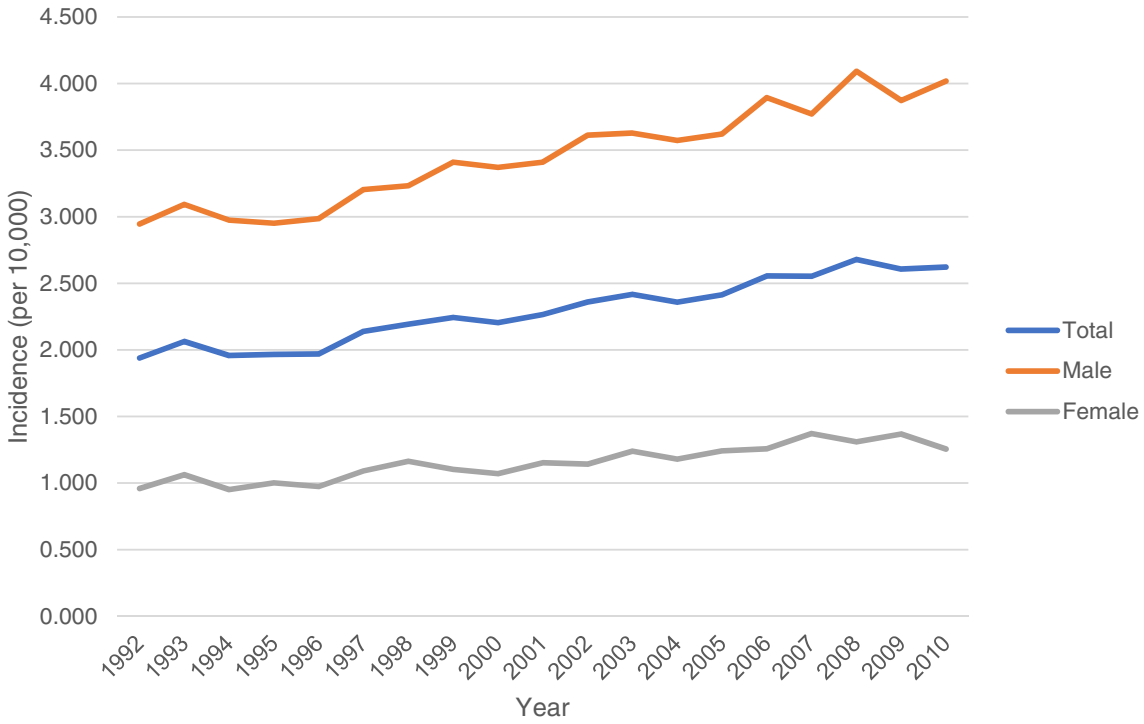

Fig. 1 Incidence of bladder cancer per 10,000 in Canada and by sex from 1992 to 2010. Note: *Incidence for Canada does not include Ontario as it did not report* in situ *bladder cancer cases for the time period considered*

incidence of bladder cancer increased steadily for both male and female populations over the time period of the study; however, there were noticeable differences in incidence between them. In 1992, the incidence of bladder cancer in men was 2.95 per 10,000, which increased to 4.02 per 10,000 by 2010. For women, the incidence in 1992 was 0.96 per 10,000 and 1.26 per 10,000 by 2010. Time trend analyses indicated a significant increase in bladder cancer incidence in Canada over time (coefficient = 0.042, $p < 0.001$). The trend analyses also suggested an increase in incidence of 0.064 ($p < 0.001$) per year per 10,000 people from 1992 to 2010 among males and an increase of 0.022 ($p < 0.001$) per year per 10,000 people among females.

Table 1 reports the incidence of bladder cancer separated by province from 1992 to 2010. The incidence has significantly increased in all provinces. The provinces that had the greatest positive trend in incidence include all of those east of Ontario: QC (coefficient = 0.056, $p < 0.001$), NS (coefficient = 0.045, $p < 0.001$), NB (coefficient = 0.059, $p < 0.001$), and NL and PE (coefficient = 0.047, $p < 0.001$); the trend for BC was also notably positive (coefficient = 0.046, $p < 0.001$).

Socio-economic inequalities in bladder cancer incidence

Income-related inequalities

Table 2 reports the concentration indices for bladder cancer incidence for the male and female populations of Canada from 1992 to 2010 using income (equivalized average household income) as a measure of SES. The consistently negative values suggest that bladder cancer incidence for each year from 1992 to 2010 was concentrated among those with lower income, both male and female. The trend analysis demonstrated the value of C decreasing among females (coefficient = − 0.003, $p = 0.001$). These findings demonstrate an increase in the concertation of bladder cancer incidence among poor females. Income-related inequalities for bladder cancer incidence were also estimated using median household income as a measure of SES. As reported in Table 4 in the Appendix, the negative values of C indicated a higher concentration of bladder cancer among those with lower income in both male and female populations in Canada.

Table 1 Incidence of bladder cancer per 10,000 in total population by province from 1992 to 2010

Year	Canada[†]	AB	BC	MB	NB	NS	QC	SK	NL&PE[‡]
1992	1.939	1.435	1.680	1.999	2.101	2.085	2.183	2.368	1.524
1993	2.064	1.515	1.865	2.139	2.031	2.310	2.318	2.265	1.741
1994	1.957	1.386	1.573	1.999	2.193	2.000	2.330	2.048	1.765
1995	1.966	1.555	1.531	2.045	1.919	2.278	2.273	2.201	1.838
1996	1.969	1.536	1.642	1.954	2.261	2.722	2.130	2.304	1.838
1997	2.139	1.667	2.227	2.227	2.193	2.556	2.195	2.201	1.985
1998	2.193	1.742	2.255	2.181	2.193	2.333	2.352	2.201	1.691
1999	2.243	1.615	2.253	1.993	2.501	2.841	2.431	2.492	1.793
2000	2.204	1.564	2.080	2.310	2.084	2.618	2.481	2.232	1.949
2001	2.265	1.530	2.279	2.039	2.501	2.340	2.551	2.440	2.105
2002	2.359	1.649	2.306	2.310	2.432	2.785	2.700	2.180	1.871
2003	2.417	1.785	2.292	2.084	2.640	2.618	2.806	2.336	1.793
2004	2.358	1.735	2.026	2.161	2.432	2.658	2.797	2.359	2.205
2005	2.413	1.812	2.152	2.382	2.779	2.658	2.817	2.149	2.205
2006	2.555	2.027	2.366	2.338	2.849	2.934	2.905	2.044	2.678
2007	2.553	1.827	2.404	2.161	2.640	2.658	3.033	2.411	2.205
2008	2.679	1.965	2.555	2.382	2.779	2.713	3.120	2.831	2.127
2009	2.607	1.794	2.463	2.214	3.058	2.980	3.020	2.726	2.637
2010	2.622	1.892	2.370	2.171	3.262	3.311	3.046	2.577	2.482
Trend	0.042	0.027	0.046	0.014	0.059	0.045	0.056	0.019	0.047
(p value)	< 0.001	< 0.001	< 0.001	0.008	< 0.001	< 0.001	< 0.001	0.025	< 0.001

AB, Alberta; *BC*, British Columbia; *MB*, Manitoba; *NB*, New Brunswick; *NS*, Nova Scotia; *QC*, Quebec, *SK*, Saskatchewan, *NL&PE*, Newfoundland and Labrador and Prince Edward Island

[†] Data does not include Ontario because the province did not report in situ bladder cancer cases for the time period considered

[‡] In order to meet the disclosure requirement of Statistics Canada's Research Data Centre (RDC), the incidences of bladder cancer were combined in NL and PE provinces

Education-related inequalities

Table 3 reports the concentration indices for bladder cancer incidence for males and females in Canada from 1992 to 2010 using education level (proportion of individuals with bachelor's degree or higher level) as a measure of SES. The consistently negative values for the estimated C among males suggest that bladder cancer incidence for each year from 1992 to 2010 was concentrated among the lower-level education attainment groups. The results also showed a statistically significant concentration of bladder cancer incidence among females in Canada with lower education attainment in recent years. The trend analysis suggested an increasing trend in the concentration of bladder cancer incidence among less-educated males (coefficient = − 0.002, $p = 0.049$) and females (coefficient = − 0.004, $p < 0.001$) in Canada.

Discussion

Using data from the CCR, CCP, and the NHS, this study examined socio-economic inequalities in bladder cancer incidence in Canada from 1992 to 2010. The descriptive results indicated a higher incidence of bladder cancer among males compared with females in Canada (excluding Ontario). The higher incidence in men at any point in time in the study period was as expected, as men are statistically more likely to smoke tobacco, putting them at an increased risk of developing bladder cancer (Antoni et al. 2017; Chavan et al. 2014; Mahdavifar et al. 2016; Sanli et al. 2017).

The increase in the incidence of bladder cancer in the total population of Canada noted over the time period is consistent with the trends in several other developed nations, including Germany, France, and Slovenia (Wong

Table 2 Income-related inequalities in the incidence of bladder cancer in Canada (excluding Ontario), 1992–2010 (measured based on average household income)

	Incidence rate† in each income quartile				The *C* (95% CI)
	Lowest	2nd	3rd	Highest	
Males					
1992	3.570	2.859	3.116	2.071	− 0.091 (− 0.140 to − 0.041)
1993	3.695	3.158	3.180	2.186	− 0.095 (− 0.143 to − 0.046)
1994	3.207	3.663	2.996	1.963	− 0.095 (− 0.124 to − 0.067)
1995	3.321	3.342	2.910	2.183	− 0.084 (− 0.113 to − 0.056)
1996	3.596	3.548	2.736	2.012	− 0.122 (− 0.152 to − 0.092)
1997	3.413	3.434	3.279	2.649	− 0.050 (− 0.079 to − 0.021)
1998	3.367	3.663	3.214	2.649	− 0.061 (− 0.089 to − 0.033)
1999	3.972	3.660	3.281	2.474	− 0.085 (− 0.112 to − 0.058)
2000	3.950	3.660	3.148	2.474	− 0.080 (− 0.110 to − 0.050)
2001	3.819	3.872	3.303	2.303	− 0.087 (− 0.115 to − 0.060)
2002	3.994	4.064	3.457	2.616	− 0.076 (− 0.102 to − 0.050)
2003	4.038	4.180	3.303	2.673	− 0.076 (− 0.104 to − 0.047)
2004	4.011	4.006	3.277	2.917	− 0.076 (− 0.103 to − 0.048)
2005	4.288	3.753	3.416	2.917	− 0.084 (− 0.112 to − 0.055)
2006	4.672	4.154	3.468	3.231	− 0.090 (− 0.114 to − 0.065)
2007	4.288	4.154	3.554	2.917	− 0.082 (− 0.107 to − 0.056)
2008	4.779	4.491	3.780	3.145	− 0.093 (− 0.119 to − 0.067)
2009	4.851	4.214	3.555	2.707	− 0.125 (− 0.149 to − 0.101)
2010	4.871	4.507	3.645	2.898	− 0.113 (− 0.139 to − 0.087)
Trend (*p* value)					− 0.001 (0.362)
Females					
1992	1.040	1.025	0.819	0.876	− 0.034 (− 0.095 to 0.026)
1993	1.144	1.173	1.015	0.847	− 0.048 (− 0.103 to 0.006)
1994	0.961	1.187	0.924	0.723	− 0.063 (− 0.109 to − 0.016)
1995	1.070	1.233	0.966	0.723	− 0.081 (− 0.126 to − 0.036)
1996	1.026	1.073	1.029	0.747	− 0.060 (− 0.103 to −0.017)
1997	1.136	1.165	1.050	1.012	− 0.028 (− 0.064 to 0.009)
1998	1.201	1.256	1.176	1.036	− 0.041 (− 0.080 to − 0.002)
1999	1.224	1.233	0.916	0.980	− 0.044 (− 0.083 to − 0.004)
2000	1.224	1.141	1.105	0.806	− 0.066 (− 0.110 to − 0.022)
2001	1.224	1.325	1.024	0.980	− 0.056 (− 0.093 to − 0.019)
2002	1.224	1.177	1.239	0.936	− 0.042 (− 0.083 to − 0.002)
2003	1.288	1.416	1.239	0.980	− 0.049 (− 0.087 to − 0.011)
2004	1.301	1.461	1.094	0.767	− 0.090 (− 0.129 to − 0.051)
2005	1.301	1.603	1.094	0.909	− 0.093 (− 0.131 to − 0.054)
2006	1.363	1.502	1.160	0.965	− 0.081 (− 0.119 to − 0.043)
2007	1.590	1.441	1.392	0.965	− 0.092 (− 0.130 to − 0.053)
2008	1.446	1.420	1.326	0.937	− 0.070 (− 0.107 to −0.033)
2009	1.548	1.567	1.280	1.035	− 0.095 (− 0.128 to − 0.062)
2010	1.509	1.378	1.194	0.891	− 0.109 (− 0.145 to − 0.073)
Trend (*p* value)					− 0.003 (0.001)

Note: Ontario was not included in the analysis as it did not report in situ bladder cancer cases for the time period considered

† Per 10,000 population

Table 3 Education-related inequalities in the incidence of bladder cancer in Canada (excluding Ontario), 1992–2010 (measured based on proportion of individuals with a bachelor's degree or above)

	Incidence rate† in each education quartile				The *C* (95% CI)
	Lowest	2nd	3rd	Highest	
Males					
1992	3.434	2.779	2.592	2.997	− 0.035 (− 0.086 to 0.015)
1993	3.572	2.974	2.658	3.191	− 0.038 (− 0.088 to 0.012)
1994	3.155	2.997	2.589	3.340	− 0.006 (− 0.037 to 0.025)
1995	3.018	2.929	2.737	3.248	− 0.002 (− 0.032 to 0.029)
1996	3.247	3.501	2.238	3.187	− 0.042 (− 0.076 to − 0.009)
1997	3.133	3.523	2.848	3.462	0.001 (− 0.030 to 0.029)
1998	3.155	3.569	2.903	3.432	− 0.004 (− 0.033 to 0.026)
1999	3.683	3.774	2.973	3.242	− 0.032 (− 0.061 to − 0.003)
2000	3.415	3.552	3.120	3.414	− 0.004 (− 0.036 to 0.028)
2001	3.616	3.752	2.973	3.316	− 0.030 (− 0.060 to − 0.001)
2002	3.683	4.151	2.994	3.635	− 0.021 (− 0.049 to 0.006)
2003	3.705	3.796	3.287	3.758	− 0.002 (− 0.032 to 0.028)
2004	3.572	3.837	3.486	3.386	− 0.012 (− 0.040 to 0.017)
2005	3.936	3.879	3.347	3.339	− 0.037 (− 0.067 to − 0.008)
2006	4.257	4.176	3.565	3.598	− 0.043 (− 0.069 to − 0.016)
2007	3.850	4.176	3.426	3.645	− 0.024 (− 0.052 to 0.004)
2008	4.428	4.600	3.644	3.715	− 0.051 (− 0.079 to − 0.023)
2009	4.355	4.454	3.083	3.578	− 0.062 (− 0.090 to − 0.034)
2010	4.395	4.514	3.344	3.805	− 0.049 (− 0.078 to − 0.020)
Trend (*p* value)					− 0.002 (0.049)
Females					
1992	0.997	0.816	0.853	1.197	0.046 (− 0.014 to 0.106)
1993	1.077	0.930	0.965	1.327	0.040 (− 0.015 to 0.094)
1994	0.819	0.930	0.911	1.242	0.075 (0.029 to 0.121)
1995	0.930	0.973	0.930	1.213	0.037 (− 0.009 to 0.083)
1996	0.886	1.146	0.873	1.011	− 0.006 (− 0.050 to 0.038)
1997	0.974	1.168	1.044	1.213	0.033 (− 0.004 to 0.070)
1998	1.218	1.146	1.063	1.271	− 0.003 (− 0.042 to 0.036)
1999	1.062	1.000	1.088	1.275	0.042 (0.002 to 0.082)
2000	0.997	1.066	1.129	1.089	0.020 (− 0.025 to 0.064)
2001	1.106	1.153	1.088	1.298	0.026 (− 0.011 to 0.064)
2002	1.062	1.283	1.067	1.159	0.005 (− 0.036 to 0.046)
2003	1.149	1.370	1.170	1.275	0.013 (− 0.026 to 0.051)
2004	1.134	1.177	1.094	1.330	0.025 (− 0.015 to 0.066)
2005	1.257	1.280	1.211	1.219	− 0.001 (− 0.042 to 0.039)
2006	1.237	1.342	1.250	1.219	0.004 (− 0.035 to 0.043)
2007	1.402	1.486	1.269	1.330	− 0.016 (− 0.057 to 0.024)
2008	1.278	1.321	1.250	1.375	0.013 (− 0.025 to 0.051)
2009	1.527	1.460	1.260	1.241	− 0.044 (− 0.078 to − 0.009)
2010	1.429	1.322	1.043	1.241	− 0.044 (− 0.082 to − 0.005)
Trend (*p* value)					− 0.004 (< 0.001)

Note: Ontario was not included in the analysis as it did not report in situ bladder cancer cases for the time period considered

† Per 10,000 population

et al. 2018). However, the opposite trend was observed in the UK (Cancer Research UK 2017), the US (National Cancer Institute SEER - Bladder Cancer 2015), and New Zealand (Antoni et al. 2017). The increase in Canadian incidence may be explained by a recent study (Wong et al. 2018) that suggests increase in bladder cancer incidence in more developed nations is due to the increase in significant risk factors such as smoking, obesity, alcohol consumption, and red meat consumption. Yet, other recent studies have demonstrated that rates of smoking (the highest risk factor for bladder cancer) (Antoni et al. 2017; Mahdavifar et al. 2016; Wong et al. 2018) are declining in Canada (Huang et al. 2014; Sanli et al. 2017), so it would be expected that smoking-related bladder cancer rates should be declining as well. Since overall incidence of bladder cancer is not decreasing in Canada with a reported decrease in smoking rates, it is possible that greater use and availability of diagnostic testing (e.g., urine cytology, cystoscopy, CT scans), occupational and environmental exposure to carcinogens (e.g., aromatic amines), and non-smoking risk factors (such as the ones stated above) could be having an increased impact on bladder cancer incidence (Wong et al. 2018).

Additionally, we observed income- and education-related inequalities in bladder cancer in Canada for both sexes. The trend analyses demonstrated a significant increase in income-related inequalities among females. The concentration of bladder cancer incidence increased among less-educated men and women over the study period. Widening socio-economic inequalities in bladder cancer are consistent with several studies that suggested there is an increase in bladder cancer incidence in the lower SES population (Goy et al. 2008; Weiner et al. 2018). Widening socio-economic inequalities in other measures of health were also observed in a recent study of the National Population Health Survey that demonstrated a significant increase in health inequalities among all Canadians between 1998 and 2011, with a more notable increase for women (Hajizadeh et al. 2016).

This study has several notable limitations. First, we calculated socio-economic inequalities in bladder cancer using incidence and SES of CDs. Individual-level datasets that contain both incidence and measures of the SES would have provided more precise measures of the association between the two. Second, the CCP is only administered every 5 years; therefore, the data for the years between each CY were assumed to be similar to the nearest CY, rather than having data from that specific year. Third, the study excluded the Canadian territories due to low incidence. Thus, further studies are required to measure socio-economic inequalities in bladder cancer incidence in Canadian territories. Finally, Ontario does not report cases of bladder carcinoma in situ in the CCR, whereas all other provinces report bladder carcinoma in situ. Therefore, we excluded Ontario from the analyses. The estimation of income- and education-related inequalities in the incidence of bladder cancer with Ontario included and excluded from the analyses informed qualitatively similar inference.

Conclusion

Caveat considered, this study demonstrated an increase in the concentration of bladder cancer incidence among men and women in Canada with lower SES, with a greater magnitude of increase in women. The concentration of bladder cancer among lower SES populations warrants further attention. Appropriate healthcare resources should be directed to help ameliorate these inequalities and provide equitable care to those who are in the greatest need. Further studies are required to help elucidate causal relationships in SES and bladder cancer incidence. Furthermore, an examination of the relationship between SES and mortality of bladder cancer in Canada over time would shed more light on the seriousness of the inequalities of this disease.

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Compliance with ethical standards

Ethics The data for this study were accessed through Statistics Canada's Research Data Centre (RDC). Statistics Canada has put in place strict disclosure practices which the RDC closely obeys, allowing their approved project to be exempt from research ethics board review based on Tri-council policy statement: Ethical conduct for research involving humans (TCPS2) article 2.2 (a).

Conflict of interest The authors declare that they have no conflict of interest.

Appendix

Table 4 Income-related inequalities in the incidence of bladder cancer in Canada (excluding Ontario), 1992–2010 (measured based on median household income)

	The *C* (95% confidence interval)	
Year	Male	Female
1992	− 0.099 (− 0.148 to − 0.049)	− 0.048 (− 0.108 to 0.012)
1993	− 0.103 (− 0.151 to − 0.055)	− 0.070 (− 0.124 to − 0.016)
1994	− 0.105 (− 0.133 to − 0.077)	− 0.076 (− 0.122 to − 0.03)
1995	− 0.096 (− 0.124 to − 0.068)	− 0.093 (− 0.138 to − 0.048)
1996	− 0.122 (− 0.152 to − 0.092)	− 0.064 (− 0.107 to − 0.021)
1997	− 0.051 (− 0.080 to − 0.023)	− 0.035 (− 0.072 to 0.002)
1998	− 0.061 (− 0.090 to − 0.033)	− 0.037 (− 0.076 to 0.002)
1999	− 0.090 (− 0.117 to − 0.063)	− 0.061 (− 0.1 to − 0.021)
2000	− 0.091 (− 0.121 to − 0.062)	− 0.079 (− 0.122 to − 0.035)
2001	− 0.092 (− 0.119 to − 0.065)	− 0.078 (− 0.115 to − 0.042)
2002	− 0.086 (− 0.111 to − 0.061)	− 0.044 (− 0.084 to − 0.003)
2003	− 0.088 (− 0.115 to − 0.06)	− 0.059 (− 0.097 to − 0.02)
2004	− 0.080 (− 0.107 to − 0.053)	− 0.105 (− 0.143 to − 0.067)
2005	− 0.079 (− 0.108 to − 0.051)	− 0.100 (− 0.138 to − 0.061)
2006	− 0.087 (− 0.111 to − 0.063)	− 0.085 (− 0.122 to − 0.047)
2007	− 0.082 (−0.107 to − 0.056)	− 0.093 (− 0.131 to − 0.054)
2008	− 0.087 (− 0.114 to − 0.061)	− 0.074 (− 0.111 to − 0.037)
2009	− 0.116 (− 0.141 to − 0.091)	− 0.086 (− 0.119 to − 0.053)
2010	− 0.103 (− 0.129 to − 0.077)	− 0.098 (− 0.135 to − 0.061)
Trend (*p* value)	− 0.0001 (0.842)	− 0.0369 (0.330)

Note: Ontario was not included in the analysis as it did not report in situ bladder cancer cases for the time period considered

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