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Lung cancer survival by immigrant status: a population-based retrospective cohort study in Ontario, Canada

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Abstract

Background Lung cancer is one of the most common cancers and causes of cancer death in Canada. Some previous literature suggests that socioeconomic inequalities in lung cancer screening, treatment and survival may exist. The objective of this study was to compare overall survival for immigrants versus long-term residents of Ontario, Canada among patients diagnosed with lung cancer.

Methods This population-based retrospective cohort study utilized linked health administrative databases and iden-tified all individuals (immigrants and long-term residents) aged 40 + years diagnosed with incident lung cancer between April 1, 2012 and March 31, 2017. The primary outcome was 5-year overall survival with December 31, 2019 as the end of the follow-up period. We implemented adjusted Cox proportional hazards models stratified by age at diagnosis, sex, and cancer stage at diagnosis to examine survival.

Results Thirty-eight thousand seven hundred eighty-eight individuals diagnosed with lung cancer were included in our cohort including 7% who were immigrants. Immigrants were younger at diagnosis and were more likely to reside in the lowest neighbourhood income quintile (30.6% versus 24.5%) than long-term residents. After adjust-ing for age at diagnosis, neighbourhood income quintile, comorbidities, visits to primary care in the 6 to 30 months before diagnosis, continuity of care, cancer type and cancer stage at diagnosis, immigrant status was associated with a lower hazard of dying 5-years post-diagnosis for both females (0.7; 95% CI 0.6–0.8) and males (0.7; 95% CI 0.6–0.7) in comparison to long-term residents. This trend held in adjusted models stratified by cancer stage at diagno-sis. For example, female immigrants diagnosed with early stage lung cancer had a hazard ratio of 0.5 (95% CI 0.4–0.7) in comparison to long-term residents.

Conclusion Overall survival post diagnosis with lung cancer was better among Ontario immigrants versus long-term residents. Additional research, potentially on the protective effects of immigrant enclave and the intersection of immigrant status with racial/ethnic identity, is needed to further explore why better overall survival for immigrants remained.

Keywords Lung cancer, Immigrants, Survival, Retrospective cohort study

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Background

Lung cancer is one of the most common cancers and causes of cancer death in Canada [1, 2]. It is estimated that there were 30,000 new cases in 2022 accounting for approximately one quarter of all cancer deaths [2]. The probability of developing lung cancer is estimated at 7%, with 1 in 15 Canadians expected to be diagnosed with the disease during their lifetime [1]. Stage of diagnosis is strongly associated with survival, with stage IV survival estimated at less than 10% over 5 years [2]. Unfortunately, about 70% of lung cancer cases in Canada are diagnosed at a late stage when treatment is likely to be less effective and studies suggest that socioeconomic status (SES) may play a role [1].

Socioeconomic inequalities in lung cancer screening, treatment and survival have been documented [3–5]. A recent overview of 8 systematic reviews conducted from 2010–2021 representing many high-income geographical regions including North America, the United Kingdom (UK), Scandinavia, Australia, New Zealand, and Korea observed that socioeconomic inequalities present in several lung cancer outcomes including those related to diagnosis, treatment and survival [3]. For example, one of the reviews found that lower SES was associated with a lower likelihood of receiving cancer treatment (OR 0.79; 95% CI 0.73–0.86) [4]. Another review conducted by Finke et al., [6] found that those with lower income had higher mortality rates (HR 1.13; 95% CI 1.08–1.19). This finding was also consistent for those who lived in lower SES neighbourhoods [6].

Ontario, Canada's most populous province, has over 14 million residents, with an estimated 30% of the population being foreign-born [7]. Immigrants are more likely to have lower income than non-immigrants, [8] and therefore it may be important to explore whether immigration status may confer additional risk. Previous studies have also reported on the "healthy immigrant effect," where those who immigrate to a country tend to be in better health that native-born residents which may help to explain some differences by immigration status, though this effect is said to diminish over time with longer time since landing [9]. While the healthy immigrant effect has been observed in prior work, previous studies have also found this not to be true. For example, we previously found no difference in lung cancer diagnostic stage between immigrants and non-immigrants [10]. It is unknown if inequalities in lung cancer survival between immigrants and non-immigrants are present in Canada. The objective of this study was to compare survival for immigrants versus long-term residents of Ontario among individuals diagnosed with lung cancer between 2012–2017.

Methods

Study design and setting

This population-based retrospective cohort study used linked health administrative databases from Ontario, Canada's most populous and multi-ethnic province. Ontario provides universal coverage for medically-necessary hospital care and physician services through the Ontario Health Insurance Plan (OHIP) with almost all Ontario residents being beneficieries (coverage approximately 95%) [11]. Given the universal coverage, health administrative databases in the province are comprehensive in capturing most health care delivered in the jurisdictions. The databases are held at ICES (formerly known as the Institute for Clinical Evaluative Sciences). ICES is an independent, non-profit research institute whose legal status under Ontario's health information privacy law allows it collect and analyze health care and demographic data, without consent, for health system evaluation and improvement. The study was approved by the Research Ethics Board at Unity Health Toronto (REB # 19–072) and reporting of the study is consistent with the RECORD statement (Appendix A) [12].

Data sources

Several data sources were used to construct the analytic dataset. The datasets were linked using unique encoded identifiers and analyzed at ICES. The Ontario Cancer Registry (OCR) was used to ascertain cancer diagnosis, tumour characteristics and survival. OCR contains information on approximately 95% of cancers diagnosed in the province since 1964. The Immigration, Refugees and Citizenship Canada – Permanent Resident (IRCC-PR) database was used to ascertain immigrant status and contains information on all permanent residents since 1985 including country from which the person emigrated and country of birth. The Registered Persons Database (RPDB) contains demographic information on all individuals who are beneficiaries of OHIP from April 1991 onwards. Physician billing data were obtained from OHIP and information on patient-provider rostering was obtained through the Client Agency Program Enrolment database. The Discharge Abstract Database (DAD) and National Ambulatory Care Reporting System (NACRS) and the Same Day Surgery (SDS) database contain information for all inpatient hospitalizations and ambulatory/outpatient hospital services and were used to obtain healthcare utilization information. The Ontario Registrar General – Deaths (ORG) Database was used to confirm mortality.

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Study cohort

We identified all individuals (immigrants and long-term residents) who were diagnosed with incident lung cancer at age 40 years and older between April 1, 2012 and March 31, 2017. Long-term residents included anyone not recorded in the IRCC-PR database. We excluded those with invalid identifiers, missing sex, living in rural areas, who had previously been diagnosed with lung cancer prior to April 1st, 2012, who were not residents of Ontario, whose date of last contact with the healthcare system was more than 3 years ago (and thus had limited available data), and those whose cancer was stage 0/in situ. Individuals were followed from study entry until death, last date of OHIP eligibility or until the end of the follow-up period (December 31, 2019), whichever occurred first.

Covariates

The primary outcome of interest was 5-year overall survival. We selected this outcome over cancer-specific survival due to the small sample size of the immigrant group. We obtained demographic characteristics for individuals in our cohort including age at lung cancer diagnosis (continuous and categorical: 40–64, 65–74, 75+), sex (male, female), socioeconomic status based on the median neighbourhood income quintile (Q1-lowest to Q5-highest), and comorbidities using the Johns Hopkins ACG® System (version 10) Aggregated Diagnosis Groups (ADGs) [13]. We also stratified based on cancer stage at diagnosis (early stage (I & II), late stage (III & IV)) and collected information on cancer type (adenocarcinoma, small cell, squamous cell, other).

Immigrant characteristics included immigrant category (economic class, family class, resettled refugee and protected persons, other immigrants), region of origin based on the World Bank regions (East Asia and Pacific, Europe and Central Asia, Latin America and the Caribbean, Middle East and North Africa, South Asia, Sub-Saharan Africa, USANZ), and years since landing.

We assessed the number of primary care visits for each patient and their continuity of care was captured through the Usual Provider of Care (UPC) Index, [14] which uses primary care physician billing claims in the 6 to 30 months prior to the cancer diagnosis date to determine the proportion of visits to the most-often visited primary care provider. Primary care visits in the 6 months prior to diagnosis may be related to the diagnosis and thus not reflective of usual care. This index is calculated only for patients with at least 3 visits; high continuity of care is defined as > 0.75 [14].

Analysis

We used descriptive statistics to summarize the study cohort and baseline characteristics stratified by immigrant status. We compared 5-year overall survival by sociodemographic and clinical characteristics between immigrants and long-term residents using Chi-Square tests and standardized differences. Standardized difference scores are intuitive indexes which measure the effect size between two groups. Compared to a t-test or Wilcoxon rank-sum test, they are independent of sample size. Their use can be recommended for comparing baseline covariates [15]. Kaplan–Meier curves were produced for 5-year overall survival by age, stage group and immigrant status.

We used Cox proportional hazards models to model the outcome in a time-to-event analysis. Models were censored at 5 years. We explored results stratified by age group, sex, and cancer stage to examine the risk of mortality post-diagnosis for immigrants in relation to long-term residents. Age was included as a continuous variable in the models. We also adjusted models for neighbourhood income quintile, comorbidities, primary care provider visits in the 6 to 30 months before diagnosis, continuity of care, stage at diagnosis and cancer type and present adjusted hazard ratios with 95% confidence intervals and associated *p*-values. Significance was determined at the $p = 0.05$ level with 2-sided *p*-values. We also conducted a sensitivity analysis including those diagnosed with non-small cell lung cancer only, because of the differences in aggressiveness of the disease. Observations with any missing values were minimal and excluded from the analysis. All analyses were completed using SAS software (version 9.4).

Results

A total of 38,788 individuals were diagnosed with lung cancer between April 1, 2012 and March 31, 2017 including 2,696 immigrants (7%) and 36,092 long-term residents (93%) (Fig. 1). Baseline characteristics of the study cohort have been previously published [10]. Approximately 49.3% of the cohort was female and 26.5% of the total cohort was diagnosed with early-stage lung cancer. Overall, immigrants were younger at diagnosis (68 years versus 72 years) and were more likely to reside in the lowest neighbourhood income quintile (30.6% versus 24.5%). Immigrants in our cohort also had a lower median number of co-morbidities in comparison to long-term residents (7 (IQR 5–10) versus 8 (IQR 5–11)). Stage of diagnosis did not differ by immigrant status. Mean number of PCP visits in the 6 to 30 months prior to diagnosis was 9.4 ± 8.5 for immigrants and 9.0 ± 8.7 for non-immigrants. A total of 12.2% of individuals had at

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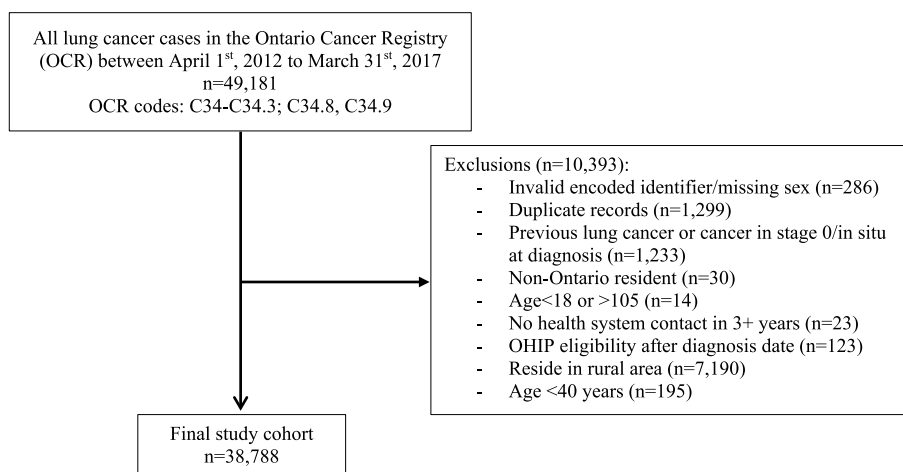
Fig. 1 Cohort creation flow chart

least 5 years of follow-up. However, among those without 5 years follow-up 84% died within 5 years. Median follow-up time (IQR) was similar among immigrants (5 years with IQR 4–6) and long-term residents (5 years with IQR 4–6).

A total of 34,394 individuals had cancer stage information available (*n* = 4,394 with missing stage). Those diagnosed at an early stage were more likely to be males for immigrants (50.7%) and females for long-term residents (53.6%). Those diagnosed at a late stage had

fewer comorbidities and were more likely to have small cell carcinoma for both groups. The median number of PCP visits in the 6 to 30 months prior to diagnosis was higher among those diagnosed with early stage for immigrants (9 versus 7 visits) and long-term residents (8 versus 6 visits). The stage of diagnosis was not associated with immigrant class, region of origin or years in Canada.

Table 1 includes immigration characteristics stratified by cancer stage at diagnosis for immigrants with this

Table 1 Immigrant characteristics stratified by cancer stage at diagnosis (*N* = 2,405)

	Early stage (*n* = 692) N (%)	Late stage (*n* = 1,713) N (%)	Standardized difference
Immigrant category			
Economic class	207 (29.9%)	492 (28.7%)	0.03
Other immigrants	20 (2.9%)	47 (2.7%)	0.01
Resettled refugee & protected persons	99 (14.3%)	289 (16.9%)	0.07
Sponsored family class	366 (52.9%)	885 (51.7%)	0.02
World Bank region			
East Asia and Pacific	300 (43.4%)	728 (42.5%)	0.02
Europe and Central Asia	184 (26.6%)	446 (26.0%)	0.01
Latin America and the Caribbean	45 (6.5%)	145 (8.5%)	0.07
Middle East and North Africa	50 (7.2%)	112 (6.5%)	0.03
South Asia	75 (10.8%)	200 (11.7%)	0.03
Sub-Saharan Africa	22 (3.2%)	55 (3.2%)	0
USANZ	16 (2.3%)	26 (1.5%)	0.06
Years since landing			
Median (IQR)	20 (12–24)	19 (12–24)	0.05
0–5 years	66 (9.5%)	174 (10.2%)	0.02
5-<10 years	61 (8.8%)	149 (8.7%)	0
10+ years	565 (81.6%)	1,390 (81.1%)	0.01

USANZ United States, Australia and New Zealand

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Table 2 Description of 5-year mortality by immigrant status, sex, age group and cancer stage at diagnosis

	Immigrants		Long-term residents	
	Female	Male	Female	Male
Parameter	N (%)	N (%)	N (%)	N (%)
Number of deaths	559 (35.6)	1,012 (64.4)	11,654 (47.1)	13,067 (52.9)
Age group				
40–64	221 (39.5)	403 (39.8)	3,126 (26.8)	3,268 (25.0)
65–74	134 (24.0)	281 (27.8)	3,837 (32.9)	4,337 (33.2)
75+	204 (36.5)	328 (32.4)	4,691 (40.3)	5,462 (41.8)
Cancer stage at diagnosis				
Early	66 (34.2)	127 (65.8)	2,062 (46.7)	2,349 (53.3)
Late	493 (35.8)	885 (64.2)	9,592 (47.2)	10,718 (52.8)

information available ($n = 2,405$). Most immigrants (81%) had immigrated more than 10 years previous to diagnosis with the median years since landing being 20 years prior (interquartile range 12–24). The most common immigrant category was sponsored family class followed by economic class and resettled refugees and protected persons. The most common region of origin was East Asia and Pacific followed by Europe and Central Asia (Table 1).

Table 2 presents the number of deaths in the 5-years after diagnosis by immigrant status, sex, age group and cancer stage. Briefly, 1,571 immigrants died in the cohort compared to 24,721 long-term residents. Figure 2 displays the 5-year overall survival Kaplan Meier curve by immigrant status (Fig. 2A) stratified by age group (Fig. 2B) and cancer stage at diagnosis (Fig. 2C). Overall, survival varied by immigrant status and was higher for immigrants (32.2%) versus long-term residents (20.6%) (Fig. 2). Survival rate decreased with increasing age including 26.5% for those aged 40–64, 24.2% for those aged 65–74 and 12.5% for those 75+. Immigrants had better overall survival even when stratifying by age group and cancer stage.

Table 3 presents the multivariable time-to-event model for the hazard of dying 5-years post diagnosis by immigrant status stratified by cancer stage at diagnosis, sex and age group. Immigrant status was associated with better overall survival for both females (0.7; 95% CI 0.6–0.8) and males (0.7; 95% CI 0.6–0.7) in comparison to long-term residents. This was consistent even when stratified by cancer stage at diagnosis. For example, female immigrants diagnosed with early stage lung cancer had a hazard ratio of 0.5 (95% CI 0.4–0.7) in comparison to long-term residents. A similar pattern was observed for males. However, when stratified by age category female
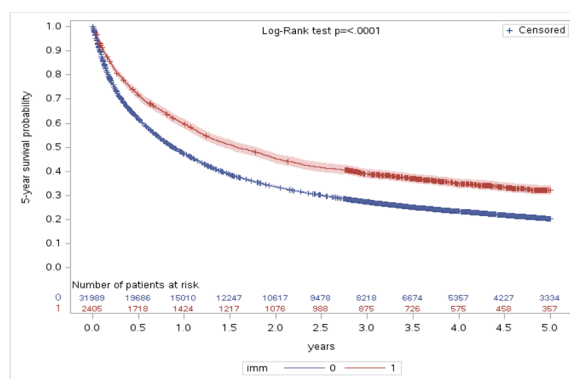
A. Overall 5-year survival by immigrant status
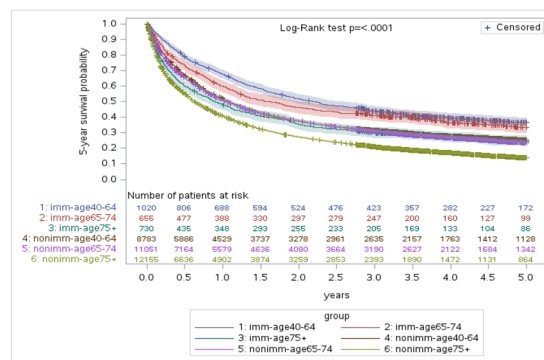
B. Overall 5-year survival by immigrant status and age category
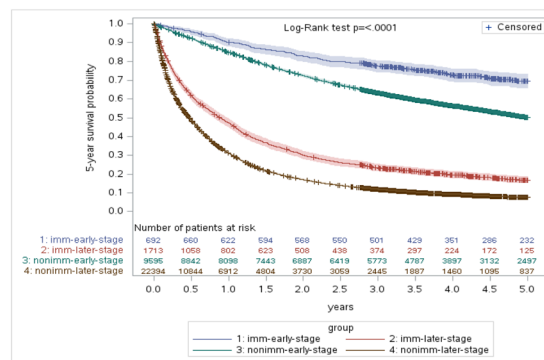
C. Overall 5-year survival by immigrant status and stage at diagnosis

Fig. 2 Kaplan Meier curves with 95% confidence intervals for overall 5-year survival by immigrant status and stratified by age group and cancer stage at diagnosis. **A** Overall 5-year survival by immigrant status **B** Overall 5-year survival by immigrant status and age category. **C** Overall 5-year survival by immigrant status and stage at diagnosis

immigrants aged 65–74 diagnosed with early-stage disease did not have a significantly different hazard ratio compared to their long-term resident counterparts. Immigrants diagnosed with late-stage disease had better overall survival for both females and males and when stratified by age group.

Results from the sensitivity analysis including only those diagnosed with non-small cell lung cancer showed

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Table 3 Multivariable models[a] for the hazard of death 5-years after diagnosis by immigrant status stratified by cancer stage at diagnosis, sex and age group

	Early stage		Late stage	
	Female	Male	Female	Male
	Hazard Ratio (95% CI)	Hazard Ratio (95% CI)	Hazard Ratio (95% CI)	Hazard Ratio (95% CI)
Overall	0.5 (0.4–0.7)	0.7 (0.6–0.9)	0.7 (0.7–0.8)	0.7 (0.6–0.7)
Age group				
40–64	0.5 (0.3–0.9)	0.6 (0.4–0.9)	0.6 (0.5–0.7)	0.6 (0.6–0.7)
65–74	0.6 (0.4–0.9)	0.7 (0.5–1.0)	0.7 (0.5–0.8)	0.7 (0.6–0.8)
75 +	0.5 (0.3–0.7)	0.7 (0.6–1.0)	0.8 (0.7–0.9)	0.7 (0.6–0.8)

[a] Multivariable models have been adjusted for continuous age, neighourhood income quintile, ADG comorbidity score, primary care provider visits in the 6–30 months before the index date, UPC index, cancer stage at diagnosis and cancer type

that survival varied by immigrant status with 37% of immigrants and 26% of long-term residents surviving at least 5 years (data not shown). Similar to the overall results, in fully adjusted models, immigrant status was either not associated with survival or protective for longer survival in all age, sex, and stage strata.

Discussion

Our results show that immigrants to Ontario had better overall survival after diagnosis in comparison to long-term residents. Specifically, we found that 5-year overall survival was 32.2% for immigrants compared to only 20.6% for long-term residents. Immigrant status was associated with a lower hazard of dying for both females (0.7; 95% CI 0.6–0.8) and males (0.7; 95% CI 0.6–0.7) in comparison to long-term residents. This trend held true even when stratified by cancer stage at diagnosis.

The observed difference in overall survival by immigrant status for lung cancer has also been observed for other types of cancers including colorectal cancer [16]. These findings may be partially explained by the healthy immigrant effect, a phenomenon where those who immigrate to a country are in better health than native-born residents. Canadian immigration policies do rely on the health of immigrants as a condition for entry in many cases [17]. Support for the healthy immigrant effect has been reported including for chronic diseases such as cancers and within the Canadian context and in prior work comparing survival among immigrants and those who are native-born [9, 17, 18]. A study comparing differences in cancer survival between immigrants and non-immigrants in Norway, found that non-Western immigrants had better lung cancer survival compared to Norwegians (HR 0.78; 95% CI 0.71–0.85) [19]. However, it has also been observed that the advantage of the healthy immigrant effect diminishes [9, 17, 18] or that immigrants converge to non-immigrants [9, 18] over time though we did not

assess this in our study. Diminishing of the healthy immigrant effect may be a reflection of increasing age and thus increased comorbidities, as we observed increasing hazard ratios with increasing age for both immigrants and long-term residents in our study. Of note, immigrants had fewer comorbidities than non-immigrants regardless of age.

Differences in smoking prevalence have also been found among immigrants and non-immigrants which may help to explain some of our findings related to better survival among immigrants. A recent study exploring disparities in cigarette smoking in Canada found that the relative risk of smoking was higher among males versus females (RR 1.39) and that male and female non-immigrants were more likely than their immigrant counterparts to smoke (RR 1.26 for male non-immigrants and 2.93 for female non-immigrants) [20].

Future research should consider the heterogeneity that exists within immigrant populations including the intersection with race. For example, immigrants in our study had immigrated from a number of regions including East, Central or South Asia and Europe. It would be important to explore how health outcomes may differ between immigrants who are racialized versus not. Some prior work suggests that immigrants who are racialized may experience worse health outcomes as a result of racial discrimination and socioeconomic disadvantage [21]. Additionally, many immigrant enclaves exist in Canada in big cities like Toronto. As such, the potential protective effects of immigrant enclaves and immigrant-based residential segregation should be considered in future work [22].

The results of this study should be interpreted considering study strengths and limitations. Limitations of this study include those common to studies using health administrative databases including limitations in data availability and coding errors. In this case, the IRCC-PR

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database contains information on all permanent residents only since 1985. As a result, we were unable to ascertain if some of the long-term residents in our analyses were indeed immigrants from prior to 1985. We also did not have information on any incident lung cancer diagnoses if these occurred while an individual was living in another country or if they are Canadian-born but used to live in another province. Additionally, we excluded those living in rural areas as the number of immigrant lung cancer patients residing in rural areas is very small. Given the limited number of immigrants living in rural areas, we don't believe that inclusion of those living in rural regions would have materially impacted the results of our study. However, this could be an area for further research to examine outcomes among those living in rural areas. We also excluded those with no contact with the healthcare system in the last 3 years. However, we anticipate those with limited contact with the healthcare system are likely to be healthier and our estimates are likely conservative of the true effect. We also recognize that the data set used for this study had follow-up until 2019, before the COVID-19 pandemic. As such, it is possible that our findings may not be the same as seen today given the large influx of refugees since the pandemic and other global pressures forcing individuals around the world to immigrate. Strengths of this work include use of databases that contain a complete census of cancers in the province given the context of a universal healthcare system. We were also able to ascertain survival by stage of diagnosis for the majority of people diagnosed with lung cancer during our study period. The results of our study may have some limited generalizability to other Canadian provinces with similar population demographics including a large number of immigrants and similar set-up of healthcare services such as British Columbia.

Conclusions

In conclusion, overall survival 5-years post diagnosis with lung cancer is better among Ontario immigrants versus long-term residents. In a system of universal healthcare, additional strategies to address previously documented socioeconomic inequalities especially for those living in the lowest income neighbourhoods are needed given the social gradient of cigarette smoking, one of the biggest risk factors for lung cancer. Additional research, potentially on the protective effects of immigrant enclave and the intersection of immigrant stautus with racial/ethnic identity, is needed to further explore why better overall survival for immigrants remained despite the reported diminishing impact of the healthy immigrant effect.

Abbreviations

ADGs	Aggregated Diagnosis Groups
CI	Confidence Interval
DAD	Discharge Abstract Database
HR	Hazard Ratio
ICES	Institute for Clinical Evaluative Sciences
IQR	Interquartile range
IRCC-PR	Immigration, Refugees and Citizenship Canada – Permananet Resident
NACRS	National Ambulatory Care Reporting System
OCR	Ontario Cancer Registry
OHIP	Ontario Health Insurance Plan
ORG	Ontario Registrar General – Deaths
PCP	Primary Care Provider
RPDB	Registered Persons Database
SES	Socioeconomic Status
UK	United Kingdom
UPC	Usual Provider Index
USANZ	United States, Australia and New Zealand

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12885-024-12804-7.

Supplementary Material 1.

Availability of data and materials

The dataset from this study is held securely in coded form at ICES. While legal data sharing agreements between ICES and data providers (e.g., healthcare organizations and government) prohibit ICES from making the dataset publicly available, access may be granted to those who meet pre-specified criteria for confidential access, available at www.ices.on.ca/DAS (email: das@ices.on.ca). The full dataset creation plan and underlying analytic code are available from the authors upon request, understanding that the computer programs may rely upon coding tem-plates or macros that are unique to ICES and are therefore either inaccessible or may require modification.

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Declarations

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