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RESEARCH

Treatment and Survival Outcomes for Indigenous and Non-Indigenous Australians Within the Victorian Lung Cancer Registry: A Retrospective Cross-Sectional Cohort Study

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ABSTRACT

Objectives: Our goal was to explore and compare risk factors, patterns of management and survival outcomes in Indigenous compared with non-Indigenous Australian patients using the Victorian Lung Cancer Registry (VLCR).

Study Type: A retrospective observational cohort study of the VLCR.

Setting: Data collected from the VLCR between 18 January 2011 and 24 January 2024.

Participants: Primary lung cancer patients in the VLCR.

Main Outcome Measures: Patient, disease and management characteristics of Indigenous and non-Indigenous Australian patients. Impacts of patient and clinical variables on treatment and survival, measured by multivariable Cox regression and propensity-matched survival analysis.

Results: We included 186 Indigenous and 17,439 non-Indigenous Australian patients. Indigenous Australian lung cancer patients were younger in age {median, 62 years (interquartile range [IQR], 55–69 years) vs. median, 71 years (IQR, 63–77 years); $p < 0.001$}, had lower socio-economic status (lowest quintile, 57 patients [31%] vs. 3274 patients [19%]; $p < 0.001$), were more likely to be current smokers (118 patients [65%] vs. 5963 patients [35%]; $p < 0.001$) and had higher levels of respiratory comorbidity (64 patients [34%] vs. 4088 patients [23%]; $p < 0.001$). There were no statistically significant differences in receipt of guideline-concordant treatment (82 patients [51%] vs. 8036 patients [56%]; $p = 0.12$) and survival outcomes (median survival, 1.4 vs. 1.5 years; hazard ratio, 1.06 [95% confidence interval, 0.88–1.27]).

Conclusion: We found lung cancer patients of Indigenous status were more likely to have demographic disadvantage and clinical risk factors that may contribute to discrepancies in management compared with patients of non-Indigenous status. Identifying barriers to healthcare and treatment in the Indigenous Australian population is an important research priority to improve disparities between the two populations.

JEL Classification: Indigenous health, Neoplasms, Respiratory tract diseases, Statistics, epidemiology and research design

Victorian Aboriginal Community Controlled Health Organisation (VACCHO) would like to advise Aboriginal and Torres Strait Islander people that this publication may contain images, voices, and discussions of those who have returned to the Dreaming.

For affiliations refer to page 9.

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Plain Language Summary

The Known: The confirmation of equity for Indigenous Australians is a critical objective of Australian cancer registries targeting healthcare improvement.

The New: Indigenous Australian patients with lung cancer had increased radiotherapy and a non-significant decrease in surgery and guideline-concordant treatment in comparison to non-Indigenous Australian patients. Indigenous Australian NSCLC patients had similar median survival to non-Indigenous Australian NSCLC patients (1.4 vs. 1.5 years).
The Implications: Clinical quality registries have strong capability in describing disparity for vulnerable populations. The earlier age of lung cancer diagnosis raises concerns regarding screening eligibility for Indigenous Australians in the Lung Cancer Screening Program.

1 | Introduction

Confirmation of equity, disparity and unwarranted clinical variation in disease outcomes is a cornerstone of quality of care [1]. Inequitable outcomes are well recognised in cancer care and frequently associated with socio-economic, ethnic and geographic inequalities [2, 3].

The proportion of patients identifying as Indigenous Australian background is about 1.0% in Victoria, Australia [4]. Registry studies have suggested Indigenous Australians have a much higher incidence of smoking-related cancers, with incidence levels increasing in remote areas [5], and are more likely to present with preventable cancers, diagnosed in late stage with poor prognosis [6, 7].

Observational studies of lung cancer in Indigenous Australians have suggested increased risk of suboptimal treatment, and lack of treatment, compared with non-Indigenous Australians [7, 8]. The risk of cancer death among Indigenous Australians is increased, as are competing death risks [9–11]. Indigenous Australians have been observed to have a significant survival disadvantage compared with non-Indigenous Australians following a lung cancer diagnosis (median survival, 4.3 vs. 10.3 months) [7, 12].

A qualitative study of lung cancer management suggests that barriers to optimal care may include healthcare preferences, language and communication, and sociodemographic factors [13]. Reduced service access relates to complex interplays of cultural and spiritual values, remoteness, entrenched socio-economic inequality and racism, demanding a multifaceted solution design [14].

We sought to examine lung cancer management and survival outcomes among Indigenous Australians in a contemporary population cohort using the Victorian Lung Cancer Registry (VLCR) [15]. We aimed to identify differences in patient demographics, patient and disease characteristics, management outcomes and survival between Indigenous and non-Indigenous Australian cohorts.

2 | Methods

2.1 | Study Design and Setting

This project was undertaken in collaboration with the Victorian Aboriginal Community Controlled Health Organisation (VACCHO). It was a retrospective observational cohort study, using prospectively collected data on all consecutively registered patients in the VLCR between 18 January 2011 and 24 January 2024. The VCLR is a clinical quality registry collecting data on patients with a principal diagnosis of lung cancer identified through 50 participating hospitals in Victoria, Australia, including metropolitan, regional, public and private hospitals [16, 17]. Patients are identified using coded admission data (International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification), and data are collected by medical record review by trained data collectors.

2.2 | Participants

Eligible patients included those who had newly diagnosed primary lung cancer, were 18 years or older and were receiving treatment or were admitted to a VLCR participating hospital. A letter of invitation and opt-out consent to participation in the VLCR is sent to patients before they are added to the registry. Registry participants were excluded if they had secondary lung cancer, mesothelioma, disease diagnosed before the health service-specified commencement date or opted out of registry consent. Letters of invitation to participate in the VLCR have been sent to all major hospitals in Victoria.

2.3 | Variables

2.3.1 | Demographic Variables

Basic patient demographics were collected, including Indigenous Australian status [18], socio-economic status and region of residence (capital cities, secondary cities, regional areas—Modified Monash Model). Socio-economic status was ranked based on population-based quintiles using the Index of Relative Socio-economic Advantage and Disadvantage (IRSAD), with a score of 1 indicating greatest disadvantage and 5 indicating least disadvantage, identified by patient residential postcode [19]. Sex was classified according to the patient's biological and physical characteristics assigned at birth.

2.3.2 | Clinical Variables

Smoking status was categorised as never smoked, ex-smoker and current smoker. Performance status was defined using the Eastern Cooperative Oncology Group (ECOG) scale from score 0, fully active, to score 4, completely disabled [20]. Comorbidities, which included diabetes mellitus, renal insufficiency, myocardial infarction, respiratory disease and neoplastic disease, were confirmed by medical record documentation, as previously reported [21].

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2.3.3 | Cancer Variables

Cancer type was defined histologically as small cell lung cancer (SCLC) or non-small cell lung cancer (NSCLC). Cancer staging was categorised using the tumour, nodes and metastases (TNM) system, into localised (stage I–II), locally advanced (stage III) and metastatic (stage IV) disease [22].

2.3.4 | Hospital and Location Characteristics

Hospital status was categorised as public or private and metropolitan or regional. The treating hospital for each patient was defined as the hospital used for the first treatment—surgery, radiotherapy or systemic anti-cancer therapy (SACT).

Location data were used to determine time taken to drive to hospital [23]. This was also used to estimate the travel time between postcode of residence to postcode of treating hospital. A minimum travel time of 15 min was set, even if the patient lived in the same postcode as the hospital.

Patients and treating hospital locations were defined based on the 2019 Modified Monash Model of locality classification, containing seven categories from MM1, metropolitan, to MM7, very remote communities [24]. Residential status was then categorised as MM1 for metropolitan, MM2 for regional centres, and MM3–MM7 for rural/remote centres.

2.3.5 | Treatment Variables

Timeliness intervals identified in the Optimal Care Pathways, as defined by Cancer Australia, included referral to diagnosis interval (target < 28 days), diagnosis to treatment interval (target < 14 days) and referral to treatment interval (target < 42 days) [25]. Management variables included discussion at a multi-disciplinary meeting (MDM), psychosocial distress screening and molecular testing for programmed death-ligand 1, epidermal growth factor receptor, anaplastic lymphoma kinase and oncogene fusion driver status in NSCLC patients.

Treatment provided was categorised as guideline-concordant treatment (GCT), non-GCT or no treatment received. GCT was defined as the minimal treatment patients should receive based on the National Comprehensive Cancer Network guidelines [26, 27]. Non-GCT was defined as treatment inconsistent with the guidelines. Treatments recommended for Stage I–II NSCLC include surgical resection and stereotactic ablative body radiotherapy. GCT for operable Stage III NSCLC is surgical resection with adjuvant SACT, and SACT and radiotherapy for inoperable Stage III NSCLC. Minimal treatment for Stage IV NSCLC is SACT. SACT includes chemotherapy, targeted therapies and immunotherapy.

Survival analysis was evaluated in the overall population, in landmark analysis (excluding all patients who died within 28 days of diagnosis) and in propensity-matched analysis.

2.4 | Bias

The VLCR collects consecutive diagnoses from all participating hospitals, but bias may be introduced from diagnoses from non-participating hospitals. It is possible that Indigenous Australian patients living in regional areas may be under-represented. There is also a possibility that patients not included in the registry data differ in characteristics and variables from those who are included. Information bias is controlled for by data validation using the VLCR data dictionary.

2.5 | Statistical Methods

Patient, disease and management characteristics of Indigenous and non-Indigenous Australian patients were compared using the chi-squared test, Wilcoxon rank-sum test or Fisher's exact test for count data. Univariable and multivariable analyses assessing impact of Indigenous status on overall survival were performed using backward stepwise Cox proportional hazards regression with results presented as adjusted hazard ratios (aHRs) and 95% confidence intervals. Variables with $p < 0.05$ on univariable analyses or those deemed to be clinically relevant were entered into a hierarchical regression model to assess the independent association between Indigenous status and survival.

Overall survival was calculated from date of diagnosis until death or census date (10 January 2024). The Kaplan–Meier product-limit method was used to plot survival as a function of time and comparisons between survival curves were made via the log-rank test. Sensitivity analysis was conducted using landmark analysis (excluding patients who died within 28 days of diagnosis), and propensity score matching methods were used to account for confounding factors. Propensity scores were generated using a multivariable logistic regression model with Indigenous status as the dependent variable and baseline characteristics that were unbalanced between groups or had clinical relevance as the independent variables (age, sex, ECOG performance status, comorbidities, histological type, clinical stage, hospital location and hospital type).

All calculated p values were two-tailed and a $p < 0.05$ indicated statistical significance. Statistical analyses were performed using R version 4.4 (https://www.r-project.org).

2.6 | Ethics Statement

This study was approved by the Monash University Human Research Ethics Committee (project number 43554) with the support of VACCHO. This study involved Indigenous Australian investigators (KEG, JC), who provided oversight in conceptualisation, manuscript writing and revisions and ensured Indigenous values and perspectives were respected throughout the study. This article was reported in line with the Consolidated Criteria for Strengthening Reporting of Health Research Involving Indigenous Peoples statement and the Strengthening the Reporting of Observational studies in Epidemiology Statement (CONSIDER checklist and STROBE statement in Supporting Information) [28].

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3 | Results

3.1 | Participants

The study included 17,625 individuals, of whom 186 (1.06%) identified as Indigenous and 17,439 were non-Indigenous Australian; 232 (1.30%) patients excluded due to unknown heritage status (Table 1). Indigenous Australian patients had a lower median age compared with non-Indigenous patients (median, 62 years [IQR, 55–69 years] vs. median, 71 years [IQR, 63–77 years]; $p < 0.001$) (Figure 1). Indigenous Australian patients were more likely to be current smokers (65% vs. 35%) and less likely to be never smokers (1.7% vs. 13%). The Indigenous Australian cohort were more likely to live rural and remote areas (74 [40%] vs. 4059 [23%]), have longer driving time to hospital (> 3 h: 32 [17%] vs. 1038 [6%]) and live in areas of lower socio-economic status (lowest IRSAD quintile: 57 [31%] vs. 3274 [19%]; $p < 0.001$). The two cohorts had similar cancer type (NSCLC, 88%) and cancer stage at diagnosis (stage IV: 81 [52%] vs. 7399 [54%]), but Indigenous Australian patients had higher levels of respiratory comorbidity (34% vs. 23%) and lower levels of neoplastic comorbidity (13% vs. 21%).

3.2 | Management Outcomes

Indigenous Australian patients were more likely to be treated in public hospitals (176 [96%] vs. 14,543 [83%]) and regional hospitals (49 [26%] vs. 2440 [14%]) (Table 2). Indigenous and non-Indigenous cohorts had similar management timeliness trajectories, similar likelihood of MDM presentation (132 [71%] vs. 11,803 [68%]) and similar psychosocial supportive care needs screening (51 [27%] vs. 5213 [30%]). Although not statistically significant, there was a lower overall proportion of Indigenous Australian patients receiving GCT compared with non-Indigenous patients (82 [51%] vs. 8036 [56%]). Propensity-matched analysis revealed similar likelihood of GCT for Indigenous Australians compared with non-Indigenous patients (52% vs. 55%; $\chi^2 = 0.2$) (Table S1) and a reduced proportion of Indigenous Australian patients with NSCLC receiving GCT (Figure 2). Indigenous Australian patients were more likely to receive radiotherapy (104 [56%] vs. 7923 [45%]) (Table 2). Indigenous and non-Indigenous cohorts had similar levels of EGFR molecular testing (54 [29%] vs. 5940 [34%]) and SACT (94 [51%] vs. 8956 [51%]).

3.3 | Impacts of Patient and Clinical Variables on Survival

An adjusted multivariable Cox regression analysis was undertaken to assess patient and clinical factors associated with overall survival, evaluating 15,538 NSCLC and 2085 SCLC patients (Table S2). Male sex (female aHR, 0.83 [95% CI, 0.8–0.86]), older age groups (age 70–79 years aHR, 1.32 [95% CI, 1.2–1.4]; reference, < 50 years), smoking status (current smoker aHR, 1.72 [95% CI, 1.6–1.8]; reference, never smoker), poorer performance status (ECOG 2 aHR, 1.98 [95% CI, 1.7–2.4]; reference, ECOG 0), higher clinical stage (stage IV aHR, 6.04 [95% CI, 5.6–6.5]; reference, stage I), SCLC (aHR, 1.5 [95% CI, 1.4–1.6]), myocardial infarction (aHR, 1.06 [95% CI, 1.0–1.1]), renal insufficiency (aHR, 1.22 [95% CI, 1.1–1.4]), and residence in regional centres (aHR, 1.19 [95% CI, 1.1–1.3]) and rural/remote regions (aHR, 1.19 [95% CI, 1.1–1.3]) were associated with poorer survival outcomes.

3.4 | Survival

Overall median survival following lung cancer diagnosis was similar for Indigenous Australians (1.40 years [95% CI, 0.94–2.00]) and the non-Indigenous cohort (1.50 years [95% CI, 1.4–1.6]; aHR 1.06 [95% CI, 0.88–1.27]) (Figure 3). Survival outcomes were similar for NSCLC and SCLC overall and by stage groupings except for SCLC limited stage where insufficient data were available for analysis.

Adjusted survival analysis controlling for factors having significant impact on multivariable cox regression analysis (Table S2) found no significant survival difference for lung cancer overall between Indigenous Australians and the non-Indigenous cohort (Indigenous Australian cohort aHR, 0.99 [95% CI, 0.83–1.2]).

Landmark median survival analysis (Indigenous Australian cohort, 5.4% vs. non-Indigenous cohort, 5.8%; $p > 0.90$) found similar survival for the Indigenous Australians (160 patients; median survival, 1.6 years [95% CI, 1.1–2.4 years]) and non-Indigenous cohort (16,428 patients; median survival, 1.8 years [95% CI, 1.8–1.9 years]; aHR, 1.13 [95% CI, 0.92–1.39]). Median survival in NSCLC was non-significantly lower for the Indigenous Australian cohort (1.4 years [95% CI, 0.94–2.5 years]) than the non-Indigenous cohort (1.9 years [95% CI, 1.8–1.9]; aHR, 1.16 [95% CI, 0.94–1.43]).

Indigenous Australian and non-Indigenous cohorts had similar median survival in propensity-matched analysis with Indigenous Australian mortality (Indigenous Australian median survival, 1.4 years [95% CI, 0.95–2.2] vs. non-Indigenous median survival, 1.8 years [95% CI, 1.4–3.0]; non-Indigenous aHR, 1.13 [95% CI, 0.87–1.48]) (Figure S1). There were no significant differences in survival for NSCLC (Indigenous Australian median survival, 1.4 years [95% CI, 0.99–2.5] vs. non-Indigenous median survival, 2.3 years [95% CI, 1.8–4.7]; non-Indigenous aHR 1.28 [95% CI, 0.95–1.73]) and there were insufficient numbers of patients with SCLC for propensity-matched analysis (Figure S2). Propensity-matched survival was also similar for Indigenous Australian and non-Indigenous cohorts receiving GCT, non-GCT and no treatment (Figure S3).

4 | Discussion

Indigenous Australian patients were diagnosed with lung cancer at a younger age, were more likely to be current smokers and more likely to be diagnosed and managed in regional and public hospitals with longer driving time to treatment centres. Survival outcomes were not significantly different from the non-Indigenous cohort despite the substantial difference in age at diagnosis.

Disparities in lung cancer care and outcomes between Indigenous Australian and non-Indigenous patients can be attributed to risk factor exposures, regionality, cultural differences and socio-economic disadvantage resulting in poorer access to healthcare services [14]. Smoking is the leading preventable risk factor

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TABLE 1 | Patient characteristics.

Characteristic	Number (%) of patients			*p**
	Overall (*N* = 17,625)	Non-Indigenous (*n* = 17,439)	Indigenous (*n* = 186)	
Age category				< 0.001
< 50 years	759 (4.3%)	730 (4.2%)	29 (16%)	
50–59 years	2279 (13%)	2233 (13%)	46 (25%)	
60–69 years	5313 (30%)	5241 (30%)	72 (39%)	
70–79 years	6306 (36%)	6275 (36%)	31 (17%)	
80–89 years	2742 (16%)	2734 (16%)	8 (4.3%)	
90 years and over	226 (1.3%)	226 (1.3%)	0 (0%)	
Sex				
Male	9798 (56%)	9704 (56%)	94 (51%)	0.16
Female	7827 (44%)	7735 (44%)	92 (49%)	
Smoking status				< 0.001
Never	2161 (13%)	2158 (13%)	3 (1.7%)	
Ex-smoker	8870 (52%)	8810 (52%)	60 (33%)	
Current smoker	6081 (36%)	5963 (35%)	118 (65%)	
Missing	513	508	5	
Residential status				< 0.001
Metropolitan	12,061 (68%)	11,979 (69%)	82 (44%)	
Regional centres	1420 (8.1%)	1390 (8.0%)	30 (16%)	
Rural/remote	4133 (23%)	4059 (23%)	74 (40%)	
Missing	11	11	0	
IRSAD quintile				< 0.001
1	3331 (19%)	3274 (19%)	57 (31%)	
2	2364 (13%)	2312 (13%)	52 (28%)	
3	3559 (20%)	3524 (20%)	35 (19%)	
4	3243 (18%)	3220 (18%)	23 (12%)	
5	5119 (29%)	5100 (29%)	19 (10%)	
Missing	9	9	0	
Driving time to hospital				< 0.001
< 1 h	13,892 (79%)	13,774 (79%)	118 (63%)	
1–3 h	2659 (15%)	2623 (15%)	36 (19%)	
> 3 h	1070 (6.1%)	1038 (6.0%)	32 (17%)	
NSCLC	15,540 (88%)	15,376 (88%)	164 (88%)	> 0.99
SCLC	2085 (12%)	2063 (12%)	22 (12%)	
Clinical stage				0.45
I	2544 (18%)	2518 (18%)	26 (17%)	
II	1279 (9.2%)	1267 (9.2%)	12 (7.7%)	
III	2631 (19%)	2594 (19%)	37 (24%)	

(Continues)

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TABLE 1 | (Continued)

Characteristic	Number (%) of patients			*p**
	Overall (*N* = 17,625)	Non-Indigenous (*n* = 17,439)	Indigenous (*n* = 186)	
IV	7480 (54%)	7399 (54%)	81 (52%)	
Missing	3691	3661	30	
ECOG performance status				0.07
0	4109 (34%)	4081 (34%)	28 (23%)	
1	5323 (44%)	5260 (44%)	63 (51%)	
2	1848 (15%)	1826 (15%)	22 (18%)	
3	785 (6.4%)	777 (6.4%)	8 (6.5%)	
4	107 (0.9%)	105 (0.9%)	2 (1.6%)	
Missing	5453	5390	63	
Comorbidities				
Diabetes mellitus	2793 (16%)	2757 (16%)	36 (19%)	0.19
Renal insufficiency	381 (2.2%)	377 (2.2%)	4 (2.2%)	> 0.99
Myocardial infarction	2642 (15%)	2615 (15%)	27 (15%)	0.856
Respiratory disease	4152 (24%)	4088 (23%)	64 (34%)	< 0.001
Neoplastic disease	3619 (21%)	3594 (21%)	25 (13%)	0.016
No comorbidities	7914 (45%)	7830 (45%)	84 (45%)	0.94

Abbreviations: ECOG, Eastern Cooperative Oncology Group; IRSAD, Index of Relative Socio-economic Advantage and Disadvantage; NSCLC, non-small cell lung cancer; SCLC, small cell lung cancer.
*Pearson's chi-squared test.

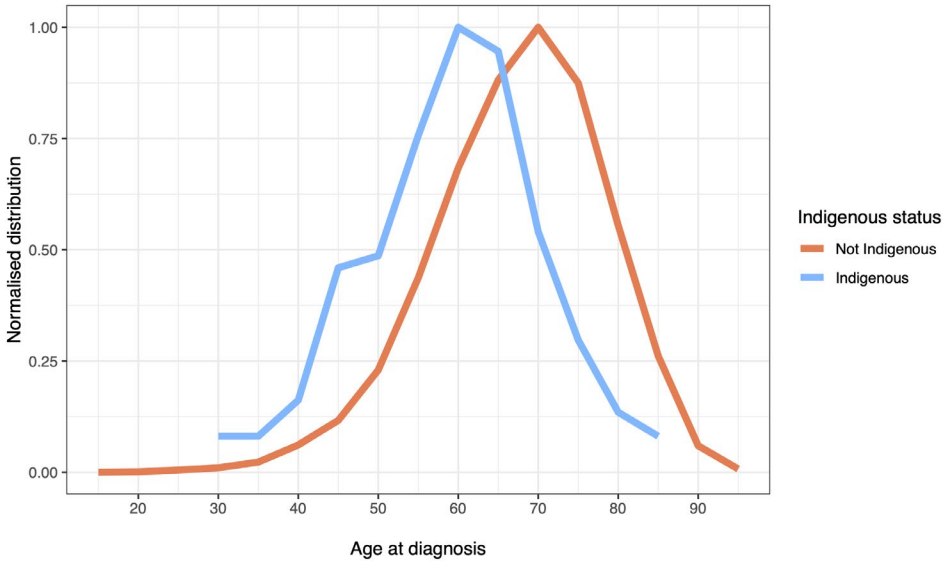

FIGURE 1 | Age distribution of Indigenous and non-Indigenous lung cancer patients in Victoria.

for lung cancer, and smoking rates in Australian Indigenous communities are estimated to be 2.9 times higher than in non-Indigenous communities [29].

The difference in expected survival for Indigenous Australian males is 8.6 years shorter than non-Indigenous males (71.6 vs. 80.2 years) and similarly 7.8 years for females (75.6 vs. 83.4 years) [30]. Indigenous Australians are less likely to have curative treatment recommended and, when given the option of treatment, are less likely to choose or complete treatment (relative risk, 2.5 [95% CI, 2.1–3.0]) [31]. Cultural safety of treatment providers heavily impacts on failure to engage with treatment. Factors that contribute to this include miscommunication, difference in verbal and body language, spiritual beliefs in cancer diagnosis, inadequate information provision and difficulty accessing healthcare in remote areas [32].

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TABLE 2 | Lung cancer management outcomes.

Characteristic	Number (%) of patients			
	Overall ($N=17,625$)	Non-Indigenous ($n=17,439$)	Indigenous ($n=186$)	p*
Hospital type				<0.001
Public	14,721 (84%)	14,543 (83%)	178 (96%)	
Private	2904 (16%)	2896 (17%)	8 (4.3%)	
Hospital region				<0.001
Metropolitan	15,136 (86%)	14,999 (86%)	137 (74%)	
Regional	2489 (14%)	2440 (14%)	49 (26%)	
Diagnosis <28 days from referral[a]	11,011 (69%)	10,894 (69%)	117 (68%)	0.89
Treatment commenced <14 days from diagnosis[a]	5977 (39%)	5917 (39%)	60 (37%)	0.59
Treatment commenced <42 days from referral[a]	6589 (48%)	6517 (47%)	72 (48%)	0.84
MDM discussion	11,935 (68%)	11,803 (68%)	132 (71%)	0.34
Psychosocial supportive care screening	5264 (30%)	5213 (30%)	51 (27%)	0.5
GCT[a]	8118 (55%)	8036 (56%)	82 (51%)	0.12
Non-GCT[a]	3616 (25%)	3565 (25%)	51 (32%)	
No treatment[a]	2899 (20%)	2871 (20%)	28 (17%)	
Surgical resection	3752 (21%)	3719 (21%)	33 (18%)	0.24
SACT performed	9050 (51%)	8956 (51%)	94 (51%)	0.82
Radiotherapy performed	8027 (46%)	7923 (45%)	104 (56%)	0.004
EGFR test performed	5994 (34%)	5940 (34%)	54 (29%)	0.15
ALK test performed	5100 (29%)	5043 (29%)	57 (31%)	0.61
ROS1 test performed	1777 (10%)	1751 (10%)	26 (14%)	0.08
PD-L1 test performed	8035 (46%)	7947 (46%)	88 (47%)	0.64

Abbreviations: ALK, anaplastic lymphoma kinase; EGFR, epidermal growth factor receptor; GCT, guideline concordant treatment; MDM, multidisciplinary meeting; PD-L1, programmed death-ligand 1; ROS1, oncogene fusion driver; SACT, systemic anti-cancer therapy.
*Pearson's chi-squared test.
[a]Percentages were calculated excluding missing values. Missing data count for diagnosis <28 days from referral (overall $n=1566$, non-Indigenous $n=1551$, Indigenous $n=15$); treatment commenced <14 days from diagnosis (overall $n=2430$, non-Indigenous $n=2405$, Indigenous $n=25$); treatment commenced <42 days from referral (overall $n=3768$, non-Indigenous $n=3731$, Indigenous $n=37$); GCT, non-GCT and no treatment (overall $n=2992$, non-Indigenous $n=2967$, Indigenous $n=25$).

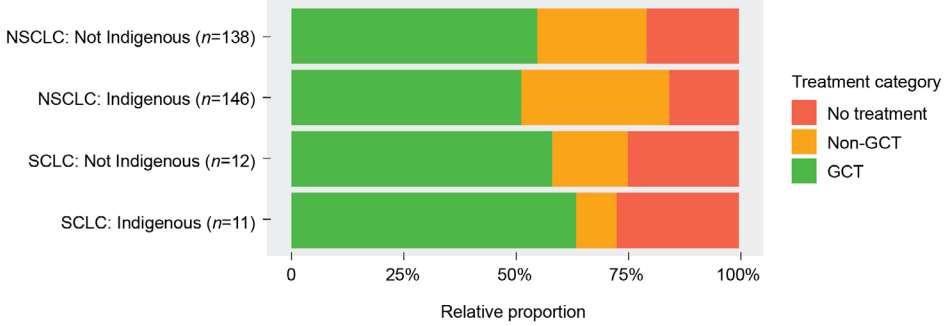

FIGURE 2 | Propensity-matched comparison of GCT. GCT, guideline concordant treatment; NSCLC, non-small cell lung cancer; SCLC, small cell lung cancer.

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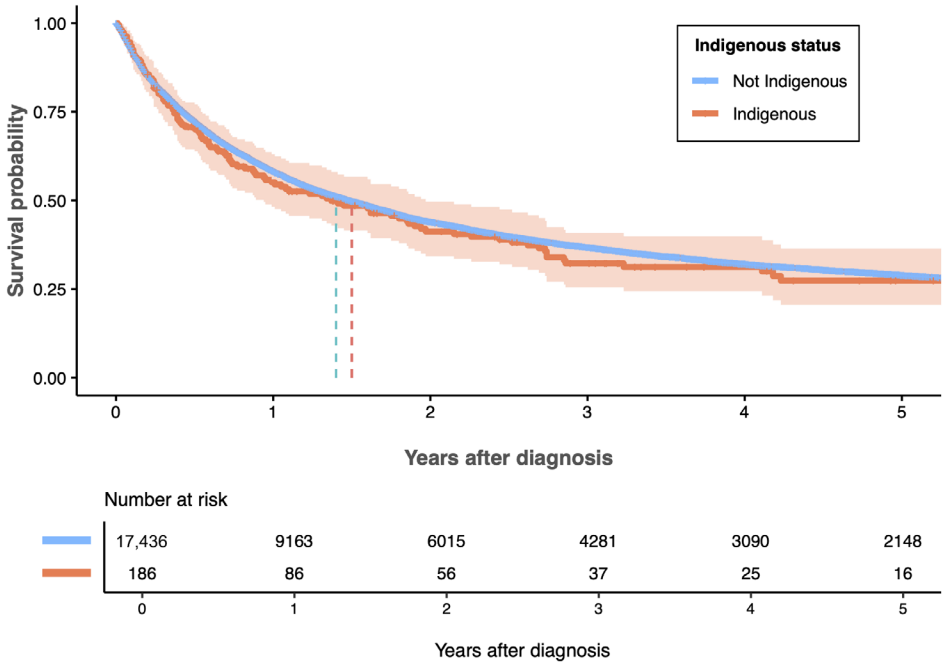

Indigenous status	*n*	1 year survival (95% CI)	Median survival, years (95% CI)	Hazard ratio (95% CI)	*P*
Not Indigenous	17,436	58.0% (57.3–58.8)	1.5 (1.4–1.6)	Ref	Ref
Indigenous	186	55.1% (48.2–63)	1.4 (0.94–2.0)	1.04 (0.87–1.25)	0.6

FIGURE 3 | Overall survival following lung cancer diagnosis of Indigenous and non-Indigenous Australians in Victoria.

This evaluation identifies slight variation in delivered treatments to Indigenous Australians compared with non-Indigenous populations, showing increased radiotherapy delivered to Indigenous populations and non-significant trends to reduced surgery and GCT for Indigenous Australian populations. The explanation for these trends is uncertain but factors requiring further evaluation include advanced disease at presentation, healthcare access and healthcare availability.

Lung cancer was the most diagnosed cancer among the Indigenous Australian population between 2009 and 2013, with a 2.1 times higher incidence rate compared with non-Indigenous people (85 per 100,000 vs. 41 per 100,000) [33]. The mortality rate for lung cancer was 1.8 times higher for Indigenous Australian people (57 per 100,000) than for non-Indigenous people (31 per 100,000).

Australians living in rural and remote Australia have worse cancer outcomes than those living in major cities, presenting with later stage disease, poorer access to cancer treatment and poorer overall survival [33]. A Western Australian lung cancer study suggests that Indigenous Australians living in regional areas waited up to eight times longer than their metropolitan counterparts to see a general practitioner after symptom onset and longer referral times from general practice to specialist review [34]. Less access and longer travel times to health services are major barriers to receiving adequate care and likely contribute to patients' ability to receive GCT.

Multifaceted interventions, enabling policies that target individuals, communities and health professionals, are necessary to improve lung cancer outcomes and disparities [35]. The National Aboriginal Community Controlled Health Organisation (NACCHO) is a representative providing policy guidance to the Australian Government to improve healthcare for Indigenous Australians. NACCHO has developed the Aboriginal and Torres Strait Islander Cancer Plan, which outlines principles in achieving holistic, equitable and culturally safe cancer care [36]. Efforts to improve lung cancer care for Indigenous Australians should align to Area of Focus 1: Enablers for real change, through active collaboration and co-design between the broader Australian healthcare system and the community-controlled sector.

Notably, the National Lung Cancer Screening Program (NLCSP) commenced in Australia on 1 July 2025, with eligibility criteria including age between 50 and 70 years. In this studied cohort, some 16% of the Indigenous Australian cohort were diagnosed at an age < 50 years compared with 4.2% of the non-Indigenous cohort. This finding and the 9-year difference in age at diagnosis questions the appropriateness of eligibility criteria for Indigenous Australian populations for lung cancer screening. The NLCSP also has potential barriers to engagement due to limited access and longer distance to culturally appropriate healthcare, raising the need for mobile screening services and promotion of benefits at local community levels. Program delivery and promotion may be more effective if guided by Indigenous Australian people with personal experience of lung cancer [37].

4.1 | Limitations

This article has a major strength in the use of a single, prospective cohort database, collecting consecutive diagnoses to

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describe disease outcomes for both Indigenous Australian and non-Indigenous cohorts.

Recently, there has been growing concern voiced over the use of the phrase 'no significant difference' when a *p* value fails the 0.05 threshold [38]. However, when hazard ratios suggest increased mortality hazards of 10%–20%, there may be important survival disadvantages which may not be acknowledged when dichotomous statistical categorisation is employed. The low number of Indigenous Australian patients in this study limits generalisability and may reduce statistical power of the study, and should be interpreted with caution.

Remote and very remote communities are likely to be underrepresented in the VLCR, introducing selection bias. There is some lack of certainty regarding notification of Indigenous status among healthcare registries, with recently published articles citing 6.2%–13.3% of populations having no Indigenous status recorded [11, 39]. Such non-disclosure adversely impacts Indigenous Australian population outcome estimates, while linkage with administrative and healthcare datasets may help to overcome this deficiency [40]. Improving identification rates of Aboriginal and Torres Strait Islander people in health service organisations has been prioritised as part of the Australian Government's commitment to Closing the Gap though the National Indigenous Reform Agreement [41].

Additionally, our article cites all-cause mortality rather than lung cancer-specific mortality, due to the limited availability of mortality causation.

There is substantial concern around generalisability of the findings from a Victorian Indigenous population compared with outcomes observed in other Australian Indigenous populations. These issues may relate to culture, language, health care practices and behaviours, health service availability, region, and distance from diagnosing and treating facilities. There is an important need to explore and evaluate equity and unwarranted clinical variation in lung cancer management and outcomes throughout Indigenous Australian populations.

4.2 | Conclusions

Lung cancer provides the highest burden of cancer mortality and continuing evidence confirms inequitable distribution of this disease burden across disadvantaged populations. There is an urgent need to confirm the equity and access to cancer care and outcomes across Australia.

Author Contributions

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Conflicts of Interest

The authors declare no conflicts of interest. Indigenous Australian study investigators (Kalinda E. Griffiths and Justine Clark) provided oversight that was critical to study conceptualisation, important contextualisation of the study and its findings and manuscript development and revisions.

Data Availability Statement

Data are available from the corresponding author upon reasonable request and with the permission of the institution.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Table S1:** Propensity matched management analysis. **Table S2:** Univariate and multivariate assessment of impacts on survival (Cox regression analysis). **Figure S1:** Propensity matched overall survival analysis. **Figure S2:** Propensity matched NSCLC survival analysis. **Figure S3:** Propensity matched overall survival analysis based on receipt of guideline concordant treatment (GCT).

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