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What health inequalities exist in access to, outcomes from and experience of treatment for lung cancer? A scoping review

Laura Lennox ,[1,2] Kate Lambe,[3] Chandni N Hindocha,[1,2] Sophie Coronini-Cronberg[1,2,3,4]

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[1]Primary Care and Public Health, Imperial College London, London, UK
[2]NIHR Applied Research Collaboration Northwest London, London, UK
[3]Chelsea and Westminster Hospital NHS Foundation Trust, London, UK
[4]West London NHS Trust, London, UK

Correspondence to
Dr Laura Lennox;
l.lennox@imperial.ac.uk

ABSTRACT

Objectives Lung cancer (LC) continues to be the leading cause of cancer-related deaths and while there have been significant improvements in overall survival, this gain is not equally distributed. To address health inequalities (HIs), it is vital to identify whether and where they exist. This paper reviews existing literature on what HIs impact LC care and where these manifest on the care pathway.

Design A systematic scoping review based on Arksey and O'Malley's five-stage framework.

Data sources Multiple databases (EMBASE, HMIC, Medline, PsycINFO, PubMed) were used to retrieve articles.

Eligibility criteria Search limits were set to retrieve articles published between January 2012 and April 2022. Papers examining LC along with domains of HI were included. Two authors screened papers and independently assessed full texts.

Data extraction and synthesis HIs were categorised according to: (a) HI domains: Protected Characteristics (PC); Socioeconomic and Deprivation Factors (SDF); Geographical Region (GR); Vulnerable or Socially Excluded Groups (VSG); and (b) where on the LC pathway (access to, outcomes from, experience of care) inequalities manifest. Data were extracted by two authors and collated in a spreadsheet for structured analysis and interpretation.

Results 41 papers were included. The most studied domain was PC (32/41), followed by SDF (19/41), GR (18/41) and VSG (13/41). Most studies investigated differences in access (31/41) or outcomes (27/41), with few (4/41) exploring experience inequalities. Evidence showed race, rural residence and being part of a VSG impacted the access to LC diagnosis, treatment and supportive care. Additionally, rural residence, older age or male sex negatively impacted survival and mortality. The relationship between outcomes and other factors (eg, race, deprivation) showed mixed results.

Conclusions Findings offer an opportunity to reflect on the understanding of HIs in LC care and provide a platform to consider targeted efforts to improve equity of access, outcomes and experience for patients.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Provides first comprehensive summary of the literature published in the last decade pertaining to health inequalities (HIs) and where they may manifest on the lung cancer (LC) patient pathway.
⇒ Two HI classification approaches were employed. One looking at four broad domains; Protected Characteristics; Socioeconomic and Deprivation Factors; Geographical Region; and Vulnerable or Socially Excluded Groups. The second categorising HI according to where on the care pathway they manifest: access to, outcomes from and experience of care.
⇒ This comprehensive approach to studying HIs provides a holistic look at HIs and serves as a mechanism to begin consideration of how, and where, to target efforts to improve equity of LC care for patients.
⇒ Due to the complex nature of the research question and study heterogeneity, assessment of comparable effect sizes, pooling of results or quantitative analysis were not possible.
⇒ HIs in LC care are likely to be under-represented due to restrictions in recruitment and inclusion criteria for research studies investigating HIs (eg, exclusion of those who are homeless, disabled, minority ethnic groups).

INTRODUCTION

It has long been recognised that health policies and interventions do not benefit everyone equally, resulting in health inequalities (HIs). These may be described as, 'unfair and avoidable differences in health across a population, and between different groups in society'.[1] Addressing these systematic differences is a question of social justice.

The global commitment to reduce HIs is reflected in the United Nations' sustainable development goals.[2] In England, there are persistent HIs across the life-course, with disparities in healthy life expectancy rising in the last decade.[3] This is despite explicit duties requiring the taxpayer-funded and universal National Health Service (NHS) to reduce unwarranted variation by having: 'regard to the need to reduce inequalities between

patients in access to health services and the outcomes achieved'.[4] Building on this, the NHS Long Term Plan,[5] outlines ambitions for the whole health system to close the gap on HIs and set specific targets such as significantly improving cancer survival.

The urgent need to reduce HIs has received particular focus due to the COVID-19[6] pandemic, both globally and within England.[7] It accentuated the inequitable access to hospital treatment, including cancer services[8]: for example, the shift to remote consultations[9] disproportionately, negatively impact already-vulnerable groups and their ability to access healthcare.[9 10] Following the first COVID-19 wave in 2020, the NHS announced it was accelerating the equitable and inclusive restoration of non-COVID-19 health and care services to enable all population groups to benefit equally.[7] An explicit new goal was set for the NHS to deliver, 'exceptional quality healthcare for all through equitable access, excellent experience, and optimal outcomes'.[11]

HIs in lung cancer

Lung cancer (LC) originates in the lung due to uncontrolled growth of abnormal cells.[12] The most common types are small cell LC (SCLC) and non-small cell LC (NSCLC).[13] As the leading cause of cancer-related deaths, LC is an important global public health issue.[14] In the UK, LC is the third most common cancer accounting for 16%–18% of all new cancer cases and 21% of all cancer deaths.[15] Annually, LC costs the UK economy £2.4 billion which is far higher than any other cancer.[16] While recent years have seen significant overall improvements in LC survival, driven by improved awareness, earlier diagnosis and increasing rates of curative treatment, this trend of improvement is not equally distributed among all population groups.[17] For example, people of lower socioeconomic status have lower LC survival[18 19] and higher early LC mortality rates[20] and patients living in more socioeconomically deprived circumstances; from minority background; lower income or lower education are less likely to receive treatment including surgery, chemotherapy or radiotherapy.[19 21]

Aims and objectives

To address HIs, it is vital to identify whether and where any exist. Clinical pathways are a common point of intervention for health system improvement initiatives and may, for example, be used to reduce unwarranted variation, enhance care quality or improve outcomes.[22] In line with emerging national policy in England,[23 24] the purpose of this review was to identify relevant existing literature to understand which HIs affect access to, outcomes from and experience of, a cancer pathway, using LC as an example.

METHODS

A systematic scoping review was conducted based on Arksey and O'Malley's five-stage framework[25] using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews.[26 27]

Identifying the research question

The research questions were established through discussion between authors and agreed as:

1. What HIs impact LC care?
2. Where do HIs manifest on the LC care pathway (access, experience, outcomes)?

Identifying relevant studies

An online search was conducted in April 2022 (online supplemental file 1: Full search strategy). The following Cochrane Medical Subject Headings(MESH), derived terms were used: ("health inequalit*" OR "health inequit*" OR "health disparit*" OR equalit* OR equit* OR inequality* inequit*) AND ("lung cancer"). The following databases were searched: EMBASE, HMIC, Medline, PsycINFO and PubMed. To provide conclusions and recommendations using the most up-to-date literature,[28] search date limits were set to retrieve articles published in the last 10 years (January 2012 to April 2022). Snowballing of reference lists for included papers was also conducted (see figure 1).

Study selection

Papers specifically looking at primary LC (SCLC and NSCLC) which examined domains of HI in relation to access to, outcomes from or experience of the LC pathway were included. The following types of papers were excluded: non-English language; study protocols; supplementary files; conference proceedings; editorials and opinion pieces. Investigations of other types of cancer or medical condition in conjunction to LC; those looking solely at factors such as risk and incidence relating to LC; LC screening (which is not currently endorsed as part of the LC pathway[29 30]) were also excluded. Due to the complexity of reported changes in HIs restricting the ability to present a single finding, papers focused on trend data were excluded. Two authors screened papers based on title and abstract, and then assessed the full texts. Any discrepancies were resolved by discussion.

Charting the data

Data was organised using COVIDENCE,[31] an online screening and extraction tool, and collated in a Microsoft Excel spreadsheet, allowing data to be sorted into themes, promoting structured analysis and interpretation.[25] Extracted variables included: author; year of publication; country of study; study design; population type; sample size; HI domain examined and point on care pathway (access, outcomes, experience). Data were independently retrieved by two authors and verified by a third author.

Collating, summarising and reporting the results

Examining HIs

The definition of HI factors varies across different contexts and settings.[32] To apply findings to an NHS context, HIs were categorised in two separate ways. First, they were

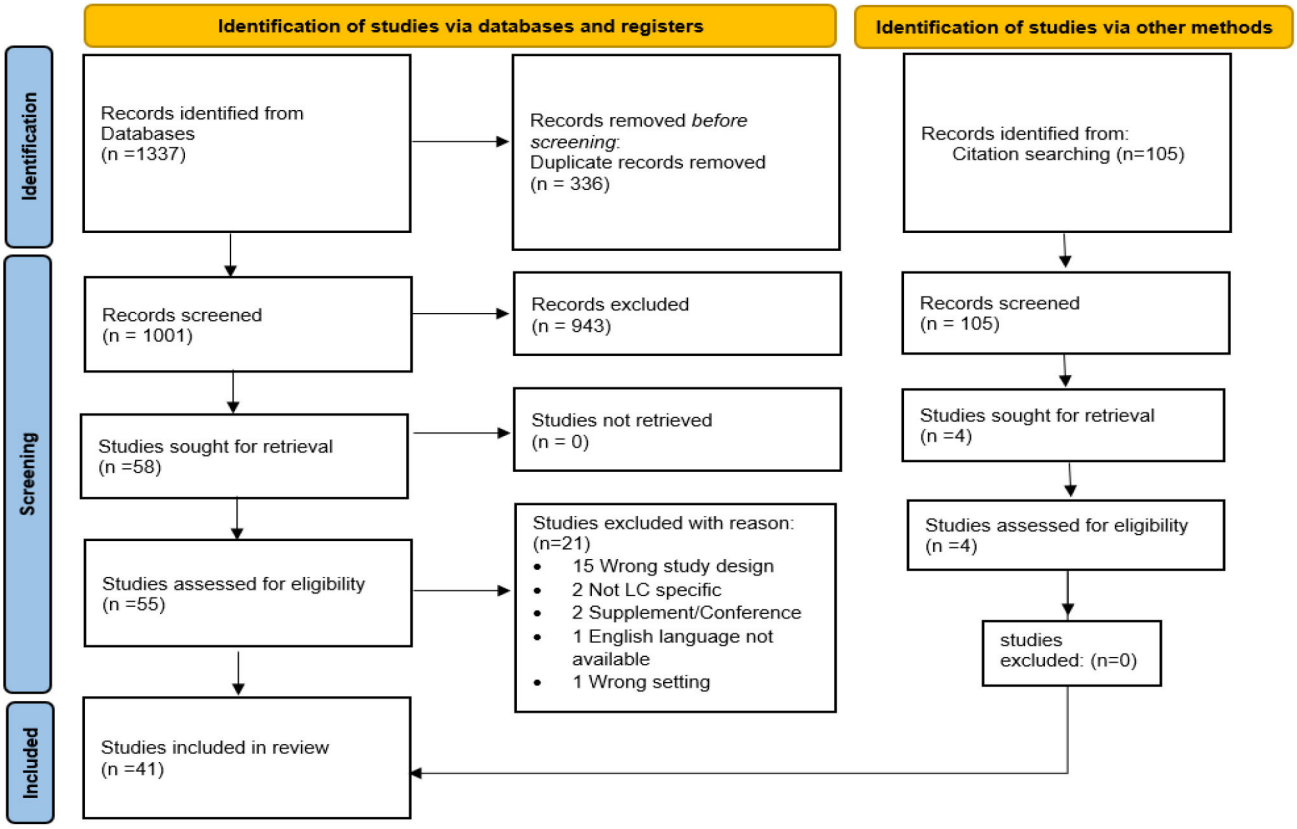

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram illustrating the process of identification, screening, eligibility and exclusion of papers (adapted from PRISMA 2020 statement[27]). LC, lung cancer.

considered across four broad HI domains which have been adapted from national guidance.[33]

1. *Protected Characteristics* (*PC*) as set out in the Equality Act,[34] for example, sex, race, religion, marital status or disability. For this review, 'race' encompasses nationality, skin colour and ethnic origin[1 34] and 'sex' includes sex, and gender.[1]
2. *Socioeconomic and Deprivation Factors* (*SDF*), for example, income, area deprivation.
3. *Geographical Region* (*GR*), for example, where people live or work for example, urban, rural, coastal.
4. *Vulnerable or Socially Excluded Groups* (*VSG*), which are not routinely well-provided for by healthcare services, for example, traveller communities, refugees, insecure housing tenure, etc.

These domains are not exhaustive; therefore, classification is open to interpretation. Even where domains are clearly defined, they may still overlap or transcend one another.[35]

The second approach to categorising HIs follows NHS England's (NHSE) approach,[24 36] whereby HIs are categorised according to where on the care pathway they manifest:

- *Access to health services*: uptake of diagnostics; treatment (including surgery, chemotherapy, radiotherapy); palliative care; or supportive care (eg, pain management, nutritional support, counselling).
- *Experience*: encompassing views of patients, their families and carers, but also the staff providing care.[37–39]
- *Health outcomes*: formal diagnosis and tumour staging; mortality and survival rates.[40]

Results reporting

Results were summarised narratively to present study characteristics, HI domains identified in LC care, and point of HIs on the care pathway. Study heterogeneity did not allow for any pooling of results or quantitative analysis.

Patient and public involvement

None.

RESULTS

Following the database searches, screening and snowballing, 41 papers were included in this review (figure 1), with summary characteristics presented in table 1. Two-thirds of studies were conducted in the USA (68.3%), followed by the UK (7.3%).

Identifying HIs impacting LC care

All four HI domain categories were represented within the reviewed articles, with 24 HI factors investigated (figure 2). The most studied HI domain was *PC* in 78.0% (32/41) of papers. Within the PC domain, race was the

Table 1 Summary characteristics of included papers (n=41)

Author	Year	Location	Study population	Sample size (n)	Health inequality domain(s) explored	Access	Outcomes	Experience
Andrykowski *et al*,[70]	2014	USA	LC survivors (aged 18+), 10–15 months post-diagnosis	193	GR	N	N	Y
Annesi *et al*,[41]	2022	USA	Black and white patients diagnosed with NSCLC during 2004–2016	229 018	GR; PC	Y	Y	N
Ascha *et al*,[42]	2020	USA	Medicare patients with LC with brain metastases	74 142	PC	Y	Y	N
Atkins *et al*,[52]	2017	USA	Patients diagnosed with LC between 2000 and 2006	348 002	GR; VSG	Y	Y	N
Backhus *et al*,[66]	2013	USA	County level data. No defined population	US population 296 314 208	GR; PC	N	Y	N
Bergamo *et al*,[59]	2014	USA	Individuals ≥66 years of age with NSCLC with schizophrenia	96 702	PC; VSG	Y	Y	N
Berglund *et al*,[60]	2012	UK	Patients with LC	15 582	PC; SDF	Y	Y	N
Check *et al*,[43]	2018	USA	Patients with NSCLC	5786	PC	Y	N	N
Cheyne *et al*,[78]	2013	UK	Patients with LC	1432	SDF	Y	Y	N
Concannon *et al*,[72]	2020	USA	Patients with NSCLC	162	GR; SDF; VSG	Y	Y	N
Dalwadi *et al*,[44]	2019	USA	Patients with LC age 60+ (stage I NSCLC)	62 312	PC	Y	Y	N
Elkbuli *et al*,[64]	2020	USA	Patients with LC	179 630	PC	N	Y	N
Erhunmwunsee *et al*,[73]	2012	USA	Patients with complete tumour staging and complete address in census	4820	SDF	N	Y	N
Evans *et al*,[53]	2017	Canada	Patients with LC	32 502	GR; PC; SDF; VSG	Y	N	N
Ganti *et al*,[45]	2014	USA	Patients with NSCLC	82 414	PC	Y	Y	N
Gibberd *et al*,[46]	2016	Australia	Patients with NSCLC	20 154	PC; VSG	Y	Y	N
Holmes *et al*,[119]	2018	USA	Patients with NSCLC	White=1 23 388; African American=11 824	PC	Y	N	N

Continued

Table 1 Continued

Author	Year	Location	Study population	Sample size (n)	Health inequality domain(s) explored	Access	Outcomes	Experience
John *et al*,[67]	2014	USA	Patients aged ≥21 years within 4 months of diagnosis	378	PC; SDF; VSG	N	N	Y
Johnson *et al*,[47]	2016	USA	Patients with LC	8322	GR; PC; SDF	Y	Y	N
Johnson *et al*,[48]	2020	USA	Patients with NSCLC	22 750	GR; PC; SDF	Y	Y	N
Koshy *et al*,[120]	2015	USA	Patients with primary NSCLC and received all or part of their first course of treatment	39, 822	GR; PC; SDF	Y	N	N
Lee *et al*,[121]	2020	USA	Patients with LC from 50 US states	1 087 810	GR	N	Y	N
Mazor *et al*,[68]	2022	USA	Patients with NSCLC or SCLC	99	PC	N	N	Y
Mehta *et al*,[122]	2012	USA	Patients with NSCLC	62 514	PC; SDF; VSG	Y	N	N
Morere *et al*,[69]	2015	France	'Representative sample' (aged 40–75)	1603	SDG; VSG	Y	N	N
Morgan *et al*,[106]	2020	USA	Patients with LC	36 469	PC	Y	N	N
Nadpara *et al*,[58]	2016	USA	Patients with LC	1689 (cohort A) and 1924 (cohort B) patients	GR; PC; VSG	Y	Y	N
Neroda *et al*,[49]	2021	USA	Patients with NSCLC	3616	PC; SDF	Y	N	N
Nur *et al*,[61]	2015	UK	Patients with NSCLC	192 658	GR; PC; SDF	Y	Y	N
Osuoha *et al*,[54]	2018	USA	Patients with LC	12 964	GR; PC	Y	Y	N
Pilleron *et al*,[62]	2021	New Zealand	Patients with LC	22 487	PC; SDF; VSG	N	Y	N
Rapp *et al*,[51]	2020	USA	Patients with NSCLC	56 534	GR; PC; SDF	Y	Y	N
Ray *et al*,[55]	2020	USA	Patients with NSCLC	6259	GR; SDF	Y	Y	N
Schroder *et al*,[107]	2020	Germany	Individuals with LC on statutory health insurance	3 163 211	SDF	N	Y	N
Shin *et al*,[123]	2019	South Korea	Patients with LC	57 400	PC	Y	Y	N
Starr *et al*,[124]	2012	Denmark	Patients with NSCLC	5, 538	PC; SDF; VSG	Y	N	N
Thomas *et al*,[56]	2017	Ireland	Patients with NSCLC	15 031	GR; PC; SDF; VSG	Y	Y	N
Walter *et al*,[57]	2018	Germany	Patients with LC	12 929	GR; PC; VSG	Y	N	N

Continued

Table 1 Continued

Author	Year	Location	Study population	Sample size (n)	Health inequality domain(s) explored	Access	Outcomes	Experience
Williams *et al*,[50]	2016	USA	Patients with NSCLC	18466	PC	Y	Y	N
Zhang *et al*,[65]	2021	China	Patients with LC	3687	GR; PC	N	Y	N
Zullig *et al*,[63]	2013	USA	Patients with LC	2200	PC	Y	Y	N

GR, Geographical Region; LC, lung cancer; NSCLC, non-small cell lung cancer; PC, Protected Characteristics; SCLC, small cell lung cancer; SDF, Socioeconomic Deprivation Factors; VSG, Vulnerable or Socially Excluded Groups.

most frequently studied factor (19/31), followed by age (15/31), sex (13/31), marital status (6/31) and disability (1/41). *SDF* was the second most studied domain with 48.8% (19/41), with deprivation (9/20) most commonly investigated, followed by income and insurance status (6/20). *GR* was studied within 43.9% (18/41) of papers, most commonly rural residence (10/18) was investigated, followed by studies on proximity to or density of, specific services or infrastructure (4/18). *VSG* was the least studied domain (13/41) with comorbidities (7/14) and smoking status (4/14) as the most frequently investigated factors.

Where HIs manifest across the LC care pathway

HIs for LC patients were investigated based on where they manifest on the care pathway in terms of: (a) access to, (b) outcomes from or (c) experience of services. Most studies investigated inequalities in access (31/41) or outcomes from LC care (28/41). Few papers investigated inequalities of patient or staff experience (4/41). Summary findings for each pathway point can be found in online supplemental files 2 and 3 and table 2.

HIs in access to LC care (n=31)

Access to LC treatment (surgery, radiation, chemotherapy) was covered in the majority (29/31) of access studies (online supplemental file 2). Differences in receipt of treatment by race was investigated within 10 studies.[41–50] Black and non-white patients had decreased odds of receiving surgical treatment for LC.[41–50] For example, Ascha *et al* demonstrated that black, American Indian (AI) and 'white Hispanic' patients had a 0.70 (95% CI 0.65, 0.75) and 0.86 (95% CI 0.79, 0.93) times the odds of treatment compared with 'white non-Hispanic' patients.[42] Similarly, Gibberd *et al* found that Aboriginal people were 46% less likely to have surgery than non-Aboriginal people (OR: 0.54; 95% CI 0.36, 0.80).[46] One study found patients who were not referred for surgery were more likely to be non-white (p≤0.01).[51]

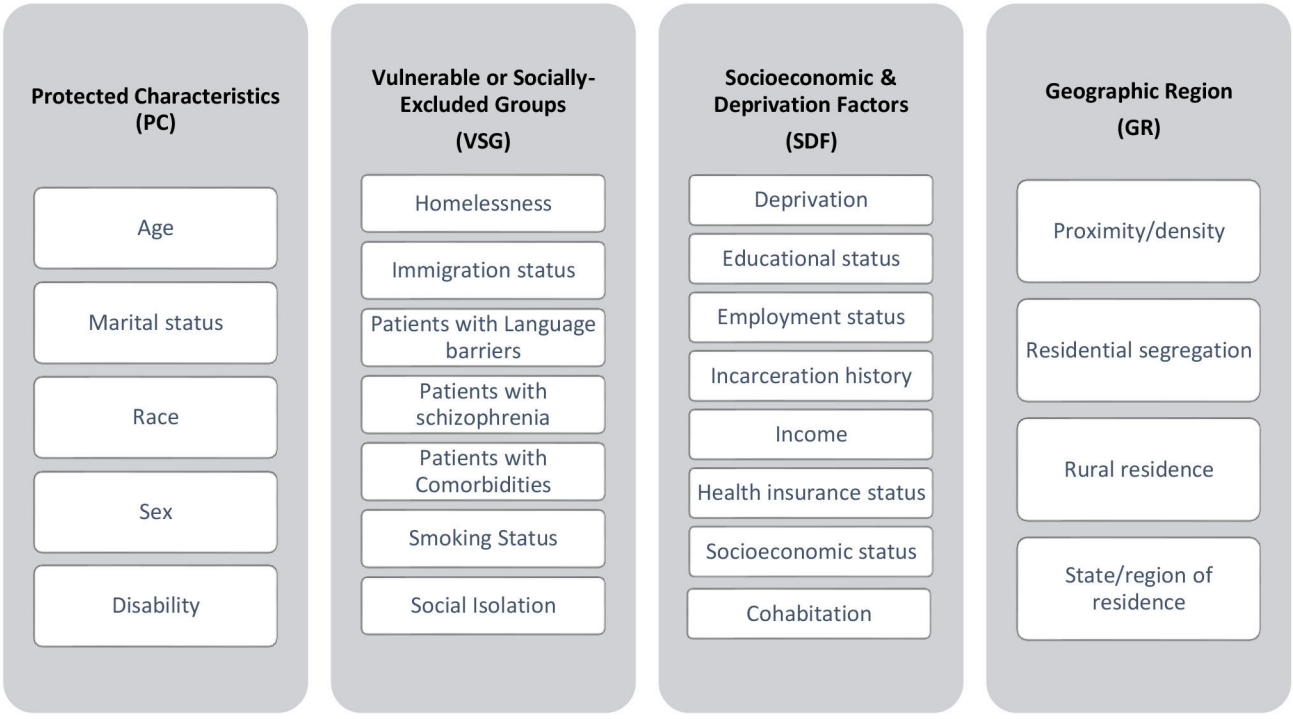

Figure 2 Health inequality domains and factors investigated within the reviewed articles.

Table 2 Summary of papers investigating health inequalities in experience of LC care

Pathway Point	Study population	Sample size (n)	HI domain explored	HI category	Indicator variable	Summary of findings	Reference
Experience	Survivors of LC (aged 18+), 10–15 months post-diagnosis	193	GR	Rural residence	► Mental health (MH) outcomes	► Rural LC survivors reported poorer MH status than urban LC survivors in all MH outcomes with three outcomes reaching significance (MOS-Mental Health, HADS-Depression and HADS-Total; all p<0.05). ► Rural LC survivors reported poorer MH relative to urban LC survivors with a mean effect size (ES) of 0.29 SD ► Model adjusted for education and number of physical comorbidities.	Andrykowski *et al*,[70]
Experience	Patients with LC aged ≥21	378	PC	Age; marital status; race; sex	► Unmet needs	► Patients with any perceived unmet need included 7% of white-US born (USB), 9% of white-foreign-born (FB), 13% of black-USB, 8% of Latino-USB, 24% of Latino-FB, 4% of Asian/Pacific Islander (API)-USB, 14% of API-FB and 11% of 'other' patients (p<0.01). ► Black-USB, Latino-FB and Asian-FB patients were more likely to perceive an unmet need than white-USB patients (p<0.05). ► Being younger, female, never married, uninsured, a current smoker or having comorbidities, anxiety/depression were significantly associated with unmet need (p<0.05). ► Models adjusted for race, age, sex, marital status, income, English proficiency, income, insurance status, smoking status, healthcare access and health system, need and perceived discrimination in care.	John *et al*,[67]
			SDF	Insurance Status			
			VSG	Patients with comorbidities; smoking status			
Experience	Patients with NSCLC or SCLC	99	PC	Race	► Self-reported supportive care needs	► At baseline, minorities reported higher needs across each domain (mean differences in need domains: psychological/emotional 4.9; daily living 1.9; financial 2.0; symptom 2.7; spiritual/existential 1.1; social 0.8; p<0.01 for all) except medical communication/information (mean difference 3.0; p=0.09). Over time, reported differences remained consistent except for medical communication. ► Model adjusted for age, sex, marital status, functional status and comorbidity index.	Mazor *et al*,[68]
Experience	Sample population of 1603 individuals aged 40–75 years	1603	SDF	Deprivation	► Confidence in health system	► Vulnerable population shows a lower level of confidence in the national healthcare system (p≤0.05). ► Vulnerable individuals are less likely to cite their general practitioner as their source of information (p≤0.05).	Morere *et al*,[69]
			VSG	Patients with comorbidities; smoking status			

GR, Geographical Region; HI, health inequality; LC, lung cancer; NSCLC, non-small cell lung cancer; PC, Protected Characteristics; SCLC, small cell lung cancer; SDF, Socioeconomic and Deprivation Factors; VSG, Vulnerable or Socially Excluded Groups.

Five papers[52–56] found rural patients were less likely to undergo surgery[52 54–56] or have chemotherapy.[53]

Access to appropriate or supportive care showed mixed results in relation to sex and race. Walter *et al* found men were given supportive care less often than females[57] which was also corroborated by Nadpara *et al*, who found that male patients were 27% (p≤0.05) less likely to receive appropriate care.[58]

HIs in outcomes from LC care (n=28)

Outcomes from LC treatment were covered in 28/41 studies (online supplemental file 3). PC was the most studied domain in 19/28 papers, followed SDF in 11/28, GR in 10/28 and VSG in 6/28. Formal diagnosis and staging were discussed in 6/28[41 46 52 58–60] studies and found to be influenced by age, sex, comorbidities,[58 60] race[41 46] and being part of a VSG.[58 59] One study found that black patients who lived in more segregated areas were more likely to be diagnosed at stage IV (p≤0.01),[41] while another found patients with schizophrenia were more likely to be diagnosed with early-stage LC compared with the general population (34.9% vs 30.6%, respectively; p<0.01).[59]

Most studies on outcomes investigated differences in survival (18/28) and/or mortality (13/28). Sex and age were both predictors of mortality and survival, with several studies finding being older,[51 54 56 61–63] and male[42 54 56 61 64 65] both negatively impact survival and mortality for LC patients. Studies investigating the relationship between survival (n=5)[41 44 50 62 63] and mortality (n=8)[42 45–48 50 54 66] and race reported mixed results. For example, Dalwadi *et al* found that African American (AA) and AI patients had worse overall survival from early-stage NSCLC (AA 65%, AI 60% vs 70% for Caucasian individuals p≤0.01).[44] Annesi *et al* found that black patients in the highest quartile of segregation had 5% increased risk of death compared with white patients (HR 1.05, 95% CI 1.03, 1.08).[41] Conversely, Zullig *et al* found black patients had longer survival rates than Caucasian patients (133 days vs 117 days, HR: 0.31; p≤0.01),[63] while Williams *et al* found no association between overall survival and race (HR: 0.97; 95% CI 0.93, 1.02).[50]

Survival and its links to geographic region was outlined in four studies.[51 52 55 65] Rural residence was a predictor of worse survival[51] with rural patients having significantly reduced median survival (40 vs 52 months; p=0.06) compared with urban patients.[52]

HIs in experience of LC care (n=4)

Four papers investigated inequalities in patient experience of LC care, with none considering staff experience (table 2). Two explored patient needs,[67 68] with one finding that USA-born black and Latino patients, and overseas-born Asian patients, were more likely to report unmet needs for supportive services compared with white-USA born patients (p≤0.05).[67] Minority ethnic groups were also reported as having higher supportive care needs (p≤0.05).[68] The impact of being part of a vulnerable population was also shown to impact experience of LC care with those in VSGs showing lower confidence levels in national healthcare systems.[69] Finally, rural residence was also shown to impact patient experience with LC survivors living in rural areas reporting poorer mental status than those living in urban areas (p≤0.05).[70]

DISCUSSION

This scoping review provides a comprehensive summary of the literature published in the last decade pertaining to HIs and where they may manifest along the LC patient pathway in terms of access to, outcomes from or experience of care, and classified by one of four domains: PC, SDF, GR or VSG.

Access

We identified numerous studies that demonstrate that race impacts access to LC diagnosis and treatment.[41–50] This finding is reinforced within recent findings that black and Asian patients wait up to a month longer than white patients for some cancer diagnoses.[71] Rural residence and being part of a VSG also appear linked to limited treatment access[51–56] including access to timely and appropriate care.[58 59 72] Multiple studies demonstrated the negative impact of deprivation on access to surgery,[48 60 61 73] a finding consistent with previous work which found that low socioeconomic position reduced the likelihood of receipt of any type of LC treatment, surgery or chemotherapy.[21]

Outcomes

We found numerous studies that that demonstrated that being older,[51 54 56 61–63] and male[42 54 56 61 64 65] both negatively impact survival and mortality for LC patients. This finding reflects current LC mortality rates in the UK which are significantly lower in females than in males.[74] Decreasing survival with age also reflects UK trends with the 5-year net survival in men ranging from 42% for 15–39 years old to just 6% for 80–99 years old.[75] Within reviewed articles, the relationship between race and survival or mortality was mixed, with studies reporting both better, worse and similar outcomes for specific groups.[42 45–48 50 54 66] National LC mortality rates for England and Wales demonstrate that people of non-white ethnicity had lower mortality rates compared with the white ethnic group between 2017 and 2019,[76] similar to a study, which found that Bangladeshi, Indian, Caribbean and Black African men had higher LC survival estimates compared with white men.[77]

While several reviewed studies showed deprivation impacted survival or mortality,[47 48 61 73] others found no such association.[62 78] However, an analysis of Cancer Registry data for England found LC patients from the most deprived areas lost more life years than those from the least deprived.[79]

Experience

Studies assessing experience-related HIs were limited, though this review highlights the potential for factors

such as race[67 68] and rural residence[70] to impact patient care needs and mental health outcomes. These findings support the 2021 National Cancer Patient Survey which found that respondents from mixed ethnic backgrounds were least likely to say they were always treated with dignity and respect while receiving hospital treatment.[80]

Implications for HI-reduction

The COVID-19 pandemic increased the spotlight on the differences experienced by patients receiving NHS care.[6 23] As a result, the NHS's Board announced strategic changes intended to ensure providers and commissioners of NHS services proactively deliver equitable services[81–83]: the 'Core20PLUS5' initiative aims to reduce HIs in the 20% most deprived geographic areas, along with targeting five clinical areas with recognised inherent HIs, including early cancer diagnosis.[24] Accompanying this strategic shift, are several structural changes, including: a requirement for NHS organisations to name an accountable officer for reducing HIs and the Care Quality Commission, announcing a focus on HI-reduction as part of its inspection regime.[81–83]

Despite some variability, the findings from this review offer a timely opportunity to not only reflect on the current understanding of HIs in LC care, but also provide a platform to begin consideration of targeted efforts to improve equity of access, outcomes and experience for patients. Based on our findings two key recommendations are suggested:

1) Collect, interrogate and act on the data

Understanding existing data is an important starting point to first recognise, and then mitigate HIs. To do this, services must be supported to collect, analyse, act on and share relevant HI data. Service evaluations should employ mixed method approaches to not only identify unwarranted variation within care but also understand the experiences of those using services.

There are some emerging practical examples of how inequalities in access, outcomes or experience are being addressed or mitigated. For example, an NHS Trust in London uses annual equity audits to identify and proactively target underrepresented groups in accessing clinical services,[84] including a review of sexual health screening coverage by PC which highlighted low screening offer rates for men. Using a combination of community events and in-reach and outreach clinics, the screening test offer was successfully increased to 98% of patients in this group.[84] Clinical guidelines have also been successfully developed to improve their cultural relevance and sensitivity to specific populations, thereby improving health outcomes (eg, for patients with diabetes who wish to fast safely during Ramadan[85 86]).

Interventions such as these have valuable lessons for translation in LC care. For example, newly recommended targeted LC screening programmes in the UK will be designed to screen specific high-risk groups, who could be engaged through targeted events or outreach services.[87] Equally, tailored resources such as guidelines or factsheets could be developed for specific LC populations to support practitioners in addressing the HIs identified in this review.

2) Embrace the complexity of studying HIs-intersectionality and cumulative impact

Many studies included in this review focused on sole HI indicators (eg, race). This is an important limitation of existing research, as it is increasingly recognised that, 'people are shaped by their simultaneous membership of multiple interconnected social categories'.[88] Without consideration of the combined effect of HI domains, studies are unable to accurately or adequately describe their collective impact.[89] Using an intersectional approach, defined as, 'a way of identifying, understanding, and tackling structural inequality in a given context that accounts for the lived experience of people with intersecting identities'[88], to explore HIs can give a deeper, more nuanced understanding.[89]

Three reviewed papers discussed aspects of intersectionality between HI variables.[47 48 73] One study found that black patients were not affected by neighbourhood economic deprivation alone but were significantly impacted by the combined negative effects of segregation and poverty.[47] Another found LC outcomes are impacted by neighbourhood environments that are shaped by distribution of race, ethnicity and class.[48] Finally, Erhunmwunsee *et al* explored the relationship between poverty/median income and higher educational attainment and concluded these indicators were highly correlated: those living in areas with higher percentages of residents achieving higher education having improved LC outcomes.[73]

As well as considering the intersectionality of HIs, there is also credible evidence of a cumulative effect of HIs. Experiencing inequalities in access to care will ultimately impact patient outcomes with several studies acknowledging that differences in survival may be attributed to disparities in receipt of treatment.[52 90–94] To improve outcomes, healthcare planners should prioritise addressing issues in access to and uptake of LC treatment.[95] This has the potential to promote more equitable care by avoiding a cumulative effect of disadvantage across care pathways.

Limitations and future research

While this review provides a comprehensive summary of HIs along the LC patient pathway, some limitations should be considered.

Due to the novel and complex nature of the research question a scoping review was conducted to enable the range and type of HIs in LC to be investigated.[25] While this approach was considered particularly appropriate given: HIs are not universally defined; there are many potential HI domains, and study designs vary considerably, it did however, preclude quality assessment of the included studies[25 96 97] as well as assessment of comparable effect

sizes. However, this review provides a valuable precursor to a full systematic review with relevant keywords, inclusion criteria and research questions defined.[25] Another limitation is related to the time-bound nature of the results. The literature search was conducted in April 2022 and further evidence may have accumulated in the intervening period. However, the method presented here provides a template for updating the search and/or expanding it to a systematic review in future work.

This review excluded studies investigating screening for LC. While LC screening programmes have already been introduced in several countries, for example, Australia,[98] it was only in June 2022 when the UK's National Screening Committee recommended a targeted programme be introduced to address HIs.[99] The programme invites people aged 55–74 years who are current or previous smokers, and therefore are at the highest risk of LC.[99 100] An initial 10-region roll-out began in summer 2023 with national coverage expected by 2024.[101 102] An evaluation is expected to explore impacts on HIs, including health outcomes and experiences, though it will require some time for sufficient data to accumulate.[100] This review also excluded papers which outlined trend data on HI indicators, due to the complexity of reporting a single finding for each study. To understand changes to HIs overtime, future work may seek to explore and monitor how HIs are impacted by changes to access and treatment options.

It should also be noted that most included studies were conducted in the USA. Our findings may therefore be significantly influenced by the characteristics of the local healthcare system. As a mixed-system without universal coverage, availability and accessibility of care is often fragmented and based on individual and geographical factors.[103 104] Therefore, caution should be applied when generalising these findings to other countries and settings.

There are also several limitations of existing published research in this area which may have impacted our findings. First, recruitment and inclusion criteria for research studies often exclude those groups (eg, homeless, disabled, minority ethnic groups) most at risk of HIs.[105] Our review identified examples of exclusion of those without: spoken or written English[68 70]; a postcode[53 73]; complete housing records[47 48 53 57 62 73]; medical insurance,[42 51 58 59 106 107] suggesting findings of HIs may be significantly under-represented.

The lack of common or agreed definitions for HIs factors[108] also poses a limitation and complicates the topic in terms of inclusion criteria and scope. For example, our review found definitions of deprivation ranging from census variables (eg, poverty level; education level; income; employment status; telephone access, etc[47–49 62 73]) to index of multiple deprivations[61 78 109] making meaningful comparisons even in single HI domains difficult. Similarly, some variables interact, for example, the UK's Equality Act 2010 defines a cancer diagnosis in itself as a disability[110 111] thereby potentially allowing for 'double counting' of PC characteristics within studies. Additionally, 'gender' is related but distinct from 'sex': while the former is a social construct (eg, societal roles or norms), the latter a physiological characteristic.[112] So, for example, gender-based variations in smoking patterns may explain LC-incidence variations but are less plausible drivers of diagnosis disparities in the never-smoker population, or differing treatment access rates.[113 114]

Another complication is that while 'Ethnicity' is a self-determined identity reflecting culture, traditions, history, language, religion, it is often conflated with 'race' which is based on externally observed characteristics such as skin colour.[34 115 116] Categories of race and ethnicity varied from country of birth (eg, 'foreign-born Asian'; 'Aboriginal people') to race (eg, 'Hispanic') to both skin colour and race (eg, 'white Hispanic'). While localised characterisation of race aids in responding to specific research questions, it impedes consolidation of findings across studies. Equally, multiple studies allocated race or ethnicity to binary categories (eg, 'white and 'non-white'[51]). This limited categorisation prevents more nuanced understanding of HIs experienced by patients from other/additional ethnic backgrounds.

Finally, we cannot exclude possible misclassification bias or missing data, a problem that is increasingly identified in health datasets.[105] Despite a gold standard for how to capture census and ethnicity data existing in the UK,[117] this is not universally applied within the health services or research: indeed, a recent Race Health Observatory report found systematic inaccuracy of NHS ethnicity data,[28] highlighting the ongoing challenge of conducting meaningful, unbiased HI research.[118]

Conclusion

This review provides a comprehensive overview of the current evidence for how HIs impact LC care and identifies where these HIs manifest in terms of access to, outcomes from or experience of care. There are numerous studies that provide evidence detailing that overall, HIs impact patient access to LC diagnosis, treatment and supportive care. While there is more evidence of the impact of specific HI factors (eg, age, sex) on outcomes such as mortality and survival, the relationship with other factors like race, show mixed evidence. This review provides a mechanism to begin consideration of how, and where, to target efforts to improve equity of LC care for patients. Specifically, both research and service improvement efforts to address HIs should consider the need for common definitions to align HI research, the cumulative impact of disadvantage and the role that intersectionality plays in exacerbating disparities in care for LC patients.

Twitter Laura Lennox @LauraLennox3

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ORCID iD

Laura Lennox http://orcid.org/0000-0002-8991-1702

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Supplementary File 1: Full search strategy_LC scoping review

Database	**Search strategy (publications accessible from 1st January 2012 – 1st April 2022)** ***the Ovid platform was accessed to search via the databases presented below:**
EMBASE	**Search terms:** ("health inequalit*" OR "health inequit*" OR "health disparit*" OR equalit* OR equit* OR inequality* inequit*) AND ("lung cancer") **Search:** Advanced multi-field search **Fields:** Title and abstract **Limits:** Humans, English language **Publication year:** 2012-2022
HMIC	**Search terms:** ("health inequalit*" OR "health inequit*" OR "health disparit*" OR equalit* OR equit* OR inequality* inequit*) AND ("lung cancer") **Search:** Advanced multi-field search **Fields:** Title and abstract **Limits:** Humans, English language **Publication year:** 2012-2022
Medline	**Search terms:** ("health inequalit*" OR "health inequit*" OR "health disparit*" OR equalit* OR equit* OR inequality* inequit*) AND ("lung cancer") **Search:** Advanced multi-field search **Fields:** Title and abstract **Limits:** Humans, English language **Publication year:** 2012-2022
PsychINFO	**Search terms:** ("health inequalit*" OR "health inequit*" OR "health disparit*" OR equalit* OR equit* OR inequality* inequit*) AND ("lung cancer") **Search:** Advanced multi-field search **Fields:** Title and abstract **Limits:** Humans, English language **Publication year:** 2012-2022
PubMed	**Search terms:** ("health inequalit*" OR "health inequit*" OR "health disparit*" OR equalit* OR equit* OR inequality* inequit*) AND ("lung cancer") **Search:** Advanced multi-field search **Fields:** Title and abstract **Limits:** Humans, English language **Publication year:** 2012-2022

Supplementary File 2: **Summary of studies investigating health inequalities in Access to LC care**

Pathway	Study population	Sample size (n=)	HI domain explored	HI Category	Indicator variable	Summary of findings	Reference
Access	Black and White patients diagnosed with NSCLC during 2004-2016	229,018	GR PC	Residential segregation Race	• Surgical resection uptake	With increasing Index of dissimilarity -IoD-validated segregation measure): • Black and White patients less likely to receive surgery for localized disease (RR: 0.53; 95% CI: 0.46, 0.59) and (RR: 0.82, 95% CI: 0.72-0.93) respectively.	Annesi
	Medicare LC patients with brain metastases	74,142	PC	Race; Sex	• Stereotactic radiosurgery (SRS)	• Males with synchronous brain metastases (SBM) had 0.85 times the odds of SRS compared to females. • Black patients and those of other (American Indian or White Hispanic) race had 0.70 (95% CI: 0.65, 0.75) and 0.86 (95% CI: 0.79, 0.93) times the odds of SRS treatment among White Non-Hispanic (WNH) patients. • Models were adjusted age, race, sex, region, stage, histology, metastases, and surgery.	Ascha
	Patients diagnosed with LC between 2000 and 2006	348,002	GR	Rural residence	• Smoking status • Surgery	• Rural patients underwent fewer surgeries (p=.01). • Model adjustment for age, sex, race, and marital status.	Atkins
	Individuals ≥66 years of age with primary NSCLC diagnosed between 1992 and 2007 with Schizophrenia	96,702	PC VSG	Age Patients diagnosed with Schizophrenia	• Stage-appropriate treatment	Patients with schizophrenia: • Less likely to receive stage-appropriate treatment compared to those without Schizophrenia (p=<.01). • Less likely to undergo surgery for stages I-IIIA (p<.01), receive combined RT and chemotherapy for stage IIIB (p<.01) or chemotherapy for stage IV (p=<.01) NSCLC. • Elderly patients with schizophrenia were less likely to receive stage-appropriate treatment compared to those without schizophrenia (p<.001) • Models adjusted for age, gender, marital status, race/ethnicity, income, histology, comorbidities, and stage.	Bergamo
	Patients with LC	15,582	PC SDF	Age Deprivation	• Access to surgery	• In early-stage NSCLC, likelihood of surgery was lowest in the most deprived group. Significant reduction in	Berglund

					• Uptake of radiotherapy and chemotherapy	surgical resection with increasing age at diagnosis (p<.01). • Reduced odds of chemotherapy were observed with increasing levels of socioeconomic deprivation (p<.01) and with increased age at diagnosis (p<.01) and co-morbidity burden (p<0.1). • All models were adjusted for sex, age at diagnosis and the comorbidity index	
	Patients with NSCLC	5,786	PC	Race	• Access to care • Likelihood of surgery	• Black patients within Kaiser Permanente Northern California (KPNC) were least likely to receive surgery regardless of access to integrated care. • The Black-White difference in the likelihood of surgery receipt was similar for KPNC members (RR: 0.82, 95% CI: 0.73–0.93) and non-members (RR: 0.86, 95% CI: 0.80–0.94).Adjusted RR for surgical receipt across different members and non-members included age at NSCLC diagnosis, gender, marital status, area-level SES, tumor stage, size and histologic subtype.	Check
	Patients with LC	1,432	SDF	Deprivation	• Receipt of surgery and treatment	• No significant difference in the median Indices of Multiple Deprivation (IMD) score for patients undergoing curative surgery compared to those not undergoing surgery. • No statistically significant difference in IMD scores of those receiving anti-cancer therapy compared to those not receiving anti-cancer therapy.	Cheyne
	Patients with NSCLC	162	SDF VSG	Income Homelessness	• Access to diagnostic biopsy and treatment	Homeless patients: • With NSCLC had longer delays to diagnostic biopsy, more missed appointments, and were more quickly lost to the health care system (p=.03). • With localized disease waited longer from radiographic finding to biopsy than did housed patients and between diagnosis and initial treatment but this was not significant (p=0.37). • Models adjusted for race	Concannon
	Patients with LC age 60+ (stage 1 NSCLC)	62,312	PC	Race	• Access to surgery	• African America (AA) and American Indian race less likely to receive surgery than Caucasian patients (p<.01).	Dalwadi

	Patients with LC	32,502	GR	Rural residence	• Surgical resection • Adjuvant chemo (AC)	• Sex and geography did not affect resection rates. • Probability of surgical resection decreased substantially with age (p<.01) • Patients in highest income quintiles more commonly underwent surgery (p<.05). • Patients from areas with highest number of immigrants had higher resection rates (p<.05). • Patients in rural areas were as likely to receive AC as urban dwellers. • Older aged patients (≥65) and those from the lowest income neighbourhoods were significantly less likely to receive AC (p<.01). • Age was adjusted to calculate resected stage II or IIIA NSCLC receiving AC by health region.	Evans
			PC	Age; Sex			
			SDF	Income			
			VSG	Immigrant status			
	Patients with NSCLC	82,414	PC	Race	• Stage appropriate treatment	• For stage I disease, a greater percentage of Caucasian patients received surgery than AA patients (p<.01). • For stage IV, a greater percentage of Caucasian patients received chemotherapy compared with African-American patients (p=.03). • A slightly higher proportion of AA patients received no treatment for their LC, compared with Caucasian patients (p<.01).	Ganti
	Patients with NSCLC	20,154	PC	Race	• Surgical treatment	• Odds of having surgery were 46% lower for Aboriginal than non-Aboriginal people (Odds Ratio [OR] 0.54, 95% CI: 0.36–0.80). • Only 30.8% of Aboriginal people received surgery, compared with 39.5% of non-Aboriginal people. • Smoking status had little effect on the odds ratio for surgery for Aboriginal compared with non-Aboriginal people (OR 0.68, 95% CI: 0.46–1.03). • Aboriginal people with no comorbidities were half as likely to have surgery as similar non-Aboriginal people (22% versus 43%) (p=.018).	Gibberd
			VSG	Patients with comorbidities; Smoking status			
	Patients with NSCLC	White = 123,388; African	PC	Race	• Time to treatment	• AA patients had longer median time to treatment for external beam radiation, stereotactic body radiotherapy, and surgery (p<.01).	Holmes

		American = 11,824				• 34% AA vs 24% white patients (p≤.01) had treatment initiation eight or more weeks after diagnosis. • AA patients experienced an average 8.2-day delay compared with white patients (p<.01). multivariable analysis included adjusted age, demographics, stage, and treatment type.	
	Patients with NSCLC	22,750	GR	Residential segregation; Rural residence	• Receiving treatment	• White patients who lived in low Black segregation/high deprivation areas had 15 % lower odds of receiving surgery (95% CI: 0.76-0.93). • Rurality did not reach statistical significance in any of treatment or surgery models. • Likelihood of receiving surgery for Black patients who lived in high Black segregation/low deprivation and high Black segregation/high deprivation was lower than for Black patients who lived in low black segregation/low deprivation neighbourhoods (Adjusted OR [AOR] 0.56 [0.38-0.85], AOR 0.69 [0.54-0.88]). • Models were adjusted for age, gender, tumor grade, tumor stage, insurance status, smoking status, marital status.	Johnson (2020)
			PC	Race			
			SDF	Deprivation			
	Patients with LC	8,322	GR	Residential segregation; Rural residence	• Access to surgery	• Living in areas with the high deprivation associated with decreased odds [AOR 0.35, 95% CI: 0.19–0.64] of receipt of surgery. • For White and Black patients, deprivation was associated with decreased odds of surgery. • For White patients, living in areas with the lowest level of education was associated with 48% decreased odds of receiving surgery (AOR 0.52, 95% CI: 0.42–0.64). • Black patients living in the least segregated areas compared with those living in the highest levels of segregation were associated with 65% (AOR 0.35, 95% CI: 0.19–0.64) decreased odds of receiving surgery.	Johnson (2016)
			PC	Race			
			SDF	Deprivation; Education			

						• Black patients, living in suburban areas associated with decreased odds of receiving surgery compared urban residence (AOR 0.65, 95% CI: 0.46–0.92). • Results were adjusted for individual level (age, sex, and tumor grade) and area level (place of residence, educational attainment and elderly concentration) factors.	
	Patients with NSCLC	39,822	GR PC SDF	Proximity/ density Race Insurance status; SES	• Differences in treatment	• Treatment with stereotactic body radiography (SBRT), versus conventional radiotherapy (ConvRT) was more likely in an academic research program (OR 2.62) and a high-volume facility (OR 7.00) compared with community cancer programs or low-volume facilities. • Treatment with radiation was less likely in Black patients (OR 0.65) and Hispanics (OR 0.42) compared with whites (p<.01). • Uninsured patients were markedly less likely to undergo treatment (p<.01).	Koshy et al
	Patients with NSCLC	62,514	PC SDF VSG	Age; Sex; Marital status; Race Education Language barriers	• Receipt of surgery (a) surgery performed or (b) recommended but refused by patient	• Black patients (OR 1.88, 95% CI: 1.50, 2.36, p=.01) and individuals of ''other'' race (OR 1.95, 95% CI: 1.50, 2.52, p=.01) had greater odds of refusing surgery than White patients. • In a multivariable adjusted model, age was the only significant predictor for refusing surgery in addition to Black race. • Increasing age, male gender (OR 1.17, p=.031), and being unmarried (OR 2.1, p=.01) were associated with higher odds of refusal. • As the % of individuals with language barrier and % of individuals with less than high-school education in the county increased, the odds of refusing surgery also increased. • Model was adjusted for race, age, sex, marital status, Language barriers, and education.	Mehta
	Sample population of 1603 individuals aged 40 - 75 years	1,603	SDF VSG	Deprivation Patients with comorbidities; Smoking status	• Access to general practitioners	• Vulnerable populations reported consulting a general practitioner or an oncologist more often than the nonvulnerable group in the previous 12 months (p≤.01).	Morere

	Patients with LC	36,469	PC	Race	• Use of positron emission tomography (PET) imaging with computerized tomography (CT) imaging	• Black patients with squamous cell NSCLC were about one-half as likely to receive a PET (OR 0.51, 95% CI: 0.44 to 0.60; p<.01) and Hispanic patients were about two-thirds as likely to receive a PET (OR 0.67, 95% CI: 0.54 to 0.83; p<.01) compared with non-Hispanic Whites. Adjusted for demographic, socioeconomic, and facility characteristics. • In patients with non-squamous cell NSCLC, the likelihood of receiving a PET was also lower for Black (OR 0.57, 95% CI: 0.51 to 0.64; p<.01) and Hispanic patients (OR 0.76, 95% CI: 0.67 to 0.88; p<.01). • Logistic regression was used to evaluate the adjusted impact of demographic, socioeconomic, and facility characteristics on choice of diagnostic imaging modality. • Base model adjusted for year of diagnosis, gender, age at diagnosis, type of NSCLC, race, marital status, Commuting Area Codes, poverty level, education, imaging, and provider, teaching hospital, or community hospital.	Morgan
	Patients with LC	Elderly patients residing in a rural and medically underserved area: 1689 (Cohort A) and 1924 (Cohort B) patients	GR	Rural residence	• Receipt of guideline concordant care	• Appropriate care was received by fewer than half of all rural patients (46.5%). • Sex was a significant predictor of receipt of appropriate care, with patients who were younger and female receiving appropriate care most often (p<.05). • Male patients were 27% (p<.05) less likely to receive appropriate care. • Models were adjusted for LC type, stage, age, sex, race, residence, comorbidity, education and income.	Nadpara
			PC	Age; Sex			
			VSG	Patients with comorbidities			
	Patients with NSCLC	3,616	PC	Marital status; Race	• Access to timely surgery	• 28.7% of White and 48.4% of Black patients received delayed surgery (p<.01). • Compared to White patients, the OR of receiving surgery more than 6 weeks after diagnosis for Black patients was 2.33 (95% CI: 2.00-2.74). • Living in a high poverty area was significantly associated with delayed surgery in both Blacks (OR	Neroda
			SDF	Deprivation, Insurance status			

						1.91, 95% CI: 1.09–3.35) and Whites (OR 1.37, 95% CI: 1.10–1.71). • Being married and having private insurance were associated with improved access to timely surgery. • Models adjusted for age at diagnosis, sex, marital status, histology, tumor size and grade, lymph node involvement status, surgery type, comorbidity, insurance, marital status, poverty and urbanicity.	
	Patients with NSCLC	192,658	GR PC SDF	Proximity/ density Age Deprivation	• Receipt of surgery	• Evidence of geographic differences in treatment by curative surgery across different PCT in England with 69% PCTs below the lower control limit of surgery. • Younger patients were more likely to be treated by surgery, with the odds of having surgery three times higher for those diagnosed at 20 years, compared with patients diagnosed at 71. • Patients from deprived areas have a 27% lower likelihood of having surgery compared with affluent patients (OR 0.73, 95% CI: 0.69-0.77). • Models were adjusted for adjusted for age, year of diagnosis, sex, deprivation, surgical treatment and time frame and spending on LC.	Nur
	Patients with LC/Bronchial Cancer	12,964	GR	Rural residence	• Receipt of surgery	• Rural and southern Nevadans had 65% (OR 1.65, 95% CI: 1.07–2.53) and 67% (OR 1.67, 95% CI: 1.20–2.13) higher odds, respectively, than Northwestern Nevadans to not have surgical treatment for localized NSCLC. Models adjusted for age, sex, race, SES level, marital status, insurance status, chemotherapy and radiation treatment.	Osuoha
	Patients with NSCLC	56,534	GR PC SDF	Rural residence Age; Marital status; Race; Sex Insurance status	• Recommendation for surgery	• Patients who were not recommended surgery were more likely to be older (p<.01), male (p<.01), non-White race/ethnicity (p<.01), lacking private insurance or Medicare (p<.01), single (p<.01), and more likely to live in a suburban or rural county (p=.02). Model adjusted for age, sex, race, insurance status, marital status, metro proximity, stage, histology, chemotherapy, radiotherapy.	Rapp

	Patients with NSCLC	6,259	GR	Rurality	• Delivery of stage preferred and stage appropriate treatment	• Urban institutions provided stage-preferred/appropriate treatment more often than rural institutions. Surgical resection rate for early-stage patients was 56% at urban institutions vs 33% at rural institutions (p<.01); nontreatment rates were 11% and 26%, respectively (p<.01). • Urban residents were more likely to receive stage-preferred treatment than rural residents: 58% vs 42% of early-stage patients received surgical resection (p<.01); 11% vs 18% received no treatment (p<.01). • Compared with rural residents attending rural hospitals, rural residents attending urban hospitals were more likely to be white and insured by Medicare, and less likely to be uninsured or insured by Medicaid. • Model adjusted for insurance status, age at diagnosis, clinical stage, and patient/hospitality rurality.	Ray
			SDF	Insurance status			
	Patients with LC	57,400	PC	People with disabilities	• Undergoing surgery	• People with disabilities were less likely to undergo a surgical procedure (19.8% versus 21.9%), chemotherapy (42.3% versus 46.1%), or radiotherapy (26.4% versus 27.6%). • Trend more evident in people with a severe disability, with AORs of 0.47 (95% CI: 0.42–0.52) for surgery, 0.57 (95% CI: 0.53–0.61) for chemotherapy, and 0.75 (95% CI: 0.70–0.81) for radiotherapy, whereas treatment disparity was not observed in people with a mild disability. • Logistic regression analyses and adjusted for age, sex, comorbidity index, income, place of residence, and cancer stage.	Shin
	Patients with NSCLC	5,538	PC	Age; Sex; Cohabitation	• Surgical treatment	• Age was significantly associated with no surgery, the OR increasing by 5% per year (OR 1.05, 95% CI: 1.04, 1.06), as was gender, with for women compared with men. • Patients with lower income were more likely to not receive surgery AORs 1.33 (95% CI: 1.09, 1.65).	Starr
			SDF	Income, Education,			
			VSG	Social Isolation, Patients with comorbidities			

						• Living alone was associated with greater odds for no surgery for stage I patients (OR 1.28, 95% CI: 1.12,1.47). • Comorbidity were all associated with higher odds for not undergoing surgery (AOR 1.94, 95% CI: 1.61-2.34). • No association between educational level and not undergoing surgery. • Model adjusted for age, sex and year of diagnosis.	
	Patients with NSCLC	15,031	GR	Rural residence	• Receiving surgery	• Rural patients received surgery less often than urban patients (AOR 0.86, 95% CI: 0.78 to 0.95, p<.01). • Female patients were significantly more likely to receive surgery (AOR 1.15, 95% CI: 1.04-1.26, p=.05). • Married people had a significantly increased likelihood of surgery (AOR 1.35, 95% CI: 1.22-1.48, p<.01). • Surgery was more common among patients living in the third quartile for socioeconomic level (AOR 1.31, 95% CI: 1.15 to 1.49) and the most advantaged quartile (AOR 1.50, 95% CI: 1.32 to 1.71) p<.01. • Patients who were smokers at the time of diagnosis had a decreased likelihood of surgery (AOR 0.63, 95% CI: 0.53-0.73, p<.01). • Models were adjusted for age, sex, marital status, area socioeconomic level, smoking status, year of diagnosis and stage at diagnosis, the proportion receiving surgery	Thomas
			PC	Marital status; Sex			
			SDF	SES			
			VSG	Smoking status			
	Patients with LC	12,929	GR	Rurality	• Utilisation of services and supportive care	• The likelihood of > 14 hospital days in the last 30 days was significantly higher in rural districts than in remote rural districts (OR 1.27 [1.05, 1.52], p=.03). • The number of visits to the GP in the last 30 days of life was significantly lower in urban districts than in remote rural districts (OR −0.19 [-0.32, -0.06], p<.01). • Male gender and comorbidities were significantly associated with lower numbers of doctor visits; age was associated with a higher number. • Supportive care was given to males significantly less often than to females (p<.05).	Walter
			PC	Age; Sex			
			VSG	Patients with comorbidities			

						• All models were adjusted by age, sex, comorbidities, metastases location and presence of multiple tumors at diagnosis, survival in months, and type of tumor-directed treatment.	
	Patients with NSCLC	18,466	PC	Race	• Receipt of surgery and treatment	• Proportion of black patients receiving an operation (55%) was significantly lower than the proportion of white patients (60%), and more black patients received other/no treatment compared with white patients (p<.01). • No significant racial differences in receipt of radiation were noted.	Williams
	Patients with LC who fit the outlined criteria	2,200	PC	Age; Marital status; Race	• Time from diagnosis to initiation of treatment • Time from diagnosis to referral to palliative care or hospice	• No association between time to initiation of treatment/palliative care and race (hazard ratio [HR] 1.04, p=0.80), marital status (HR 1.00, p=0.98), age at diagnosis, region, stage at diagnosis (HR 0.87, p=0.47). • Models adjusted for age, marriage, region, stage and diagnosis and performance status.	Zullig

Supplementary File 3: Summary of studies investigating health inequalities in Outcomes from LC treatment and care

Pathway	Study population	Sample size (n=)	HI Domain explored	HI Category	Indicator variable	Summary findings	Reference
Outcomes	Black and White patients diagnosed with NSCLC	229,018	PC GR	Race Residential segregation	• Diagnostic staging • 5-year cancer-specific survival (CSS)	Black patients were: • With increasing Index of dissimilarity (IoD-validated segregation measure), more likely to be diagnosed at advanced stage than White patients (Risk Ratio [RR] 1.13, 95% confidence interval [CI]: 1.08-1.20). • 8% increased hazards of death compared with White patients in the lowest quartile of IoD (HR 1.08, SE 1.01, 95% CI: 1.05-1.12). • Black patients in the highest quartile of IoD had 5% increased hazards of death compared with White patients in the highest quartile of IoD (hazard ratio [HR] 1.05, 95% CI: 1.03-1.08).	Annesi
	Medicare LC patients with brain metastases	74,142	PC	Sex; Race	• Mortality	• Males were found to have 1.21 times the hazard of mortality than females. • Asian and Pacific Islanders (API) patients had 0.76 times the hazard of mortality than White non-Hispanic (WNH) patients at any given time (95% CI: 0.73–0.78, p<.01). • Black patients had 1.04 times the hazard of mortality compared to WNH patients (95% CI: 1.01, 1.07, p=.010). • Hazard of mortality was adjusted for age, histology, location, race, sex and stereotactic radiosurgery.	Ascha
	Patients diagnosed with LC between 2000 and 2006	348,002	GR	Rural residence	• Diagnostic staging • Survival	• No rural–urban discrepancies in diagnostic stage • Rural patients had significantly reduced median survival (40 vs. 52 months; p=.06) compared with the most urban patients. • When adjusted for age, sex, race, and marital status, rural patients with stage I NSCLC	Atkins

						remained less likely to receive treatment (OR, 1.74; p< 0.001).	
	No defined population. Used country level data.	US population: 296,314,208	GR PC	Proximity Race	• Mortality	• Providers of LC care were unevenly distributed among the US counties. • Age-adjusted LC mortality rates were significantly higher for Blacks compared with whites (58.9 versus 52.4/100,000; p<.05).	Backhus
	Individuals ≥66 years of age with primary NSCLC diagnosed between 1992 and 2007 with Schizophrenia	96,702	VSG	Patients diagnosed with Schizophrenia	• Diagnostic staging • Survival	Patients with schizophrenia: • Were more likely to be diagnosed with early-stage (I-II) LC compared to the general population (34.9% vs. 30.6%, respectively; p<.01). • Had significantly shorter overall survival (mean survival 22.3 vs. 26.3 months; p=.02). • Had similar survival (mean survival 41.5 vs. 43.1 months for appropriately treated patients and 9.8 vs. 10.3 months for not appropriately treated patients with and without Schizophrenia. • Logistic regression model, adjusted for age, gender, marital status, race/ethnicity, income, histology, comorbidities, and stage.	Bergamo
	Patients with LC	15,582	PC SDF	Age Deprivation	• Diagnostic staging • Survival	• Likelihood of early-stage diagnosis did not vary by socioeconomic quintiles. • Survival in stage III disease and in advanced disease or small-cell LC was poor in all socioeconomic quintiles. • The relative contribution of age at diagnosis explaining the social inequality in survival between the most affluent and the most deprived patients was 34.6% in stage III disease and 13.9% in advanced disease or small-cell LC. • Logistic regression models were adjusted for sex, age at diagnosis and the Charlson comorbidity index.	Berglund

	Patients with LC	1,432	SDF	Deprivation	• Survival	• No significant differences were seen in survival between median and 1 year survival rates between IMD quintile and social deprivation groups.	Cheyne
	Patients with NSCLC	162	SDF VSG	Income Homelessness	• Survival	• Homeless patients with advanced NSCLC had nonsignificant decrease in median survival compared with housed patients (0.58 years, versus 1.30 years, p=0.48). Models adjusted for race.	Concannon
	LC patients age 60+ (stage 1 NSCLC)	62,312	PC	Race	• Survival	• African American (AA) and American Indian (AI) individuals continue to have worse OS and CSS from early-stage NSCLC. • Two-year overall survival (OS) for Caucasian individuals was 70%, for AA 65%, AI 60%, and API 76% (p<.0001). • Two-year cancer-specific survival (CSS) for C individuals was 79%, AA 76%, AI 73%, and API 84% (p<.0001).	Dalwadi
	Patients with primary LC	179,630	PC	Sex	• Mortality • Survival	• Females had longer median survival compared to males (9.6 vs 7.1 months). • Males had higher risk of mortality than females (Adjusted Hazards Ratio) [aHR] 1.17, 95% CI: 1.14–1.19, p<.01). • Multivariable Cox regression models adjusted for race/ethnicity, smoking status, insurance, marital status, hospital characteristics, treatment, cancer stage, cancer grade, and • comorbidities	Elkbuli
	Patients with complete tumor staging with a home address located in the 2000 Census	4,820	SDF	Deprivation; Education; Income; SES	• Survival	• Individuals residing in areas of low median household income or with high percentage of residents living below the poverty line had a shorter cancer-specific 6-year survival than individuals who resided in converse areas (p=.0167 and p=.067, respectively). • Those living in areas with higher percentage of residents achieving a high school diploma had improved disease outcomes compared	Erhunmwunsee

						with those living in areas with lower percentage attaining a high school diploma (p=.033). • A survival advantage also was observed for inhabitants of areas in which a higher percentage of residents attained a bachelor's degree (p=.045).	
	Patients with NSCLC	82,414	PC	Race	• Mortality	• AA patients had a 7% lower risk of mortality compared with Caucasian patients (Hazard Ratio [HR], 0.93; 95% CI: 0.92-0.96; p<.01). • No differences in risk of mortality were seen among Asian and Native American patients compared with Caucasian patients. • AA patients had a decreased risk of death compared with Caucasian patients (HR, 0.84; 95% CI: 0.80-0.88; p<.01).	Ganti
	Patients with NSCLC	20,154	PC	Age; Race	• Diagnostic staging • Mortality	• Aboriginal people were younger at diagnosis with non-metastatic NSCLC than non-Aboriginal people. • Observed risk of death from NSCLC 5 years after diagnosis was higher Aboriginal people (83.3%, 95% CI: 77.5–87.7) than for non-Aboriginal people (77.6%, 95% CI: 76.9–78.3). • Aboriginal people with NSCLC had a greater risk of death 5 years after diagnosis compared to non-Aboriginal people (Adjusted Sub-HR [asHR] 1.32 95% CI: 1.14–1.52). • Full model adjusted for sex, age group, spread of disease at diagnosis, year of diagnosis, surgical treatment, comorbidities, socioeconomic disadvantage quintiles, place of residence and smoking status.	Gibberd
	Patients with LC	8,322	GR	Residential segregation	• Mortality	• Black patients living in areas with high residential segregation and high economic deprivation were 31% (95% CI: 1.04–1.66) more likely to die.	Johnson (2016)
			PC	Race			
			SDF	Education; Deprivation			

						• White patients with early-stage NSCLC have an increasing risk of death with decreasing educational attainment. • White patients living in areas with the lowest educational attainment had 30%–32% increased risk of death. • Results were adjusted for individual level (age, sex, and tumor grade) and area level (place of residence, educational attainment and elderly concentration) factors.	
	Patients with LC	22,750	GR	Residential segregation; Rural residence	• Mortality	• Suburban and rural residence increased the risk of LC death for White patients by 14% and 26%, respectively (suburban sub distribution hazard ratios (SHR) 1.14 [1.05–1.24]; rural SHR 1.26 [1.08–1.46]). • Black patients living in rural areas were 54% more likely to die than their urban counterparts (SHR 1.54 [1.19–2.0]). • For White patients, living in areas with low Black segregation/high deprivation was associated with 8% (SHR 1.08 [1.02–1.15]) increased risk of death and living in areas with high Black segregation/ low deprivation was associated with 19% (SHR 1.19 [1.07–1.33]) increased risk of death. • Models were adjusted for age, gender, tumor grade, tumor stage, insurance status, smoking status, marital status.	Johnson (2020)
			PC	Race			
			SDF	Deprivation			
	Patients with LC from 50 US states	1,087,810	GR	State of residence	• Survival	• States with better health rankings, lower uninsured rates, and higher health spending were significantly associated with higher Cancer Survival Values (CSVs) (R2 0.418, p<.01; R2 0.352, p<.01; R2 0.142, p=.07, respectively). • CSVs were adjusted for age.	Lee
	Patients with LC		PC	Age; Sex	• Formal Diagnosis		Nadpara

		Elderly patients in rural /medically underserved areas: 1689 (Cohort A) and 1924 (Cohort B) patients	VSG	Patients with comorbidities		• Diagnosis delay was longer among patients with early-stage disease, old age, female sex, and high comorbidity score (p<.05). • Adjusted LC mortality risk was significantly lower among patients receiving delayed care relative to those receiving timely care (HR (95% CI) =0.75 (0.60–0.95); *P*<0.05). • Models were adjusted for LC type, stage, age, sex, race, residence, comorbidity, education and income	
	Patients with NSCLC	192,658	PC	Age; Sex	• Mortality	• Clear trend of the effect of deprivation index on mortality (deprived patients have 23% higher odds of death compared to the most affluent patients). • Patients diagnosed at the age of 40 have almost half of the odds of death compared to those diagnosed at the age of 71 (mean age of diagnosis). • Women 11% lower odds of death in the first year after diagnosis compared to men. • Models were adjusted for adjusted for age, year of diagnosis, sex, deprivation, surgical treatment and time frame and spending on LC.	Nur
			SDF	Deprivation			
	Patients with LC/Bronchial Cancer	12,964	PC	Age; Race; Sex	• Mortality • Survival	• Risk of LC death increased with age: those diagnosed at ages above 75 had 2.62 times the risk of death than those under age 45 after adjustment for covariates. • Females in Nevada had an 18% lower risk of death compared to males (HR 0.82, 95% CI: 0.79–0.86). • Compared to non-Hispanic White (NHW) patients, Hispanics and Asian/Pacific Islanders had 19% and 25% lower risk of death, respectively. • 5-year observed survival for Nevada lung cancer cases lower (15.6%, 95% CI: 14.9–16.2)	Osuoha

						but not statistically different from overall US survival (16.4%, 95% CI: 16.2–16.5). • Models adjusted for insurance and proportion in poverty, sex, age, poverty, race, marital status, region, stage at diagnosis, and histology, radiation, and chemotherapy.	
	Patients with LC	22,487	PC	Age; Race	• Survival	• Maori patients had consistently poorer net survival than non-Maori patients. • Regardless of stage at diagnosis, net survival decreased as age at diagnosis increased. • Deprivation did not influence age disparities in lung cancer survival. • In patients with regional cancer, patients without a comorbidity had slightly better one-year net survival than other patients regardless of age at diagnosis.	Pilleron
			SDF	Deprivation			
			VSG	Patients with comorbidities			
	Patients with NSCLC	56,534	GR	Rural residence	• Survival	• Sociodemographic predictors of worse survival included older age at diagnosis (80+ HR 1.92, 95% CI: 1.70-2.17), male sex (HR 1.31, 95% CI: 1.26-1.35), being underinsured (HR 1.23, 95% CI: 1.09-1.40), single (HR 1.14, 95% CI: 1.10-1.18, and living in nonmetropolitan areas (HR 1.16, 95% CI: 1.08-1.24). • Models were adjusted for age, sex, race, insurance status, marital status, metro proximity, stage and treatment type.	Rapp
			PC	Age; Marital status; Sex			
			SDF	Insurance status			
	Patients with NSCLC	6,259	GR	Rural residence	• Survival	• Urban residents were at significantly lower risk of death compared with their rural counterparts (crude HR 0.9; 95% CI: 0.84-0.9); the same was observed for recipients of care at urban hospitals (HR 0.67, 95% CI: 0.62-0.73). • Models adjusted for insurance status, age at diagnosis, clinical stage and patient/hospitality rurality.	Ray

	Individuals on statutory health insurance	3,163,211	SDF	Employment; income	• Survival	• For LC survival there were no significant social inequalities in men and in women, irrespective of whether employed or retired.	Schroeder
	Patients with LC	57,400	PC	Patients with disabilities	• Mortality	• Patients with disabilities had a slightly higher overall mortality risk than people with no disability (AHR 1.08, 95% CI: 1.06–1.11). • The difference was especially marked in the severe disability group (AHR 1.20, 95% CI: 1.16–1.24). • In the high-severity group, risk was markedly higher in the group with brain/mental impairment (AHR 1.37, 95% CI: 1.28–1.45) and slightly higher in the groups with physical impairment (AHR = 1.16, 95% CI: 1.10–1.23) and communication impairment (AHR = 1.20, 95% CI: 1.07–1.34). • Adjusted for age, sex, income, place of residence, Charlson comorbidity score, cancer stage, surgery, chemotherapy, radiotherapy.	Shin
	Patients with NSCLC	15,031	GR	Rural Residence	• Mortality • Survival	1-year survival estimates were higher for: • those who lived in the most advantaged areas, patients who had never smoked. • patients who were younger than 55 when diagnosed, women, and married people. • Rural residence was significantly related to a decrease in excess mortality for all cases (HR 0.90, 95% CI: 0.87-0.94, p<.01). Adjusted for age, sex, marital status, area socioeconomic level and smoking status. • Models adjusted for age, sex, marital status, area of residence, socioeconomic level, smoking status, stage at diagnosis, year of diagnosis, surgery, chemotherapy, radiotherapy.	Thomas
			PC	Age; Marital status; Sex			
			SDF	SES			
			VSG	Smoking status			

	Patients with NSCLC	18,466	PC	Race	• Mortality • Survival	• Black and White patients had similar 30-day mortality (2%), but Whites had higher 90-day mortality (6% and 4%, respectively). • Race was not associated with overall survival among all patients (HR 0.97, 95% CI: 0.93–1.02). • Race was not associated with LC–specific survival (LCSS) among all patients combined or within each treatment category. (48% versus 47% [p=.70]). • Models adjusted for age, stage, histologic subtype time period of diagnosis, geographical region, tobacco use, and comorbidity variables.	Williams
	Patients with LC	3,687	GR	Density/ Proximity	• Mortality	• Male sex (AOR= 1.34, 95% CI: 1.23–1.45), shorter distance to highway (AOR 1.15, 95% CI: 1.03–1.30), and higher factory density (>23.38 vs <3.14, AOR 1.20, 95% CI: 1.05–1.37) were significantly associated with an increased risk of LC death. • Models adjusted for distance to the closest highway.	Zhang
			PC	Sex			
	Patients with LC	2,200	PC	Age; Marital status; Race	• Survival	• Caucasians died sooner than AA (HR 0.31, p=.01). • Being married (HR 0.89, p=.02) and being less than 55 years of age (HR 0.76, p=.01) were protective against death compared with being unmarried or <76 years old at diagnosis. • AA patients had longer survival rates than Caucasian patients (133 days vs. 117 days, HR 0.31, p<.01). • Models adjusted for age, marriage, region, stage and diagnosis and performance status.	Zullig