Review Article on Socioeconomic Disparities in the Treatment of Thoracic Malignancies

The impact of income and education on lung cancer screening utilization, eligibility, and outcomes: a narrative review of socioeconomic disparities in lung cancer screening

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Abstract: Non-small cell lung cancer (NSCLC) is the leading cause of cancer deaths in the US and worldwide. In particular, vulnerable populations such as those of low socioeconomic status (SES) are at the highest risk for and suffer the highest mortality from NSCLC. Although lung cancer screening (LCS) has been demonstrated to be a powerful tool to lower NSCLC mortality, it is underutilized by eligible smokers, and disparities in screening are likely to contribute to inequities in NSCLC outcomes. It is imperative that we collect and analyze LCS data focused on individuals of low socioeconomic position to identify and address barriers to LCS utilization and help close the gaps in NSCLC mortality along socioeconomic lines. Toward this end, this review aims to examine published studies that have evaluated the impact of income and education on LCS utilization, eligibility, and outcomes. We searched the PubMed, Ovid MEDLINE, and CINAHL Plus databases for all studies published from January 1, 2010, to October 21, 2020, that discussed socioeconomic-based LCS outcomes. The review reveals that income and education have impact on LCS utilization, eligibility, false positive rates and smoking cessation attempts; however, there is a lack of studies evaluating the impact of SES on LCS follow-up, stage at diagnosis, and treatment. We recommend the intentional inclusion of lower SES participants in LCS studies in order to clarify appropriate eligibility criteria, risk-based metrics and outcomes in this high-risk group. We also anticipate that low SES smokers and their providers will require increased support and education regarding smoking cessation and shared decision-making efforts.

Keywords: Socioeconomic disparities; lung cancer screening (LCS); income; education

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Introduction

Rationale/background

Socioeconomic status (SES) is a complex entity commonly measured by income or education. SES reflects a person's social standing and class, which greatly impacts all aspects of health (1-3). Those of low socioeconomic position have a shorter life expectancy and inferior quality of life (4-10). Among patients with non-small cell lung cancer (NSCLC), those of lower social class have higher cancer risk,

incidence, and mortality (7,11-17). These inferior outcomes have been attributed to a higher likelihood of smoking and engaging in other risky behaviors, as well as lower access to quality healthcare, including treatment and clinical trial participation (18-27). Lower cancer screening rates also contribute to inferior outcomes among individuals of low socioeconomic position (28-30).

Most patients with lung cancer are diagnosed with stage IV disease (31,32). Lung cancer screening (LCS) is a life-saving tool used to discover lung cancer at an earlier stage when treatment can be curative. Early detection by LCS using low-dose chest computed tomography (LDCT) was associated with a 20% reduction in NSCLC mortality and a 6% reduction in all-cause mortality in the National Lung Screening Trial (NLST), a randomized controlled trial that compared the outcomes of smokers who were screened via LDCT *vs.* those who were screened via chest X-ray (33,34). Based on these results, the United States Preventive Services Task Force (USPSTF) developed LCS guidelines to reduce mortality from NSCLC, recommending annual screenings for 55–80-year-old individuals with a 30 pack-year smoking history or former heavy smokers who quit within the past 15 years (35-37). Subsequently, the Dutch-Belgian LCS [Nederlands–Leuvens Longkanker Screenings Onderzoek (NELSON)] randomized controlled trial (38-40), which included younger individuals with a lighter smoking history than the NLST, found an even greater mortality benefit of LCS. Based on these results, the USPSTF is updating its LCS guidelines to recommend annual screenings for 50–80-year-old current smokers with a 20 pack-year smoking history or former heavy smokers who quit within the past 15 years (41). This review was prompted by the recent change in the USPSTF guidelines. This narrative review aims to explore what additional changes may be needed based on additional factors contributing to LCS disparities.

Unfortunately, the studies that informed the LCS guidelines did not focus on recruiting socioeconomically diverse individuals, despite the inferior survival rates of those with fewer financial resources. In fact, the majority of the NLST study participants were of higher SES, and the percentage of participants with a college degree or higher (32%) was more than double the same percentage among individuals in the general population who met NLST age and smoking history inclusion criteria (14%) (34,42). Therefore, the study's outcomes and the consequent guidelines may not be appropriate for those of lower socioeconomic position. Furthermore, LCS is significantly underutilized in general, and socioeconomic disparities likely exacerbate the barriers to LCS utilization (43). As such, a greater understanding of SES-based disparities in LCS utilization and outcomes is critical to achieving health equity in the NSCLC space.

Objective

The goal of this narrative review is to synthesize the results of the published studies that have examined the association between income and/or education and LCS. By evaluating current LCS practices and exploring the socioeconomic factors that impact screening, we can address the disparities in LCS and, ultimately, NSCLC outcomes. The key questions identified for the review topic include the following:

(I) How does SES, specifically education and income, affect LCS utilization?
(II) How does SES, specifically education and income, affect LCS eligibility?
(III) What is the influence that SES has on LCS outcomes?
(IV) How should we move forward in understanding LCS through a SES lens?

We present the following article in accordance with the Narrative Review Reporting Checklist (available at: http://dx.doi.org/10.21037/jtd-20-3281).

Methods

Research selection

We worked with two professional medical librarians to search three online databases: PubMed, Ovid MEDLINE, and CINAHL Plus. We developed a list of index terms (*Table 1*) to find all publications from January 1, 2010, to October 21, 2020, that examined the impact of SES on LCS. Keywords included but were not limited to cancer screening, SES, education, income, lung cancer, and disparities.

After removal of duplicates and an initial screening to ensure that articles fit the inclusion criteria, there were 70 articles remaining. *Table 2* provides a list of inclusion and exclusion criteria for the articles used in this review. The title of each article was reviewed for topic relevance, and the abstract was reviewed for further clarification as necessary. Eight articles were then identified for inclusion in this narrative review. Data, including publication date, participant data, and study characteristics (author, title,

Table 1 Example of concepts translated into index terms for literature search

Concept	Index terms
Smokers	Smokers
	Smoking
	Ex-smokers
	Smoking cessation
Detection of Lung Cancer	Early Detection of Cancer
	Health care surveys
	Surveys and questionnaires
	Tomography, X-ray computed
	Mass screening
	Cancer screening
	Risk assessment
Socioeconomic Factors	Socioeconomic factors
	Socioeconomic status
	Disparities
	Healthcare disparities
	Risk factors
	Education
	Income
Lung Cancer	Lung neoplasms
	Lung cancer

Table 2 Criteria for including studies in narrative review

Exclusion criteria	Inclusion criteria
Children	45–80 years of age
Animals	Humans only
<45 or >80 years of age	Written in English
Small cell lung cancer	Conducted only in the United States
Non-smokers or never smokers	Non-small cell lung cancer
Does not include current or former smokers	Current and former smokers
Gray literature (non-peer-reviewed publications, dissertations, thesis, conference proceedings, etc.)	Socioeconomic factors related to lung cancer screening (income and/or education)
No evaluation of impact of socioeconomic status related to lung cancer screening	

study type, sample size, key findings, and outcomes), were abstracted from each article and placed in *Table 3*.

Discussion

SES influences LCS utilization

Only three studies evaluated the effects of SES-based factors on LCS utilization. Steiling *et al.* found that LCS rates are impacted by median income (50). The authors documented an overall screening rate of 16.1% among smokers evaluated at their institution who were eligible for LCS per the USPSTF LCS guidelines and found that, compared to individuals who were screened, those who were eligible but did not undergo screening were more likely to have a lower annual household income (50). Carter-Harris *et al.* noted the association of higher annual income with the completion of or intention to receive screening and found that those with government-based insurance also were less likely to complete or intend to complete screening (44). Su *et al.*, however, found no significant differences based on race, ethnicity, median per capita income, or insurance type between patients who completed screening and those who did not (51). Their study evaluated 175 patients who were diagnosed with NSCLC between 2013 and 2016 and who were eligible for LCS based on USPSTF guidelines. Eighty-one percent of patients had Medicare or Medicaid insurance, with a median per capita income by home zip code (ZIP) of $20,009.

The discrepancy in these findings may be due to the different income measurements used in the three studies. Carter *et al.* gathered individual income data, whereas Steiling *et al.* gathered per capita income per ZIP and Su *et al.* gathered median household income per ZIP. These variables remind us that "income" means different things in different circumstances. Individual income reflects an individual's SES, whereas ZIP/census-level income reflects the individuals' neighborhood/community SES. Census-based measures of income are often used as proxies for individual-level income because the latter is not commonly available. However, although studies have revealed that individual-level and area-based income measures are significantly and independently associated with cancer risk, quality of life, and survival (52-56), the agreement between

Table 3 Study results for included articles

Reference	Sample size/criteria	Study design	Results
Carter-Harris *et al.* (2018) (44)	• n=438 • 48.9% current smokers; 57.3% female; 58% White, 42% Black; mean age 62 years; 39.2% less than college education; 80.2% income level <$50,000; 63.7% government health insurance • Inclusion criteria mirrored the 2013 USPSTF guidelines	• Cross-sectional survey study conducted at a community senior center in Indiana	• Participants who indicated they intended to complete or had recently complete LCS had a significantly higher income than those who had not and did not intend to be screened (P=0.026) • 57.7% of participants who had not been screened reported annual income <$25,000 • There was a difference between screeners *vs.* non-screeners by insurance status (P<0.001) • Participants with government-based health insurance were less likely to have screened or intended to screen, mainly because they were unaware of LCS • Highest mean total knowledge of lung cancer and lung cancer screening scores (ranging from 0 to 9) belonged to those with less than a high school diploma (mean score 4.18, P=0.014)
Hall *et al.* (2018) (45)	• n=169 • 52% current smokers; 51% female; 95.2% White, 3% Black, 3.6% Other; mean age 64 years; 57.2% less than college education; 47.3% Medicare, 0.7% Medicaid • Sampled patients who were undergoing an LDCT scan for LCS from August 2015 to January 2016 based on 2013 USPSTF guidelines	• Cross-sectional survey for patients with scheduled LCS to assess LCS uncertainty (referral clarity and perceived accuracy, sociodemographic variables, and anxiety concerning LCS)	• Greater referral clarity concerning LCS was associated with more education (P=0.01) and with Medicare coverage (P<0.05)
Han *et al.* (2020) (46)	• n=100,000 • No demographic data presented • Individuals in 1950–1960 birth cohorts using data collected from the National Health Interview Survey	• Retrospective analysis evaluating screening eligibility based on 2013 USPSTF guidelines *vs.* a risk-based prediction model	• Compared to those with higher education, a significantly higher proportion (P<0.001) of high school graduates and those with less than a high school education were eligible for screening based on $PLCO_{m2012}$, a risk-based prediction model, but ineligible for LCS because they were younger than the age range recommended by USPSTF guidelines
Hammer *et al.* (2020) (47)	• n=5,835 • 48% current smokers; 85% White, 6% Black, 2% Hispanic; 46% female	• Retrospective study that evaluated the demographics influencing false-positive rates in LCS across the Brigham and Women's Hospital healthcare network from 2014–2018	• Patients living in higher-income areas had lower rates of false-positive scans (highest income *vs.* lowest income) (OR =0.43; 95% CI, 0.22–0.84, P=0.01)

Table 3 (*continued*)

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Reference	Sample Size/Criteria	Study Design	Results
Kumar *et al.* (2016) (48)	• n= 6,813 • l00% current smokers; 45.3% female; 92.7% White, 7.3% Black; median education in years (14 years for White patients/12 years for Black patients); median income in $1,000 (42.5 for White patients, 20.0 for Black patients); Insurance Status (80.2% private *vs.* 11.9% public for White patients, 52.6% private *vs.* 30% public for Black patients) • Inclusion criteria: Black and White participants from the NLST at all American College of Radiology Imaging Network (ACRIN) sites who currently smoke & completed a 12-month follow-up	• Longitudinal cohort study evaluating smoking behavior and smoking cessation activity 12 months after LCS among NLST participants who were smokers at the time of LCS	• Higher incomes were associated with a higher likelihood of 24-hour (OR =1.003; 95% CI, 1.001–1.005) and 7-day quit attempts (OR =1.004; 95% CI, 1.002–1.006) • Education was not associated with the number of quit attempts for cigarette smoking • Neither income nor education impacted 6-month abstinence rates
Li *et al.* (2019) (49)	• n=7,348 • 28.8% current smokers; 52.3% female; 77.3% White, 22.7% Black; mean age 78.1 years; 53.9% less than college education; 50.3% insured • Inclusion criteria: current or former smokers, 51+ years of age	• Cross-sectional study using data from the Health and Retirement Study (HRS) from community-dwelling adults	• Individuals with a high school education or below (OR =1.8; 95% CI, 1.5–2.3, P<0.05) or some college degree (OR =1.7; 95% CI, 1.3–2.1, P<0.05) were more likely to be eligible for LCS • Individuals with higher household income were more likely to be eligible for screening (OR =1.2; 95% CI, 1.0–1.5, P=0.018) than those with lower income
Steiling *et al.* (2019) (50)	• n=615 • 39.5% female; 43.3% White, 41.4% Black, 12.8% Unknown; 79.9% less than college education; 34.9% median household income <$50,000; 50.4% Medicare, 26.9% Medicaid/ uninsured, 21.3% Commercial/private insurance • Inclusion criteria mirrored the 2013 USPSTF guidelines in those who were evaluated by a primary care provider between March 2015 and March 2017	• Retrospective analysis evaluating Boston Medical Center and affiliated community health centers LCS program, collecting demographic data and screening status of patients	• 68.4% of the screened population had an annual household income >$50,000, whereas only 59.6% of the unscreened population had the same level of income (P=0.022) • Education level and insurance type were not significantly associated with screening status
Su *et al.* (2018) (51)	• n=175 • 70% Active Smokers; 52% Female; 37% White, 46% Black, 18% Other; $20,009 median per capita income by ZIP code; 81% on Medicare or Medicaid • Inclusion criteria mirrored 2013 USPSTF guidelines in patients diagnosed with NSCLC from 2013 to 2016	• Retrospective analysis of patients diagnosed with NSCLC at an urban medical center in Bronx, NY	• Neither median per capita income by ZIP code nor insurance impacted whether an eligible patient underwent LCS

the two is frequently poor (56). Studies also suggest that low-income individuals have even lower outcomes and quality of life if they live in low-income neighborhoods. Therefore, the multi-level evaluation of SES allows for a more comprehensive understanding of the impact of SES on outcomes (53-55). It is also important to note that ZIP median household and ZIP per capita income cannot be used interchangeably. Unlike median household income, per capita income is based on the mean income of all individuals in a group. Because income has an important impact on health, we must use multiple, consistent metrics across studies to fully understand how our vulnerable patients are affected.

Lower LCS utilization among those with lower individual and median household incomes is likely secondary to multifaceted issues, including financial barriers. For instance, most low-income patients have either no insurance or government-based insurance. A low-income individual with no insurance would need to pay out-of-pocket for a scan, which is unlikely to happen due to various competing needs. And if an individual has Medicaid, they may not have full coverage of LDCT, as only 31 of 50 Medicaid fee-for-service programs cover LCS. Twelve state programs do not provide coverage, and 7 states did not have information available on their coverage (57). And although Medicare covers all LDCT screenings, not all high-risk individuals will qualify for such coverage due to age restrictions. Thus, insurance type and coverage can impact utilization rates in those with low SES.

In addition, individuals of low income are more likely to have jobs that are not flexible in allowing for LCS during work hours when radiology centers are typically open. Lastly, many patients of low income are cared for in clinics, including federally qualified health centers, that are under-resourced and lack specialists like pulmonologists. Providers at such locations have less time and support to perform shared decision-making, which is a required component of LCS (50). Data suggest primary care providers' lack of time and knowledge about LCS impacts referrals for LCS (58-61). Certainly, lack of time and knowledge are more likely to be barriers in under-resourced clinics that low-income smokers tend to visit.

Hall *et al.* evaluated the impact that SES has on LCS uncertainty, including referral clarity and the perceived accuracy on screening. The study found that greater referral clarity about the reason for lung screening referral was associated with more education (P=0.01). Patients with Medicare also had decreased anxiety levels (P<0.01) and increased understanding of the purpose of LCS referrals (P<0.05) (45). The authors attributed these results to the Centers for Medicare and Medicaid Services' efforts to provide eligible patients with information about LCS through routine flyers and an online portal. This study and others have emphasized that high educational attainment and health literacy can bolster a patient's understanding of their treatment plan and, consequently, LCS rates (46,50,57). Williams *et al.* developed a 12-item measure of the pros and cons of getting screened for lung cancer in order to measure the decisional values of patients. The study found marginal associations between higher education levels and higher LCS knowledge scores (P=0.06) and an association between lower education levels and identifying greater cons in performing a LCS (P=0.09) (62).

The lack of patient clarity that is often associated with lower education can be addressed through the use of community educators or patient navigators. These team members play an important role in improving access and utilization of LCS among patients of lower SES status (45). Patient navigators impact the health of the underserved by facilitating access to the system by connecting patients to resources most appropriate for each patient's individual needs. Navigators also provide advice regarding screening services that may improve compliance by increasing patients' cancer knowledge and risk perception (61,62). Furthermore, they educate patients regarding screening guidelines which increases trust during shared decision making (56). Community educators and navigators assist with scheduling and transportation to screening centers, and with applying for insurance which are paramount to overcoming barriers to screening (63). Additionally, training community health workers can help increase LCS awareness by improving attitudes regarding screening benefits and reducing lung cancer stigma through education interventions (64). Many studies have shown that patient navigation improves cancer screening rates among underserved populations at community health centers by increasing utilization of screening (65,66) and follow-up after abnormal results (67), while decreasing disparities in care (68,69). Thus, high-risk patients of lower SES significantly benefit from patient navigator programs which help improve screening rates, compliance with follow-up, time to treatment initiation, patient satisfaction and quality of life (70).

Patient navigation is but one part of a required multifaceted approach to increase access and LCS utilization in the low SES community. The American

Thoracic Society's statement on addressing disparities in LCS eligibility and healthcare access revealed that Medicaid recipients are less likely to be asked about their smoking history, thus influencing their LCS utilization. The document also reinforced that the prevalence of tobacco smoking is highest among low-SES individuals, and the lack of coverage for certain Medicaid recipients leaves vulnerable at-risk populations without equitable access to screening. Moreover, individuals who smoke tend to be less educated and less likely to have a primary care provider, further reducing access to LCS (50). Therefore, obtaining an appropriate smoking history in those of low SES and providing adequate healthcare coverage to this group are necessary components to improving LCS utilization. To confront disparities in LCS faced by those of low SES, the multidisciplinary panel suggested using multilevel strategies, such as community outreach, education, telehealth, and patient navigation, to target barriers at the patient, provider, and healthcare system levels (50).

In summary, although individuals of low income are at higher risk for NSCLC, they face tremendous barriers to obtaining LCS. To help underserved groups overcome these barriers, we must increase their insurance coverage and could start by mandating that Medicaid universally cover LCS. Another useful strategy would be to increase the educational support available to smokers of low socioeconomic position and their providers. Health literacy is limited in individuals with lower income and education (71), so shared decision-making tools should also be geared toward those of low SES (61). The Agency for Healthcare Research and Quality (AHRQ) has recommendations on how to best provide health education to these vulnerable groups, including assuring that the decision aids are understandable and actionable. They also endorse the teach-back technique to increase the likelihood that patients understand the information (72). Additionally, incentives or support should be offered to providers serving these groups to ensure proper education and shared decision-making efforts (73).

SES influences LCS eligibility

Black smokers are diagnosed with NSCLC at a younger age, with fewer pack-years and shorter quit times than White smokers (74,75). Therefore, the 2013 USPSTF guidelines miss a significant number of high-risk, Black individuals. Low-SES smokers also have different smoking habits. These smokers tend to have a longer duration of smoking than those with higher income (24). They typically start smoking at a younger age and smoke more heavily (23). They are just as likely to make quit attempts but with less success than those with greater financial resources (27).

There have been important discussions regarding the associations between race-based disparities and LCS eligibility criteria (41,46,49,76-79). Risk-based models are more likely to identify high-risk Black smokers than the USPSTF 2013 guidelines. A handful of studies have reported SES-based disparities in eligibility as well. For instance, Han *et al.* evaluated the characteristics of younger (50–54-year-old) and older (71–80-year-old) smokers who were missed by the USPSTF guidelines but were identified as high-risk by the validated, risk-based $PLCO_{m2012}$ screening model, which has been shown to be more sensitive than the USPSTF criteria. They found that, compared to those with higher education, a significantly higher proportion ($P<0.001$) of high school graduates and individuals with less than a high school education were ineligible for LCS because they were younger than the age range recommended by the USPSTF (46). In contrast, Li *et al.* found that, compared to those with a college education or higher, individuals with a high school education or less were more likely to be eligible for LCS (OR =1.8; 95% CI, 1.5–2.3). Interestingly, they also found that higher household income was associated with greater eligibility (49), suggesting like Han *et al.* that smokers with low SES are less likely to meet eligibility criteria.

The recent American Thoracic Society's statement also highlighted the key fact that current LCS guidelines do not consider socioeconomic differences in smoking behaviors or lung cancer risk (50). The lack of incorporation of SES into LCS guidelines explains at least in part why the $PLCO_{m2012}$ risk-based model, which incorporates comprehensive risk factors, including education, identified 12.4% more NSCLC cases, had fewer false positives, and had a higher positive predictive value compared to USPSTF criteria (80). These findings suggest that accounting for socioeconomic factors in guidelines may help increase the number of high-risk individuals eligible for screening. Recently, the American Gastroenterological Association published a white paper focused on the future of colorectal cancer screening. They too note that marginalized groups, including those of low income and those with less than high school education have increased barriers to obtaining colorectal cancer screening despite their higher risk of colorectal cancer. The authors describe strategies to decrease the barriers for these groups but the statement falls short of

incorporating SES into their guidelines (81). Currently, there are no known cancer screening guidelines that include socioeconomic factors, but there are studies that are investigating the impact of including education in non-lung cancer risk prediction models (82). Mitigating existing SES-related disparities in LCS eligibility will require more studies specifically evaluating the suitability of current eligibility criteria for identifying at-risk individuals of lower socioeconomic position. Future studies should further evaluate the incorporation of SES into risk-based models, including individual and area-based income and education measures.

SES influences LCS outcomes

Our search identified only two articles evaluating the impact of SES on LCS outcomes.

False-positive rates

In order to determine which factors influenced the likelihood of a false positive LCS CT, Hammer *et al.* evaluated over 5,000 LCS scans that were performed across their healthcare network from 2014–2018. In the study, a false positive was defined by a Lung-RADS 3-4X (benign to suspicious categories) report with no diagnosis of lung cancer within 1 year. The authors found that false-positive rates were associated with many factors, including lower median income by ZIP (OR 0.43; 95% CI, 0.22–0.84, P=0.01) (57). Although the reasons for this association are not entirely clear, the authors proposed that it may arise because individuals of lower income tend to have worse overall health status and are at higher risk of infectious processes that simulate lung cancer. False-positive results could prompt interventions, such as biopsies, operations or additional imaging, which could lead to complications, resulting in even worse outcomes for low-income populations. Although invasive testing is very uncommon among individuals undergoing LCS (33), we recommend further studies investigating both the association between low SES and false positive rates and the link between SES and unnecessary invasive testing.

Smoking cessation

Only one study evaluated the impact of SES on smoking cessation rates among those who underwent LCS. The study found that individuals with higher self-reported household income were more likely to have 24-hour and 7-day quit attempts than those who reported lower household income (48). However, long-term abstinence was not impacted by income. Although smoking cessation rates in current smokers seeking LCS is universally low, nonetheless, the lower rate of smoking cessation attempts among low-SES individuals is concerning. A comprehensive focus on smoking cessation education and interventions may be especially important for low-SES patients. And PCP-focused educational efforts, incentives for complying with USPSTF recommendations, and measurable quality metrics on smoking cessation discussions and screening of high-risk patients may need to be implemented, especially in under-resourced communities where many underserved patients obtain care.

Intersectionality of Race and SES on LCS eligibility, utilization, and outcomes

Because race/ethnicity and SES are so tightly correlated, it is important to discuss the intersectionality of socioeconomic and racial disparities in LCS. Racial and ethnic minorities have the lowest SES. Several studies reveal that Black communities have lower eligibility and utilization of LCS (59,65,66) using current USPSTF guidelines. There are no studies that evaluate how low SES and minority racial status together impact LCS eligibility, utilization, or outcomes. Steiling *et al.* found that in a diverse community setting (41.4% Black individuals) Black participants had a lower screening rate, comprising only 37.6% of the screened population whereas White participants made up 46% of the screened population (P<0.001) (50). In the same sample, they found that unscreened patients had a lower annual household income than those who were screened. Certainly, we can imagine then that Black participants with a low annual household income would have an even lower screening rate than either individual group alone. And because data suggests that both low SES and racial minority status is also associated with lower eligibility, those who are both low SES and minority will likely have an even lower eligibility and worse outcomes. Therefore, investigation into the intersectionality between SES and race and their combined impact on LCS is paramount as we aim to improve outcomes in underserved groups.

Overall lung cancer patient survival has been significantly lower in more deprived neighborhoods, especially among lower SES, and ethnic-minority groups (75). These findings underline the importance of updating LCS guidelines to address both race-based and SES-based disparities in LCS eligibility, utilization, and outcomes.

Limitations of research reviewed

The main limitation to this review is the paucity of literature available on socioeconomic disparities on LCS. No studies identified in our search evaluated the impact of SES on several important outcomes, including annual adherence, stage of diagnosis at LCS, surgical rates, or mortality rates. Another limitation arises because the articles in this review utilized the 2013 USPSTF guidelines to screen participants instead of the upcoming guidelines and therefore it remains unclear how the new guidelines will impact patients of low socioeconomic position. In addition, as mentioned previously, there was no consistent SES metric across studies, so critical cross analysis was limited. Lastly, as with all narrative overviews, it is important to note that there are major differences between the studies presented (e.g., location, patient samples and research designs), thus we encourage readers to view how SES affects LCS in their own region.

Need for future research

In order to truly understand the impact of income and education on LCS, trials that intentionally recruit patients of low socioeconomic position are necessary. It is also important to explore how risk-based prediction models compare to the upcoming USPSTF guidelines and consider incorporating more SES measures into these models. Also, future studies need to analyze how lower individual and area-based education and income levels affect rates of follow up after positive findings (e.g., biopsies, PET and future CT scans), follow-up treatment (e.g., surgical resection and radiation treatment) and follow-up health outcomes (e.g., burden of disease and mortality rates).

Summary

This narrative review revealed several potential SES-related disparities in LCS screening rates, eligibility, and specific outcomes. Both income and education, key components of SES, have been associated with LCS eligibility, such that those of higher income are more likely to be eligible for LCS whereas those with lower education are more likely to be missed. Furthermore, among LCS-eligible patients, screening rates are lower among patients with lower income. Similar socioeconomic disparities persist beyond screening rates and eligibility, as well, as low-income populations experience fewer benefits from smoking cessation programs and may have higher false-positive rates from LCS.

Too few published studies have evaluated these associations to clearly define the mechanisms by which SES contributes to LCS disparities. Limited knowledge, time, and resources available to low-SES patients and their providers likely contribute to the LCS disparities they face. However, more research is needed to identify additional factors and to develop strategies to address them. Furthermore, as a result of the lack of relevant studies, it is not clear how SES impacts follow-up, stage at diagnosis, treatment, or mortality among LCS participants. Thus, additional studies evaluating the impact of individual income and education, as well as various area-based SES factors, on LCS eligibility, utilization, and outcomes are desperately needed. In the context of clinical practice, low-SES patients and their providers require further support, potentially through navigation and community health workers for patients or incentives and quality-metric evaluations for providers (83). These changes will ultimately help narrow gaps in NSCLC outcomes faced by low-SES populations.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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