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BRIEF REPORT

Racial disparities in eligibility for low-dose computed tomography lung cancer screening among older adults with a history of smoking

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Abstract

Purpose Lung cancer early detection screening has been demonstrated to decrease lung cancer mortality among high-risk smokers. This study aimed to examine whether current screening guidelines may disproportionately exclude African American smokers who are at higher overall risk for lung cancer.

Methods Data from the 2014 Health and Retirement Study were analyzed. Older African Americans and Whites with a history of smoking were included in the analyses ($n = 7{,}348$). Eligibility criteria established by the U.S. Preventive Services Task Force (USPSTF) for LDCT lung cancer screening were used. Multivariate logistic regression analyses were conducted to examine racial differences in eligibility for LDCT lung cancer screening.

Results Overall, 21.1% of current and 10.5% of former smokers met USPSTF's eligibility criteria for LDCT screening. In multivariate logistic regression analyses, African American smokers were less likely to be eligible for LDCT lung cancer screening compared to Whites (odds ratio = 0.5; $p < 0.001$).

Conclusion African American smokers were less likely to meet established lung cancer screening eligibility criteria compared to Whites. Current lung cancer screening criteria may not adequately capture African Americans at risk and may widen the health disparities in African Americans. Further longitudinal studies are needed to evaluate the efficacy of current lung cancer screening guideline.

Keywords Lung cancer screening · Racial disparities · Low-dose computed tomography · African American · Smoking

Introduction

Lung cancer is the second most common cancer and the leading cause of cancer mortality in the United States (US) [1]. Cigarette smoking is a major cause of lung cancer, contributing to 87% of all lung cancer deaths among American adults [2]. Despite similarities in smoking prevalence rates among African American (16.7%) White adults (16.6%) [3] prior research has shown racial disparities in lung cancer incidence and mortality. Overall, African Americans have higher adjusted lung cancer incidence and mortality rates compared to Whites and other racial groups [4]. The causes of these racial disparities in lung cancer are associated with a myriad of factors including socioeconomic disparities associated with race [5], poorer access to care [6], greater exposure to environmental hazards [7], and the under-representation of African Americans in cancer clinical trials [8].

Lung cancer screening is effective in detecting lung cancer at earlier more treatable stages, thus decreasing lung cancer mortality rates [9]. Results from the National Lung Screening Trial (NLST), which was the first, large-scale, randomly controlled trial of lung cancer screening in the United States, showed that low-dose computed tomography lung cancer (LDCT) screening reduced lung cancer-specific mortality by 15–20% among smokers [10]. Secondary analyses of the NLST trial data showed that lung cancer mortality was reduced following screening among all eligible smokers regardless of race; however, African Americans derived the most benefit [11]. Based on the significant results from the

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NLST trial, the U.S. Preventive Services Task Force (USPSTF) gave Grade B recommendation for annual LDCT lung cancer screening in adults aged 55–80 years who have a 30 pack-year smoking history, currently smoke or have quit within the past 15 years, and have no signs or symptoms of lung cancer [12]. Currently, the Centers for Medicare and Medicaid Services (CMS) and private insurers provide coverage for annual LDCT screening among people at high risk for lung cancer [13]. Widespread coverage of LDCT eliminates access as a barrier to lung cancer early detection and treatment and has the potential to reduce racial disparities in lung cancer mortality.

Chronic heavy smoking, operationalized as being a 30 + pack year smoker, is the primary criteria for CMS and USPSTF LDCT screening eligibility. The number of pack years smoked is calculated by multiplying the number of packs of cigarettes smoked per day by the number of years the person has smoked. Although the prevalence of cigarette smoking among African Americans and White adults is the same, prior studies have documented consistent differences in smoking patterns and rates that have implications for meeting current lung cancer screening eligibility criteria. For example, African Americans are more likely to be non-daily smokers and to smoke fewer cigarettes per day compared to Whites [14]. In addition, African Americans initiate smoking and transition to regular smoking at later age compared to their White counterparts [15]. As such, current Medicare eligibility criteria for lung cancer screening may systematically exclude African American smokers compared to Whites resulting in the potential widening of current lung cancer disparities.

To date, published research examining racial differences in eligibility for LDCT lung cancer screening is limited. One study using the USPSTF and CMS eligibility guidelines, examined this question in a sample of African American and White lung cancer cases in a population of lung cancer cases in the Baltimore region of Maryland [16]. An absolute increase of White lung cancer cases (3.8%) that fell within the eligible screening guidelines was observed when compared with African Americans. The results provide suggestive evidence that the current screening guidelines may capture a higher proportion of White lung cancer cases than African American cases. Although making an important contribution to the literature, results of the study were limited due to the relatively small sample size and narrow geographical location of participating patients.

Given the increased risk of lung cancer incidence and mortality in African Americans, additional research is needed to further explore potential racial differences in eligibility for LDCT lung cancer screenings. The purpose of this study was to examine racial differences in eligibility for LDCT by race among a nationally representative sample of older African American and White smokers. The specific research question addressed in this study was whether racial disparities were observed in eligibility for LDCT screening among older adult smokers.

Methods

Study design and study participants

This study utilized a cross-sectional study design. The data were derived from the Health and Retirement Study (HRS) conducted by the University of Michigan. The HRS is an ongoing longitudinal study that has used a multi-stage area probability design to obtain a nationally representative sample of community-dwelling adults aged 51 years and older in the United States [17]. This study analyzed the 2014 HRS dataset prepared by the RAND Center for the Study of Aging [18] (which provides a version of HRS data that contains cleaned and processed variables) to identify older African Americans and White Americans with a history of smoking. The analytic sample for this study was $n = 7{,}348$. The study was approved by the Institutional Review Boards (IRB) of the Rush University Medical Center.

Study measures

LDCT lung cancer screening eligibility criteria Based on the U.S. Preventive Services Task Force (USPSTF) guideline [12], study participants who met all the following criteria were identified as potentially eligible for coverage of LDCT screening: (i) were aged 55–80 years, (ii) had no diagnosis of lung cancer or related symptoms, (iii) were either current or former smokers (quit within the past 15 years), and (iv) 30 + pack year smoking history (# packs per day X # number of years smoked). A self-reported history of lung disease or a cancer diagnosis was used as a proxy measure of lung cancer diagnoses and related symptoms.

Control variables The following demographic and background variables were measured as study control variables: Age (in years), race (African American or White), gender (male or female), education (high school and below, some college, or college and above), and marital status (married, separated/divorced/widowed, or never married), household income (quartiles) and health insurance coverage (insured or non-insured) and self-rated health (excellent, very good, good, fair, or poor).

Data analysis

Descriptive statistics were used to describe the characteristics of study participants. Bivariate statistics were used to examine the association between race, other demographics

and eligibility for LDCT lung cancer screening. Finally, a multivariate logistic regression (reported with odds ratio; OR, and 95% confidence interval; 95% CI) was conducted to examine the association between race and eligibility for LDCT lung cancer screenings after controlling for other demographics. Further, the analysis was stratified by race to identify any different demographic predictors that were associated with eligibility for LDCT lung cancer screening within African Americans and Whites. SPSS Statistics version 22 was used to perform all statistical analyses.

Results

Characteristics of study participants

Among older adults with a smoking history ($n = 7{,}348$), 28.8% were current smokers and 71.2% were former smokers. The mean age of participants was 68.1 years. A majority of participants were White (77.3%), female (52.3%), had completed no more than a high school degree (53.9%), were married (53.7%), were insured (50.3%), were and in good health (66.6%). Compared to Whites, African Americans were more likely to be younger, female, less well educated, never married, uninsured and in fair or poor health ($p < 0.001$; data not shown).

Smoking Characteristics and Eligibility for LDCT Lung Cancer Screening

Figure 1 displays USPSTF's eligibility criteria for LDCT lung cancer screening based on race. Overall, 13.5% of all smokers met criteria for lung cancer early detection screening. Racial differences were observed in lung cancer screening eligibility rates. A lower and statistically significant proportion of current African American smokers met screening eligibility criteria compared to White smokers (12.1% vs. 25.5%, $p < 0.001$). In comparing each of the individual LDCT criteria by race, African Americans were more likely to be older ($p < 0.001$), to be a current smoker ($p < 0.001$) and to not report a history of lung disease ($p < 0.001$). Although African Americans and Whites had smoked for a similar number of years (28.7 vs. 27.3, $p < 0.001$), the mean number of cigarettes smoked per day were significantly lower among African Americans (11.5 vs. 18.4, $p < 0.001$) (data not shown). This results in a lower

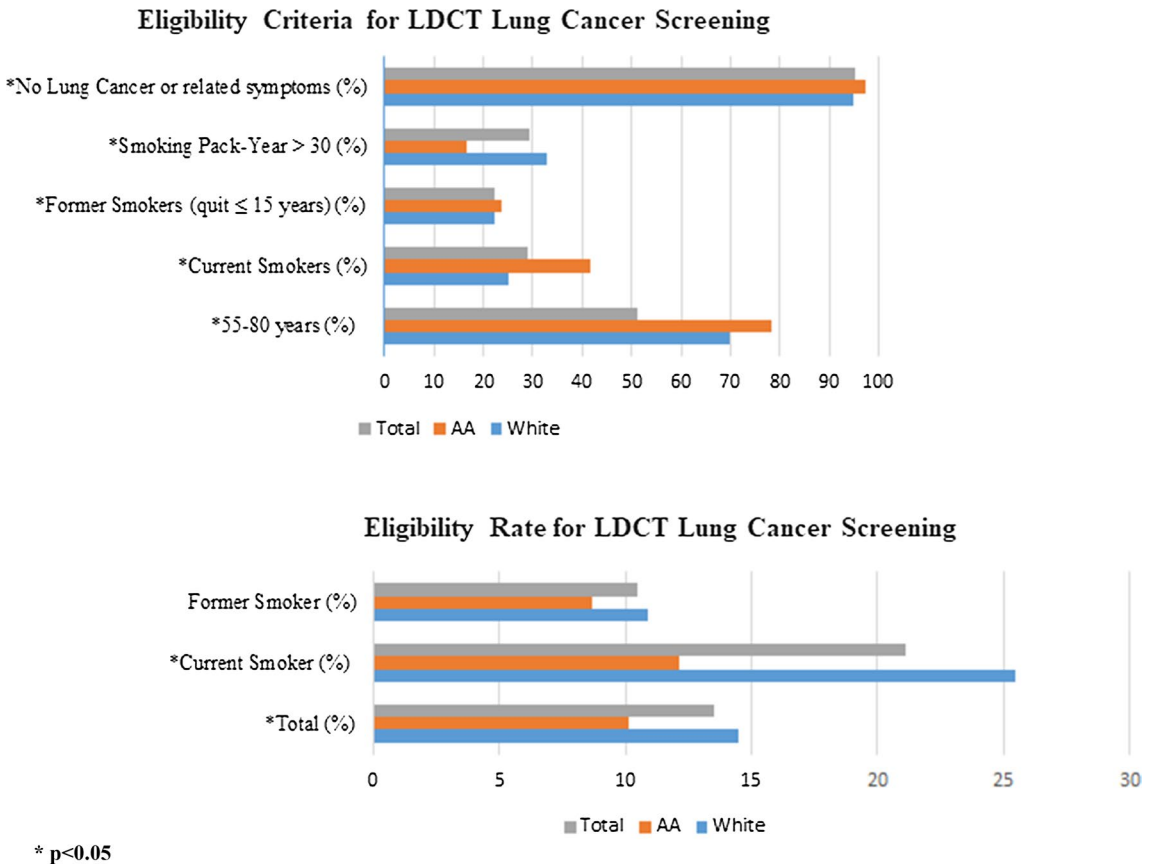

Fig. 1 Eligibility for LDCT lung cancer screening. *$p < 0.05$

proportion of African Americans achieving a 30 + pack year smoking history (16.5% vs. 33.0%, $p < 0.001$) (Fig. 1).

Factors Associated with Eligibility for LDCT Lung Cancer Screening

Results from the multivariate logistic regression analysis are shown in Table 1. Similar to univariate analyses, African American smokers were less likely to be eligible for LDCT lung cancer screening (OR 0.5; 95% CI 0.4–0.6) even after controlling for other demographic factors. In addition to race, additional demographic factors associated with LDCT eligibility included being male (OR 1.7; 95% CI 1.5–2.0), having a high school education or below (OR 1.8; 95% CI 1.5–2.3) or some college degree (OR 1.7; 95% CI 1.3–2.1), being separate/widowed/divorced (OR 1.4; 95% CI 1.1–1.9) and having a household income at third quartile (i.e., 50–75 percentile). In contrast, older people (OR 0.9; 95% CI 0.9–0.9) or people self-reported health as excellent (OR 0.6; 95% CI 0.4–0.8) or very good (OR 0.7; 95% CI 0.5–0.9) were less likely to be eligible for LDCT screening. Among Whites, racially stratified analyses were similar to the combined model. However, among African Americans, only male gender and lower levels of education were significant predictors of LDCT eligibility.

Discussion

LDCT lung cancer screening has been found to reduce lung cancer mortality among older adult smokers [10]. Current lung cancer screening guidelines are developed based on the results from the National Lung Screening Trial (NLST). However, a very small proportions of NLST participants were considered minorities. Therefore, questions exist as to whether current screening guidelines disproportionately exclude African American smokers who are at higher overall risk for lung cancer [19, 20]. In this study, older African Americans had a higher prevalence of current smoking compared to Whites. This finding is consistent with data suggesting that African Americans are less likely to successfully quit smoking than Whites [21]. Although a higher proportion of African Americans were current smokers, they were less likely to meet the 30 + pack-years smoking history threshold established as a primary eligibility criterion for lung cancer screening. African Americans and Whites reported smoking for a similar number of years; however,

Table 1 Factors associated with eligibility for LDCT lung cancer screening

Variable	Overall		African American		White	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Age	0.9 (0.9–0.9)	0.000*	0.9 (0.9–1.0)	0.506	0.9 (0.9–0.9)	0.000*
Race (reference: Whites)						
African American	0.5 (0.4–0.6)	0.000*	N/A	N/A		
Gender (reference: female)						
Male	1.7 (1.5–2.0)	0.000*	2.0 (1.4–2.9)	0.000*	1.6 (1.4–1.9)	0.000*
Education (reference: college and above)						
High school and below	1.8 (1.5–2.3)	0.000*	2.5 (1.1–5.4)	0.018*	1.8 (1.4–2.2)	0.000*
Some college	1.7 (1.3–2.1)	0.000*	2.2 (1.0–4.8)	0.048*	1.6 (1.3–2.1)	0.000*
Marital status (reference: never married)						
Married	0.9 (0.6–1.2)	0.756	1.1 (0.6–1.9)	0.639	0.9 (0.6–1.3)	0.634
Separate/widowed/divorced	1.4 (1.1–1.9)	0.022*	1.3 (0.8–2.2)	0.199	1.4 (0.9–2.1)	0.076
Self-rated health (reference: poor)						
Excellent	0.6 (0.4–0.8)	0.010*	0.5 (0.1–1.4)	0.199	0.6 (0.4–0.9)	0.018*
Very good	0.7 (0.5–0.9)	0.024*	0.9 (0.5–1.7)	0.847	0.7 (0.5–0.9)	0.025*
Good	0.9 (0.7–1.1)	0.481	0.8 (0.5–1.4)	0.569	0.9 (0.7–1.2)	0.633
Fair	0.8 (0.6–1.1)	0.362	0.8 (0.5–1.4)	0.582	0.8 (0.6–1.1)	0.464
Health insurance status (reference: insured)						
Non-insured	0.9 (0.8–1.1)	0.487	1.1 (0.7–1.7)	0.457	0.9 (0.7–1.0)	0.271
Household income (reference: Quartile 4)						
Quartile 1	1.0 (0.7–1.3)	0.842	1.2 (0.6–2.5)	0.485	0.9 (0.6–1.1)	0.574
Quartile 2	1.1 (0.9–1.4)	0.153	1.0 (0.5–2.0)	0.980	1.1 (0.9–1.5)	0.094
Quartile 3	1.2 (1.0–1.5)	0.018*	0.8 (0.3–1.6)	0.529	1.3 (1.1–1.7)	0.003*

OR Odds ratio; *95% CI* 95% confidence interval

*$p < 0.05$

the mean number of cigarettes smoked per day were significantly lower among African Americans. This is consistent with prior study findings that African American men had a longer smoking duration but had fewer pack-years than White men [14]. Prior studies have shown that African Americans were likely to experience a higher burden of lung cancer even at lower dose of tobacco compared to Whites [14, 22]. In addition, African Americans were more likely to be diagnosed with lung cancer at earlier ages than Whites [23]. One study showed that African American men aged between 40 and 54 years of age were 2 to 4 times more likely to develop lung cancer compared to White men after adjusting smoking [24]. Given the racial differences in age at diagnosis and smoking habits and behaviors, using current eligibility criteria may exclude some African Americans who may benefit from LDCT lung cancer screening and widen the disparities found in lung cancer detection and mortality rates between African American and White populations [25].

Researchers are beginning to examine the difference in lung cancer risk between ever smokers with 20 to 29 pack-year and those with 30 + pack-year [19]. Results showed that current smokers with 20 to 29 pack-year had a similar lung cancer risk compared to former smokers with 30 + pack-year. With the inclusion of current smokers with 20–29 pack-year, the LDCT screening eligible individuals among racial/ethnic minorities (i.e., other than Whites) increased by thirty percent [19]. Furthermore, several risk-based models of lung cancer screening, which may be more efficient than risk factor-based selections, were developed to select individuals at highest lung cancer risk [25–27]. In 2016, an individualized risk model was developed for American smokers that took into account of demographic variables (age, sex, race, education, body mass index), clinical variables (self-reported history of emphysema and lung cancer family history), and smoking variables (cigarettes per day, smoking duration, and smoking pack-years and quit-years) [28]. After applying the risk model to U.S. ever-smokers aged 50–80 years, 36% of the USPSTF eligible individuals who were identified as low risk were replaced by USPSTF ineligible individuals with the highest risks. With the inclusion of the replacement, the percentage of African American increased from 7.7 to 12.8%. Further longitudinal studies can use the risk model specifically developed for African Americans [29] to assess the appropriateness of lung cancer screening guidelines.

This study has a few limitations. First, the data from the HRS data were self-reported. Therefore, the self-reported bias and recall bias on key information such as smoking behavior and history should be considered. However, all eligibility assessments for LDCT lung cancer screening are based on self-reported smoking history. We are unaware of any reported studies that show racial differences in willingness and accuracy of reporting on long-term smoking patterns. As such, any recall bias is likely equally distributed across racial groups studied. Second, the information on lung cancer diagnoses and related symptoms were not objectively verified which may have resulted in an overestimation of the eligible rate for LDCT lung cancer screening. In light of these limitations, additional studies are needed to replicate our study findings.

Conclusions

In the United States, African Americans are disproportionally affected by lung cancer risk and mortality compared to White Americans. Current guideline for LDCT lung cancer screening may not adequately capture African Americans at risk, particularly younger African Americans and those light and intermittent smokers. Further longitudinal studies are needed, especially among high-risk populations, to determine if racial differences in eligibility criteria for lung screening lead to a widening of lung cancer health disparities.

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Compliance with ethical standards

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

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