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Differential eligibility of African American and European American lung cancer cases using LDCT screening guidelines

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ABSTRACT

Introduction: Lung cancer incidence and mortality is higher among African Americans compared with European Americans in the USA where screening guidelines are currently in place and based on age at diagnosis and smoking history. Given the different smoking patterns observed in these populations and the earlier age at which African Americans are diagnosed, it is possible that African Americans will be disproportionally excluded from screening programmes.

Methods: We assessed the capture of African American and EA lung cancer cases using the National Lung Screening Trial, US Preventive Services Task Force and Centers for Medicare and Medicaid Services eligibility guidelines in a population of lung cancer cases diagnosed between 1998 and 2014 in the Baltimore region of Maryland (n=1658).

Results: We found an absolute increase of 3.8% (relative increase: 11.5%) of EA lung cancer cases that fell within the eligible screening guidelines when compared with African Americans. This difference in proportions was not statistically significant (p=0.134). However, differences were more pronounced among women, where an absolute and relative difference of 4.2% and 13.6%, respectively, was observed (p=0.083). As more EA are likely to successfully quit smoking compared with African Americans, the inclusion of the time since quitting variable decreased the relative differences in eligibility.

Conclusions: Current screening guidelines are projected to capture a higher proportion of EA lung cancer cases than African American cases; however, the differences are not statistically significant. Further studies are needed, especially among high-risk populations, to determine if racial differences in eligibility criteria for lung screening will lead to a widening of cancer health disparities.

KEY MESSAGES

- African Americans, especially women, are less likely to be considered as LDCT screening eligible based on CMS screening guidelines. The relative difference of 11.5% (absolute difference 3.8%) is not statistically significant.
- The magnitude of the difference in screening eligibility is tempered by the inclusion of the "time since quitting" variable as more African Americans are likely to have quit within the 15 year category than European Americans.

INTRODUCTION

The US Preventive Services Task Force (USPSTF) currently recommends annual screening for lung cancer with low-dose CT (LDCT) in adults aged 55–80 years who have a 30 pack-year smoking history, currently smoke or have quit within the past 15 years. In 2015, the Centers for Medicare and Medicaid Services (CMS) approved reimbursement for annual LDCT screening among individuals aged between 55 and 77 years, who have a 30 pack-year smoking history or have quit within the last 15 years. These guidelines were largely based on the findings of the National Lung Screening Trial (NLST), which documented a 20% reduction in lung cancer mortality among those screened with LDCT compared with chest X-ray.[1] Approximately 9 million individuals in the USA are eligible for screening, which—assuming a 70% screening uptake rate—could prevent ~8500 lung cancer deaths each year.[2]

A post hoc analysis of the NLST found that 88% of the LDCT-prevented lung cancer deaths occurred in the 60% of patients defined as at highest risk.[3] Indeed, it has been proposed that individual risk-based screening strategies can improve lung cancer screening effectiveness and efficiency. Using a risk-based model that included an expanded set of risk factors, such as age, education, sex, race, smoking intensity, smoking duration, quit years, BMI, family history and emphysema, Katki *et al*[4] reported

that restricting screening to the highest risk patients with lung cancer averted 20% more deaths and decreased the number needed to screen by 17%.

The reduction and elimination of cancer health disparities remains of public health importance and challenging. While overdiagnosis[5] and false-positivity remains of concern,[1] the expansion of LDCT screening has significant potential to reduce the high mortality associated with lung cancer. It is also possible that the implementation of LDCT screening in its current form may lead to a widening of the disparity in cancer mortality among racial groups in the USA, particularly between European Americans and African Americans. Several studies have shown that African Americans are typically diagnosed with lung cancer at earlier ages compared with EA[6 7] and African Americans have lower overall tobacco exposure.[6 8] As age at diagnosis and smoking exposure define two of the main eligibility criteria for CMS and USPSTF LDCT screening, African Americans are perhaps more likely to be considered in the screening ineligible category, further increasing the racial disparity.

As there are currently no national data sets that include lung cancer incidence and smoking-related data, we tested this hypothesis using a series of lung cancer cases diagnosed between 1998 and 2014 within the Baltimore region of Maryland.

METHODS

Study population

The NCI-Maryland lung cancer study is an ongoing case–control study of African Americans and EA recruited from the greater Baltimore and Maryland Eastern Shore area. Patients with non-small cell lung cancer were enrolled from 1998 onwards, as previously described.[9] Exclusion criteria for eligibility included; being more than 24 months after initial diagnosis, non-US resident, non-English-speaking, residing in an institution such as a prison, nursing home or shelter, unable to give informed consent, diagnosis of HIV, hepatitis B or C. All cases of lung cancer were confirmed by pathological examination to determine histological subtype and stage. In addition to collecting clinical information, each participant completed a detailed demographic questionnaire. All participants provided informed consent and the study was approved by all of the participating institutes and the National Cancer Institute.

This analysis included 517 African American and 1141 EA lung cancer cases. A description of these cases is outlined in table 1.

Statistical analysis

Demographic differences between African Americans and EA were assessed using a χ^2 test for categorical variables and Student's t-test for continuous variables. For assessing the equality of proportions, the *prtest* function in STATA (STATA V.14; StataCorp LP, College Station, Texas, USA) was used.

Table 1 Characteristics of the cases included in this study

	African American N=517	European American N=1141	p Value
Smoking status			
Never	36 (7%)	106 (9.4%)	<0.0001
Former	188 (36.6%)	523 (46.3%)	
Current	288 (56%)	494 (43.8%)	
Missing	2 (0.4%)	6 (0.5%)	
Gender			
Male	270 (54%)	600 (53%)	0.892
Female	247 (48%)	541 (47%)	
Age (mean, range)	63.8 (34–88)	66.2 (26–91)	<0.0001
Pack-years (mean, range)	35.1 (0–185)	44.2 (0–194.2)	<0.0001
Years since quit (mean, range)	5.9 (0–48)	9.0 (0–56)	
≤15*	111 (59%)	242 (46%)	<0.0001
>15*	77 (41%)	281 (54%)	

*Former smokers only.

RESULTS

Regardless of the screening criteria considered, African Americans were more likely to fall within the screening ineligible subgroup, compared with EA (table 2). Using CMS criteria, 33.1% of African American cases fell within screening guidelines, compared with 36.9% of EA cases—this translated to a non-significant relative increase in eligibility of 11.5% among EA lung cancer cases (absolute difference 3.8%, p=0.13).

Using the USPSTF criteria however, the differences in eligibility were of borderline statistical significance. For example, while 39.4% of EA would have been eligible for screening, only 34% of African Americans were eligible. This translates to an absolute difference of 5.4% and a relative difference of 13.7% (p=0.036) (table 2).

We noted that the racial differences in eligibility were greater for women than for men (table 2), and using USPSFT criteria, these were significantly different. Using CMS guidelines, 30.9% of EA were eligible for screening, while only 26.7% of African Americans were eligible. This translates to an absolute difference of 4.2% and a relative difference of 13.6% (p=0.083). This suggests that applying the same set of screening eligibility criteria across racial and ethnic groups could unintentionally miss a proportion of high-risk female patients with lung cancer and has the potential to increase the disparity in survival, especially among women.

Our analysis also found that inclusion of the 'time since quitting' criterion reduced the disparity in eligibility criteria. One likely explanation is that EA are more likely to have successful quit attempts;[10] thus, more African American former smokers were captured in the category of having quit for <15 years (59%) compared with EA (46%) (tables 1 and 3).

Table 2 Numbers and per cent of lung cancers diagnosed in the NCI-MD case–control study from 1998 to 2015 that fall within guidelines for lung cancer screening

	Criteria					
	NLST*		USPSTF†		CMS‡	
	EA	AA	EA	AA	EA	AA
All (n=1141 EA, n=517 AA)	381 (33.4%)	161 (31.1%)	449 (39.4%)	176 (34.0%)	421 (36.9%)	171 (33.1%)
p Value	0.355		***0.036***		0.134	
Men (n=600 EA, n=270 AA)	231 (38.5%)	98 (36.3%)	269 (44.8%)	110 (40.7%)	255 (42.5%)	105 (38.9%)
p Value	0.392		0.119		0.168	
Women (n=541 EA, n=247 AA)	150 (27.7%)	63 (25.5%)	180 (33.3%)	66 (26.7%)	167 (30.9%)	66 (26.7%)
p Value	0.350		***0.007***		0.083	

Bold signifies statistical significance.
Data based on smoking status, pack-years of smoking, time since quitting and age.
*NLST criteria: aged 55–74, current or former smoker, at least 30 pack-years of smoking, if former smoker, having quit within the last 15 years.
†USPSTF criteria: aged 55–80, current or former smoker, at least 30 pack-years of smoking, if former smoker, having quit within the last 15 years.
‡CMS criteria: aged 55–77, current or former smoker, at least 30 pack-years of smoking, if former smoker, having quit within the last 15 years.
AA, African American; CMS, Centers for Medicare & Medicaid Services; EA, European Americans; NLST, National Lung Screening Trial; USPSTF, US Preventive Services Task Force.

Table 3 Comparison of the relative difference in lung cancer cases captured including (A) and excluding (B) the variable 'time since quit'

	African American 517	European American 1141	Relative per cent difference in eligibility
(A) With the time since quitting variable			
USTPSTF*	176 (34.0%)	449 (39.4%)	15.5%, p=0.211
NLST†	161 (31.1%)	381 (33.4%)	7.4%, p=0.602
CMS‡	171 (33.1%)	421 (36.9%)	11.5%, p=0.382
(B) Without the time since quitting variable			
USTPSTF*	194 (37.5%)	530 (46.1%)	22.93%, p=0.039
NLST†	169 (32.7%)	429 (37.6%)	15.0%, p=0.262
CMS‡	183 (35.4%)	486 (42.6%)	20.3% p=0.091

*NLST criteria: aged 55–74, current or former smoker, at least 30 pack-years of smoking, if former smoker, having quit within the last 15 years.
†USPSTF criteria: aged 55–80, current or former smoker, at least 30 pack-years of smoking, if former smoker, having quit within the last 15 years.
‡CMS criteria: aged 55–77, current or former smoker, at least 30 pack-years of smoking, if former smoker, having quit within the last 15 years.
AA, African American; CMS, Centers for Medicare and Medicaid Services; EA, European Americans; NLST, National Lung Screening Trial; USPSTF, US Preventive Services Task Force.

DISCUSSION

This study hypothesised that, due to differences in smoking behaviour and age at diagnosis, African Americans are disproportionally categorised as screen ineligible according to USPSTF and CMS criteria. The NLST, USPSTF and CMS criteria are largely similar, with differences mainly in the ages at which high-risk cases are considered. While it is widely known that African Americans have a lower cumulative smoking exposure compared with EA,[11] it is unclear how other screening criteria would impact overall eligibility. This analysis shows that 11% fewer (absolute difference 3.8%) African Americans are considered eligible using current screening guidelines; however, it was not statistically significant. This difference was significantly higher among women. Thus, one interpretation is that using USPSTF/CMS smoking-related subgroup categories alone could miss a proportion of high-risk female lung cancer cases. Interestingly, a recent study performed by Katki *et al*[4] found that using an individualised lung cancer risk model that removed the lowest risk individuals from the USPSTF guidelines and replaced them with those at highest risk increased the inclusion of African Americans from 7.7% to 12.8%. Using a different approach, our findings here support the observation that African Americans, and specifically high-risk African Americans, are disproportionally categorised as screening ineligible. However, our analysis demonstrates that the inclusion of the 'time since quitting' factor reduces the relative racial differences in cases that fell within the screening guidelines, suggesting that this is an important metric to include for the purposes of reducing disparities.

A strength of our analysis is that it was performed on directly observed lung cancer cases as opposed to a model-based system. However, there are some

limitations. Our study does not take into account potential differences in screening uptake among racial groups or smoking trends over the past decade. Another assumption of this analysis is that we assumed the proportion of indolent disease detected by LDCT will be same for EA and African Americans; however, we cannot be certain of that expectation at this time. Also, cases from this study were not primarily diagnosed using LDCT and race-specific efficacies of LDCT are unknown. The population examined in this analysis is representative of seven counties within the Baltimore region of Maryland. However, as no nationwide database exists that includes individual-based smoking data coupled with lung cancer incidence, studies such as this are needed to assess racial differences in screening eligibility. While our study included 1658 lung cancer cases, this is not a nationally representative number and therefore is relatively small in terms of screening studies. Also, as mentioned above, the overall difference in eligibility was not significant, though we did observe significance for women only. However, it should be noted that this subgroup comparison may reflect a false-positive result due to multiple testing and would therefore require further validation.

As ever, the best method to reduce lung cancer mortality is smoking cessation. It is possible that the implementation of LDCT screening eligibility criteria in its current form may lead to a widening of the disparity in mortality among racial groups in the USA, though this analysis suggests that the current criteria may limit the extent. The concept of precision medicine and precision prevention in terms of screening has been considered for other cancer types, including prostate and colorectal,[12 13] while the challenges in applying population-specific guidelines have also been acknowledged. However, combined with recent studies,[4] our analysis shows that the inclusion of an individual-based risk screening strategy may increase the representation of high-risk minority populations in lung cancer screening programmes.

In conclusion, current screening guidelines are projected to capture a higher proportion of EA lung cancer cases than African American cases; however, the differences, as reported in this analysis, are not statistically significant. Further studies are needed, especially among high-risk populations, to determine if racial differences in eligibility criteria for lung screening will lead to a widening of cancer health disparities, as well as methods to identify the populations at highest risk. For example, recent work on the PLCO screening trial suggested that the use of criteria in addition to age and smoking might enable improved identification of high-risk individuals.[14 15] The model consists of four smoking variables (smoking intensity, smoking duration, quit time in former smokers and current smoking status (current vs former)) and seven non-smoking variables (age, race/ethnicity, socioeconomic circumstance estimated by education level, body mass index, personal history of cancer, chronic obstructive pulmonary disease, family history of lung cancer). Future studies that compare racial differences in screening eligibility should also consider these models. Our data also suggest that while lung cancer screening has the potential to reduce mortality, there are still a significant proportion of lung cancer diagnoses that do not fall within lung screening guidelines, irrespective of race. Thus, additional research on methods that capture other individuals at risk of lung cancer development are also needed.

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