

# Brief Report: Risk Prediction Model Versus United States Preventive Services Task Force 2020 Draft Lung Cancer Screening Eligibility Criteria—Reducing Race Disparities



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## ABSTRACT

**Introduction:** Eligibility criteria for lung cancer screening based solely on age and smoking history are less sensitive than validated risk prediction models. The U.S. Preventive Services Task Force (USPSTF) has proposed new guidelines to improve the sensitivity for selecting high-risk individuals and to decrease race disparity. In this retrospective study, termed the Chicago Race Eligibility for Screening Cohort, we compare the sensitivity of the proposed USPSTF2020 criteria versus the PLCOm2012 risk prediction model for selecting a racially diverse lung cancer population with a smoking history for lung cancer screening.

**Methods:** This Chicago Race Eligibility for Screening Cohort study applies the PLCOm2012 model with a risk threshold of 1.0%/6 years and the USPSTF2020 criteria (age 50–80 y, pack-years  $\geq$  20 y, quit-years  $\leq$  15 y) to 883 individuals with a smoking history diagnosed with having lung cancer.

**Results:** The PLCOm2012 was more sensitive than the USPSTF2020 overall (79.1% versus 68.6%,  $p < 0.0001$ ) in White (81.5% versus 75.4%,  $p = 0.029$ ) and in African American (82.8% versus 70.6%  $p < 0.0001$ ) individuals. Of the total cohort, 254 (28.8%) would not have qualified owing to less than 20 pack-years, quit-time of more than 15 years, and age less than 50 years. Of these 254 cases, 40% would have qualified by the PLCOm2012 model. For the 20 pack-year criterion, of the 497 African American individuals, 19.3% did not meet this criterion, and of these, an

additional 31.3% would have qualified by the PLCOm2012 model ( $p = 0.002$ ).

**Conclusions:** Although more sensitive than USPSTF2013, the proposed USPSTF2020 draft guidelines still have a race disparity in eligibility for screening. This study provides “real world” evidence that use of the PLCOm2012 risk prediction model eliminates this race disparity.

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*Disclosure:* Dr. Tammemägi developed the PLCOm2012 lung cancer risk prediction models. The model is open access and is available free of charge to noncommercial users. For commercial users, licensing has been assigned to Brock University. To date, Dr. Tammemägi has not received any money for use of the PLCOm2012 model nor does he anticipate any payments in the future. The remaining authors declare no conflict of interest.

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**Keywords:** Lung cancer screening; PLCOm2012 risk prediction model; Race disparities; African American; United States Preventive Services Task Force

## Introduction

Lung cancer is the leading cause of cancer death in the United States.<sup>1</sup> The National Lung Screening Trial revealed a 20% reduction in lung cancer mortality with low-dose computed tomography (CT) compared with chest radiograph in high-risk individuals between the ages of 55 and 74 years, who currently smoke or quit within the past 15 years, with a smoking history of greater than or equal to 30 pack-years.<sup>2</sup> The Dutch-Belgian lung screening trial was a randomized trial comparing CT screening versus no screening in individuals aged 50 to 74 years and a smoking history of greater than or equal to 15 cigarettes a day for more than or equal to 25 years or greater than or equal to 10 cigarettes a day for more than or equal to 30 years and quit-time of less than 10 years. The Dutch-Belgian lung screening trial found a mortality benefit of greater than or equal to 26%.<sup>3</sup> The current U.S. Preventive Services Task Force (USPSTF) 2013 lung screening guidelines based on the National Lung Screening Trial define eligible individuals as aged 55 to 80 years with a greater than or equal to 30 pack-year smoking history who currently smoke or have quit within the past 15 years.<sup>4</sup> The USPSTF has proposed new guidelines to improve the sensitivity for selecting high-risk individuals and to decrease race disparity. A draft of the proposal of these guidelines (USPSTF2020) lowers the age limit to 50 years and pack-year smoking history to 20 years for those who currently smoke or those who have quit within the past 15 years.<sup>5</sup>

African American individuals who have a smoking history have a higher risk of lung cancer despite accumulating fewer pack-years compared with their White counterparts and are less likely to meet the USPSTF2013 guidelines.<sup>6</sup> In our previous study of 883 lung cancer cases with a history of smoking, the USPSTF2013 identified for screening 52.3% of this entire cohort, with 50.3% African American and 62.4% White individuals, whereas the PLCOm2012 risk prediction model at a 1.7%/6-year risk threshold identified 62.1% of this cohort, with 61.0% African American and 67.4% White individuals.<sup>6</sup> Although we revealed that compared with the USPSTF2013 guidelines, the PLCOm2012 risk prediction model is more sensitive and decreases race disparity, the USPSTF2020

proposed guidelines also aim to increase sensitivity and decrease race disparity.

In this retrospective study, termed the Chicago Race Eligibility for Screening Cohort, we compare the sensitivity of the proposed USPSTF2020 criteria versus the PLCOm2012 risk prediction model for selecting African American individuals with a smoking history for screening. The aim of this study is to provide evidence for the most optimal lung screening method that eliminates race disparities.

## Material and Methods

The material and methods have been described previously.<sup>6</sup> Briefly, the Chicago Race Eligibility for Screening Cohort study applies the PLCOm2012 model with a risk threshold of 1.0%/6 years and the USPSTF2020 criteria (age 50–80 y, pack-years  $\geq$  20 y, quit-years  $\leq$  15 y) to a sequential series of 883 individuals with a smoking history diagnosed with having lung cancer at a large urban academic medical center.<sup>6</sup> The PLCOm2012 1.0%/6 years threshold was chosen because Cancer Intervention and Surveillance Modeling Network microsimulation modeling found that it selected a similar number for screening as did the USPSTF2020 criteria.<sup>7</sup> This study (2018-0491) met the requirements for waiver of informed consent which was approved by the University of Illinois at Chicago Institutional Review Board.

## Results

This cohort was previously described ([Supplementary Table 1](#)).<sup>6</sup> The PLCOm2012 was significantly more sensitive than the USPSTF2020 overall (79.1% versus 68.6%,  $p < 0.0001$ ) in White (81.5% versus 75.4%,  $p = 0.029$ ) and African American individuals (82.8% versus 70.6%  $p < 0.0001$ ) ([Table 1](#)). Overall, 32 cases would have been missed by PLCOm2012 and detected by USPSTF2020 criteria, whereas 125 cases would have been detected by PLCOm2012 and missed by USPSTF2020 ( $OR_{McNemar} = 3.91$ , 95% confidence interval [CI]: 2.63–5.95). In White individuals, the comparable numbers are 16 and 32 ( $OR_{McNemar} = 2.00$ , 95% CI: 1.07–3.90), whereas in African American individuals the comparable numbers are 9 and 69 ( $OR_{McNemar} = 7.67$ , 95% CI: 3.81–17.47). Applying the PLCOm2012 model, the White versus African American difference in sensitivity is 1.3% and is higher in the African American cohort ( $p = 0.61$ ), whereas applying the USPSTF2020, the difference is 4.8% and is higher in the White cohort ( $p = 0.14$ ).

[Table 2](#) presents the number and proportion of lung cancer cases that failed to qualify by the

**Table 1. Sensitivity (%) of the USPSTF2020 Draft Criteria Versus the PLCom2012 Risk Prediction Model for Finding Lung Cancer Cases Eligible for Screening, Stratified by Race (N<sub>All</sub> = 883, N<sub>White</sub> = 258, N<sub>African American</sub> = 497)**

Sample	USPSTF2020 %	PLCom2012 ≥1.0% <sup>a</sup> /6 y %	OR <sup>b</sup> PLCom2012 vs. USPSTF2020	p Value <sup>c</sup>
All	68.6	79.1	3.91 (2.63-5.95)	<0.0001
White	75.4	81.5	2.00 (1.07-3.90)	0.029
African American	70.6	82.8	7.67 (3.81-17.47)	<0.0001

Note: USPSTF2020 draft guidelines for lung cancer screening (age 50-80 y, ≥20 pack-years, smoking quit-time ≤15 y).

<sup>a</sup>CISNET microsimulation modeling revealed that a PLCom2012 greater than or equal to 1.0%/6-yr threshold would find a similar number to be eligible as the USPSTF2020 draft criteria.<sup>2</sup>

<sup>b</sup>OR is McNemar's for discordant pairs.

<sup>c</sup>p value by McNemar's exact test. The p values are based on applying the summary proportions obtained from multiplying imputed data sets to the actual size of the study sample and subsamples.

CISNET, Cancer Intervention and Surveillance Modeling Network; USPSTF, U.S. Preventive Services Task Force.

USPSTF2020 criteria stratified by race and of these, the proportion of cases that would have qualified by the PLCom2012 criteria. Of the total cohort of 883 cases, 254 (28.8%) would not have qualified owing to less than 20 pack-years, quit-time of more than 15 years, and age less than 50 years. Of these 254 cases, 40% would have qualified by the PLCom2012 model. For the 20 pack-year criterion, of the 497 African American individuals, 97 (19.3%) did not meet this criterion and of these, an additional 30 (31.3%) in this group would have qualified by applying the PLCom2012 model (*p* = 0.002). The quit-time criterion of more than 15 years negatively affected the screening eligibility of White and African American patients similarly, that is, 33 of 250 White (12.8%) and 53 of 497 African American (10.7%) (*p* = 0.383). By applying the PLCom2012 model, approximately 60% of both White and African American individuals not eligible by the quit-time criterion would have qualified. In terms of age less than 50 years, (39 of 883) 4.4% of the entire cohort would have been screening ineligible by the USPSTF2020 criteria and of

these 25% would have qualified by the PLCom2012 model.

### Discussion

The USPSTF recently published their 2020 proposed draft guidelines on the eligibility for lung cancer screening with low-dose CT scan. Compared with the USPSTF2013 guidelines, the 2020 criteria would lower the restriction on smoking history from 30 to 20 pack-years and the age limit from 55 to 50 years. These changes are predicted to identify more high-risk individuals and result in an overall further decrease in lung cancer mortality; however, there will still likely be race disparities. Our study reveals that the USPSTF2020 criteria select a higher percentage of White versus African American patients with lung cancer for screening. The PLCom2012 risk prediction model (≥1.0%/6-y threshold) is more sensitive and has no race disparity. Although, the USPSTF2020 White-African American sensitivity difference only trended to statistical significance in our limited sample, a 4.8% difference applied nationally would lead to substantial race disparity.

**Table 2. The Number and Proportion (in Round Brackets) of Individuals Not Meeting USPSTF 2020 Draft Criteria by Eligibility Rules and Proportion That Would Have Been Eligible by PLCom2012 Greater Than or Equal to 1.0%/6 year [in Square Brackets], by Race**

Eligibility Criteria	Overall Sample <sup>a</sup>	White	African American	p Value <sup>b</sup>
Pack-years <20 y	162/883 (18.3%) [24.0%]	27/258 (10.5%) [22.5%]	96/497 (19.3%) [31.3%]	0.002
Quit-time >15 y	125/883 (14.2%) [50.2%]	33/258 (12.8%) [60.6%]	53/497 (10.7%) [59.2%]	0.383
Age <50 y	39/883 (4.4%) [25.0%]	12/258 (4.7%) [29.2%]	23/497 (4.6%) [22.8%]	0.998
Age >80 y	43/883 (4.9%) [91.9%]	12/258 (4.7%) [95.8%]	17/497 (3.4%) [86.8%]	0.404
Age <50 or >80 y	82/883 (9.3%) [60.1%]	24/258 (9.3%) [62.5%]	40/497 (8.0%) [50.0%]	0.557
By any of the first 3 criteria listed <sup>c</sup>	254/883 (28.8%) [40.3%]	58/258 (22.5%) [45.5%]	138/497 (27.8%) [44.6%]	0.116

Note: Percentages are based on all 20 imputed data sets, whereas the numbers presented represent one set, and therefore, they do not necessarily match perfectly.

<sup>a</sup>The overall category includes non-White and non-African American.

<sup>b</sup>The p values are for chi-square test of difference in proportion ineligible by criteria between Whites and African Americans.

<sup>c</sup>These summary statistics exclude USPSTF-ineligible individuals because they were greater than 80 years and because their health status was uncertain regarding their ability to undergo curative surgery or life expectancy.

USPSTF, U.S. Preventive Services Task Force.

As it would be beneficial for the USPSTF (and the Centers for Medicare and Medicaid) to remove the 15 year-quit criteria so as to not penalize those who have successfully quit smoking, the PLCOm2012 does not have a limit on age, pack-years, or quit-time, providing an optimal screening modality for high-risk individuals who do not meet the USPSTF guidelines.<sup>6</sup> Consistent with the known trend that African American individuals have less smoking history than their White counterparts, a race disparity was found in that a statistically significantly higher percentage of African American compared with White patients did not meet the 20 pack-year criterion. For the other two USPSTF2020 criteria, that is, age less than 50 years and quit-years of more than 15 years, there was no race disparity found and the PLCOm2012 model would have selected for screening an additional 25% and 50% of these high-risk individuals, respectively.

The American Thoracic Society recently released an official statement addressing disparities in lung cancer screening supporting screening eligibility assessment that includes both the USPSTF2020 guidelines and risk prediction models.<sup>8</sup> The USPSTF2020 draft guidelines discuss the benefits of risk prediction models with evidence from studies using simulation modeling. In addition, evidence from “real world” data is quickly accumulating which also supports risk prediction model implementation.<sup>9-11</sup> Here, we provide additional “real world” evidence and reveal that the PLCOm2012 risk prediction model at a greater than or equal to 1%/6-year risk threshold seems to effectively eliminate race disparity in lung cancer screening.

## Supplementary Data

Note: To access the supplementary material accompanying this article, visit the online version of the *JTO Clinical and Research Reports* at [www.jtocrr.org](http://www.jtocrr.org) and at <https://doi.org/10.1016/j.jtocrr.2020.100137>.

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