

ORIGINAL RESEARCH

Lung Cancer Screening Among Mammography Patients: Knowledge, Eligibility, Participation, and Interest

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Objective: To determine lung cancer screening eligibility, knowledge, and interest and to quantify the effect of the expanded 2021 lung cancer screening eligibility criteria among women presenting for screening mammography, a group with demonstrable interest in cancer screening.

Methods: A single-page survey was distributed to patients presenting for screening mammography, from January–March 2020 and June 2020–January 2021, at 2 academic medical centers on the East and West Coasts. The population served by the East Coast institution has greater poverty, greater ethnic/racial diversity, and lower education levels. Survey questions included age, smoking history, lung cancer screening knowledge, participation, and interest. Lung cancer screening eligibility was determined for both 2013 and 2021 USPSTF guidelines. Descriptive statistics were calculated, and data were compared between groups using the Chi-square test, Mann-Whitney nonparametric test, and the 2-sample *t* test.

Results: 5512 surveys were completed; 33% (1824) of women reported a history of smoking—30% (1656) former smokers and 3% (156) current smokers. Among women with a smoking history, 7% (127/1824) were eligible for lung cancer screening using 2013% and 11% (207/1824) using the 2021 USPSTF criteria. Interest in lung cancer screening was high (73%; 151/207) among eligible women using 2021 USPSTF criteria, but only 42% (87/207) had heard of lung cancer screening and only 28% (57/207) had received prior LDCT screening.

Conclusion: Eligible screening mammography patients reported high levels of interest in lung cancer screening but low levels of knowledge and participation. Linking mammography and LDCT appointments may improve lung cancer screening participation. (J Am Board Fam Med 2023;00:000–000.)

Keywords: Breast Cancer, Cancer, Early Detection of Cancer, Health Promotion, Lung Cancer, Mammography, Patient Adherence, Preventive Medicine, Screening

Introduction

Lung cancer screening with low-dose CT (LDCT) has revolutionized early detection for patients at high risk of developing lung cancer since the seminal National Lung Cancer Screening Trial demonstrated

a mortality benefit to screening high-risk patients.¹ Since 2013, the United States Preventive Services Task Force (USPSTF) has recommended screening for all patients ages 55 to 80, with a smoking history of 30-pack-years or more, who are current smokers, or who have quit within the past 15 years.² Medicare and Medicaid have covered LCS since 2015, with

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many private insurers following suit.^{3,4} Despite these national guidelines and widespread insurance coverage, only 4 to 30% of at-risk patients currently undergo appropriate screening.⁴⁻⁶ Reasons for lower participation in lung cancer screening include lack of knowledge by patients and referring physicians, complicated eligibility criteria, underestimation of lung cancer risk, and smoking stigma.^{7,8} Mandatory shared-decision making, although well-intentioned, may also create an additional hurdle to lung cancer screening participation. The fact that lung cancer screening is not a clinical practice quality metric, unlike other screening tests, may also contribute to low uptake. The USPSTF recently expanded lung cancer screening eligibility to include younger patients (beginning at age 50) with a less significant smoking history (20-pack-years).⁹ Efforts are needed to increase lung cancer screening participation among this growing number of eligible patients.

In contrast to lung cancer screening, participation in breast cancer screening guidelines with mammography is as high as 76%.¹⁰ In fact, even among women from disadvantaged socioeconomic backgrounds, such as those with income below the poverty line, participation in screening mammography is reported at approximately 50%.¹¹ Prior studies have demonstrated that many women adhering to mammography screening guidelines are also eligible for lung cancer screening, but it is only performed in 8 to 31% of these women.^{6,12} These studies, however, do not address the level of knowledge and interest in LCS among screening mammography patients. Furthermore, these studies quantified eligibility for lung cancer screening using the 2013 USPSTF guidelines and did not account for the increased number of patients now eligible under the expanded 2021 USPSTF guidelines. Lastly, these studies did not investigate potential health care disparities in lung cancer screening engagement.

Women who undergo screening mammograms have a demonstrated interest in screening and are more likely to adhere to additional health screening recommendations.¹³ In this multi-center study, we hypothesized that a subset of screening mammography patients are eligible and have interest in lung cancer screening but are not yet engaged. If so,

screening mammography patients represent an important population to target to increase participation in lung cancer screening. We also sought to quantify the impact of the revised 2021 lung cancer screening guidelines on the proportion of screening mammography patients eligible for lung cancer screening. We further hypothesized that patients receiving care in neighborhoods with higher income levels and degree of education may have greater awareness of and participation in lung cancer screening. This study used survey data to determine eligibility for, awareness of, interest in, and adherence to lung cancer screening guidelines among screening mammography patients at 2 large urban academic medical centers serving vastly different populations in terms of socioeconomic status and racial/ethnic composition.

Materials and Methods

Site Participation

Institutional Review Board approval was obtained for this prospective HIPAA-compliant survey study of patients presenting for screening mammography at multiple sites affiliated with 2 urban academic medical centers. Written informed consent was obtained from all study participants at the start of the survey.

The participating academic medical centers serve geographic regions with differences in demographics, including income level, education, race, and ethnicity (Table 1).^{14,15} One of the East Coast institutions is a safety net hospital, with greater than 70% of patients either uninsured or on Medicaid.¹⁶

Survey Design and Administration

A 6-question survey was designed in English and Spanish that asked survey participants to report their age, history of smoking (number of years

Table 1. Census Data for Communities Served by the Participating East and West Coast Institutions

	East Coast	West Coast
Median household income	\$38,085	\$94,174
Bachelor's degree or higher (%)	19.8%	67.7%
Race and ethnicity, largest categories (%)		
Non-Hispanic White	9%	53%
Black	44%	3%
Hispanic	56%	17%
Asian	5%	21%

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smoked, number of packs-per-day, and most recent date of quitting, if applicable), awareness of lung cancer screening, prior participation in lung cancer screening, and interest in undergoing lung cancer screening if eligible (Figure 1). To encourage survey participation, the survey was intentionally designed to be brief and to address the key elements of the study hypothesis.

Surveys were initially administered over 8 weeks from January–March 2020. The study was interrupted at that time due to decreased screening mammography and closure of screening mammography sites during the early months of the COVID-19 pandemic. Survey administration was then restarted and continued from June 2020–January 2021.

Surveys were administered during patient registration. The survey was administered as a printed, hard-copy survey at all sites until March 2020. At the West Coast site, an electronic version of the survey was also available after March 2020. Article surveys were collected by front-desk staff.

Patient Selection

All patients presenting for screening mammography at participating sites during survey administration

periods were eligible to participate and surveys were to be offered to patients during screening mammography intake. Participants were excluded from study results if they did not complete the survey consent or provided grossly incomplete responses.

Statistical Methods

Survey responses were compiled centrally, and descriptive statistics were calculated. Data were compared between groups using the Chi-square test for homogeneity of proportions, Mann-Whitney non-parametric test, and the 2-sample *t* test as appropriate. All analyses were performed using Stata 15.0 statistical software (StataCorp., College Station, TX). The level of statistical significance was set at 0.05.

Results

Demographics

A total of 5512 surveys were completed during the study period, 810 on the East Coast and 4712 on the West Coast. Overall response rate was 18.2%, with a lower response rate at the East Coast institution at 6% (810/13478) compared with the West

Figure 1. Paper survey in Spanish and English.

<p>1. The following short survey is for research purposes and is completely voluntary. Your answers will be completely anonymous. Any use of these answers for research purposes will be completely anonymized.</p> <p>If you would like to proceed with this short voluntary survey, please circle "Yes" below:</p> <p><input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> I don't understand</p> <p>2. Please provide your age:</p> <p><input type="text"/></p> <p>3. Have you ever smoked tobacco cigarettes? (Circle one)</p> <p><input type="checkbox"/> I currently smoke <input type="checkbox"/> I used to smoke <input type="checkbox"/> I have never smoked</p> <p>4. Please provide the following information (if applicable):</p> <p>a. Total years smoked:</p> <p><input type="text"/></p> <p>b. Packs per day:</p> <p><input type="text"/></p> <p>c. Year quit (if you have quit multiple times, please indicate the most recent year quit):</p> <p><input type="text"/></p> <p>5. Have you heard of lung cancer screening with a low dose chest CT scan? (Circle one)</p> <p><input type="checkbox"/> Yes / No</p> <p>6. Have you ever had a low dose chest CT scan for lung cancer screening? (Circle one)</p> <p><input type="checkbox"/> Yes / No</p> <p>7. If eligible, would you be interested in a low dose CT scan to screen for lung cancer? (Circle one)</p> <p><input type="checkbox"/> Yes / No</p>	<p>1. El siguiente cuestionario tiene fines de investigación y es completamente voluntario. Sus respuestas se mantendrán completamente anónimas. Cualquier uso de sus respuestas con fines de investigación será completamente anónimo. La participación es completamente voluntaria y no tendrá ningún impacto en su cita de hoy en su mamografía.</p> <p>Si le gustase responder este cuestionario voluntario, por favor marque "Sí" en las opciones que se le presentan a continuación:</p> <p><input type="checkbox"/> Sí <input type="checkbox"/> No <input type="checkbox"/> No entiendo</p> <p>2. Por favor indique su edad:</p> <p><input type="text"/></p> <p>3. ¿Alguna vez has fumado cigarrillos de tabaco? (Indique respuesta en un círculo)</p> <p><input type="checkbox"/> Actualmente fumo <input type="checkbox"/> Solía fumar <input type="checkbox"/> Nunca he fumado</p> <p>4. Por favor indique lo siguiente (si es aplicable):</p> <p>a. Número total de años que ha fumado:</p> <p><input type="text"/></p> <p>b. Número de paquetes por día:</p> <p><input type="text"/></p> <p>c. Si procede, año en que dejó de fumar (en caso de haber intentado dejar de fumar múltiples veces, por favor indique el año más reciente):</p> <p><input type="text"/></p> <p>5. ¿Ha escuchado del chequeo para cáncer de pulmón con tomografía de baja dosis? (Indique una respuesta)</p> <p><input type="checkbox"/> Sí / No</p> <p>6. ¿Le han hecho alguna vez una tomografía de baja dosis como chequeo de cáncer de pulmón? (Indique una respuesta)</p> <p><input type="checkbox"/> Sí / No</p> <p>7. ¿En caso de calificar, estaría usted interesada en hacerse una tomografía de baja dosis para chequear cáncer de pulmón? (Indique una respuesta)</p> <p><input type="checkbox"/> Sí / No</p>
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Table 2. Demographic Data

	Cumulative (n = 5512)	East Coast (n = 810)	West Coast (n = 4702)	p-Value
Mean age (SD, range)	58 (SD, 11, range 18 to 89)	56.7 (SD, 11, range 18 to 89)	58 (SD, 11, range 20 to 89)	0.0019
Spanish survey use	288 (5%)	280 (35%)	8 (0.1%)	<0.0001

Abbreviation: SD, standard deviation.

Comparisons made using two independent samples Student's *t* test.

Coast institution at 28% (4712/16,928). Response rate was artificially low at the East Coast institution due to inconsistent administration caused by COVID interruptions and limited availability of front desk staff.

The average age of participating patients was 58 (S.D. 11) with a range of 18 to 89 years. A minority (3%, 153/4412) were less than 40 years old. A greater proportion of Spanish language surveys was used among the East Coast participants (35%) compared with the West Coast cohort (0.1%, $P < .0001$). Overall use of the Spanish language survey was 5% (Table 2).

Smoking History

A total of 1824 (33%) survey respondents reported a history of smoking, with 1656 (30%) former smokers and 156 (3%) current smokers. The East Coast cohort had a significantly higher proportion of current smokers (7% vs 2%, $P < .0001$). The median pack-years for participants with a history of smoking was 10 with no significant difference between the East and West coasts (Table 3).

Eligibility for Lung Cancer Screening

Among women with a history of smoking, 7% (127/1824) were eligible for lung cancer screening based on the 2013 USPSTF eligibility criteria, and this increased to 11% (207/1824) using the 2021 USPSTF eligibility criteria. There was no

significant difference in eligibility between the East and West coast cohorts (Table 4).

Knowledge, Interest, and History of Prior Lung Cancer Screening

Awareness of lung cancer screening was higher in the East Coast cohort (20%; 163/810) compared with the West Coast cohort (13%; 590/4702) [$P < .00001$] and among East Coast smokers (30%; 70/237) compared with West Coast smokers (13%; 213/1587) [$P < .00001$]. However, there was no difference in lung cancer screening awareness between the 2 coasts when comparing only screening-eligible patients. Among women eligible for lung cancer screening by the 2013 USPSTF guidelines, 35% (45/127) had prior lung cancer screening. Among women who were eligible for lung cancer screening by the 2021 USPSTF guidelines, the majority of women expressed interest in screening (73%; 151/207), but only 42% (87/207) had heard of, and only 28% (57/207) had received a prior LDCT for lung cancer screening (Table 5).

Discussion

Despite more than a decade of evidence to support lung cancer screening with LDCT, participation of eligible patients in screening programs remains as low as 4% in the general population.¹⁷ In contrast, more than 70% of eligible women report participation in screening mammography.¹⁰ In 2021, the

Table 3. Smoking History

	Cumulative (5512)	East Coast (810)	West Coast (4702)	p-Value
Any history of smoking, N (%)	1824 (33%)	237 (29%)	1587 (34%)	0.033
Former smoker, N (%)	1656 (30%)	174 (21%)	1482 (32%)	<0.0001
Current smoker, N (%)	156 (3%)	57 (7%)	99 (2%)	<0.0001
NOS, N (%)	19 (0.3%)	14 (2%)	5 (0.1%)	<0.001
Median pack years among smokers	10	10	10	1.0

Abbreviation: NOS = Not otherwise specified.

Comparisons made using χ^2 tests.

Table 4. LCS Eligibility Among Smokers

	Cumulative smokers (1824)	East Coast smokers (237)	West Coast smokers (1587)	<i>p</i> -value
Eligibility by 2013 USPSTF Guidelines, N (%)	127 (7%)	23 (10%)	104 (7%)	0.071
Eligibility by 2021 USPSTF Guidelines, N (%)	207 (11.3%)	33 (14%)	174 (11%)	0.173

Abbreviations: LCS = Lung cancer screening; USPSTF = United States Preventive Services Task Force. Comparisons made using χ^2 tests.

USPSTF expanded criteria for lung cancer screening such that a larger number of patients are eligible for screening. This multi-site bicoastal study sought to quantify the proportion of women participating in screening mammography who are also eligible for lung cancer screening and to assess their knowledge, interest, and current participation in lung cancer screening. Women were surveyed from 2 distinct demographic populations on the East and West Coasts. Survey responses demonstrated that lung cancer screening eligibility among women with a smoking history undergoing screening mammography increased from 7% (127/1824) to 11% (207/1824) using the revised 2021 USPSTF guidelines. Although most women eligible for lung cancer screening by 2021 guidelines expressed interest (73%; 151/207), only 28% (57/207) had already undergone lung cancer screening. Awareness, interest, and participation in lung cancer screening among eligible patients was not significantly different between the East and West Coast cohorts. Among all surveyed patients, however, patients in the East Coast cohort had greater awareness of LCS (20%; 163 of 810) than patients in the West Coast cohort (13%; 590 of 4702), despite lower median household income, lower levels of education and a preference for use of the Spanish language survey.^{14,15} East coast patients with a history of smoking also had greater awareness of LCS (30%;

70/237) than their West coast counterparts (13%; 213/1587).

Our results build on prior studies that underscore the potential utility of screening mammography referrals and encounters for improving lung cancer screening participation. Lopez et al. found that 7% of the 3806 screening mammography patients in the National Health Interview Survey were eligible for LCS but only 8% of these eligible women had undergone screening.¹² Wang et al. found that 3% (70/2136) of surveyed mammography patients were eligible for LCS and up to 31% (22/70) of eligible patients were up to date with lung cancer screening.⁶ Our study, which demonstrated 35% (45/127) adherence to 2013 USPSTF lung cancer screening guidelines, supports the findings of Wang et al. However, whereas prior studies used the 2013 USPSTF lung cancer screening guidelines, our study also evaluated the expanded inclusion criteria of the 2021 USPSTF guidelines. Use of this expanded criteria resulted in a 64% increase in the lung cancer screening eligibility and a 7% decrease (35% to 28%) in lung cancer screening participation among screening mammography patients. These results highlight the importance of increasing outreach to the growing population of patients who stand to benefit from lung cancer screening.

Table 5. Awareness of LCS, Interest in LCS, and History of Prior LCS Among Patients Eligible for LCS by 2021 USPSTF Guidelines

	Cumulative (207)	East Coast (33)	West Coast (174)	<i>p</i> -Value
Awareness of LCS, N (%)	87 (42%)	14 (42%)	73 (42%)	0.957
Interest in LCS, N (%)	151 (73%)	25 (76%)	126 (72%)	0.696
History of Prior LCS, N (%)	57 (28%)	9 (27%)	48 (28%)	0.972

Abbreviations: LCS = Lung cancer screening; USPSTF = United States Preventive Services Task Force. Comparisons made using χ^2 tests.

Furthermore, our study is the first, to our knowledge, to compare lung cancer screening survey results between 2 vastly different populations. The West Coast institution serves a patient population that has a higher median income and higher education levels compared with the East Coast patient population. The West Coast patient population is predominantly non-Hispanic white and Asian, compared with the East Coast patient population which is predominantly Hispanic and Black race and ethnicity, with more than 1-third preference for the Spanish language survey. Despite these demographic differences, no significant difference in lung cancer screening eligibility was observed between the 2 cohorts (11 to 14% of patients with a history of smoking). In addition, no significant difference in lung cancer screening awareness (42%), interest (72 to 76%), or adherence to guidelines (27 to 28%) was seen between the East and West Coast cohorts among eligible screening mammography patients. It is possible that the expected health disparities between the 2 cohorts were not seen because this was a selected group of women who were already engaged in screening mammography. Alternatively, language barriers or differences in education level in the East Coast cohort may have confounded the results. Although a Spanish language survey was provided, the East Coast institution has a high number of foreign-born patients who speak myriad languages and may have not fully understood the survey questions. Nonetheless, these results suggest that the need for improved outreach efforts is not limited to a single geographic region, but rather should target patients of all backgrounds nationwide. Greater overall awareness of lung cancer screening in the East Coast cohort was observed among all surveyed patients and patients with any smoking history, which was an unexpected result, given lower education levels in this population. This finding may benefit from further study.

It is important to note that a subset of patients may choose not to undergo lung cancer screening after weighing the risks and benefits of the screening examination. For patients with poor performance status, surgical treatment of lung cancer may not be feasible, and these patients may choose not to undergo screening exams. Furthermore, lung cancer screening does come with the risk of false positive exams which might lead to unnecessary biopsies and invasive treatments. However, the risk

of false positives during lung cancer screening has decreased with the use of the American College of Radiology's published Lung CT Screening Reporting and Data System (Lung-RADS), which has been shown to decrease the false positive rate from as high as 23.3% to 10.4%.¹⁸ Furthermore, in our study, only 14% of eligible women had heard of LCS and not yet undergone screening. This implies that the primary barrier may still be lack of awareness of LCS, and not the choice to forego screening after consideration of the risks and benefits of the examination.

One distinct result of our survey study is the low rate of current smoking among participants, which is lower than reported nationwide smoking rates. According to CDC data, the rate of current smoking for women in the United States is 11%, as compared with 14.1% for men.¹⁹ Our survey data demonstrated current smoking rates of 7% and 2% among surveyed women in the East and West Coast institutions, respectively. Although this finding is surprising, it may partially reflect regional and demographic trends in current smoking rates. For example, the current smoking rate is 8% for both Asian-Americans and Hispanic Americans (male and female), both large demographics in the surveyed institutions. Current smoking rates are also below nationwide averages in the states where the study was conducted.²⁰ Even with these considerations, however, the current smoking rate at the West Coast institution is well below reported rates. This may suggest a limitation of the study—that perhaps the survey did not fully capture the target population.

Additional limitations of our study include the underestimation of the response rate due to inconsistent administration of the survey. A voluntary response bias likely occurred given the survey study design. In addition, patient health literacy and reading comprehension may have affected accurate survey completion and participation, particularly in the East Coast cohort. The generalizability of our results is limited by the gender of the participating population, as all study participants were women. Lastly, our survey administration began in January 2020 and was temporarily halted due to the COVID-19 pandemic and the associated disruptions to screening mammography, including reduced mammography volumes and missed screening appointments.

Screening mammography encounters may represent a prime opportunity for outreach to lung cancer screening-eligible patients, as these patients have already demonstrated willingness to partake in image-based cancer screening. The results of this study suggest that awareness of lung cancer screening in the community remains low among screening mammography patients. Approximately 40 million mammograms were performed in the United States in 2022.²¹ If every eligible woman presenting for a mammogram was referred for lung cancer screening, a significant number of lives would be saved from lung cancer.

In light of the USPSTF's recent expansion of lung cancer screening eligibility, many more patients stand to benefit from lung cancer screening, and it is imperative that physicians consider new tactics to improve participation in guidelines-based screening. Including lung cancer screening as a quality metric by the National Committee for Quality Assurance (NCQA) may catalyze participation, and it may be valuable for primary care physicians to assess for lung cancer screening eligibility at the time of referral for screening mammography. Imaging centers may also have an opportunity to assess for eligibility: patients presenting for screening mammography could be asked questions about their smoking history during intake and be scheduled for lung cancer screening if eligible, in coordination with referring clinicians. The present study adds to the body of literature suggesting that linking screening mammography and lung cancer screening has the potential to improve uptake of lung cancer screening and merits additional study.

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