

**American College of Radiology
ACR Appropriateness Criteria®
Lung Cancer Screening**

Variant 1: Lung cancer screening. Patient 50 to 80 years of age and 20 or more packs per year smoking history and currently smoke or have quit within the past 15 years. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT chest without IV contrast screening	Usually Appropriate	⊕⊕⊕
Radiography chest	Usually Not Appropriate	⊕
MRI chest without and with IV contrast	Usually Not Appropriate	○
MRI chest without IV contrast	Usually Not Appropriate	○
CT chest with IV contrast	Usually Not Appropriate	⊕⊕⊕
CT chest without and with IV contrast	Usually Not Appropriate	⊕⊕⊕
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	⊕⊕⊕⊕

Variant 2: Lung cancer screening. Patient younger than 50 years of age and 20 or more packs per year history of smoking and one additional risk factor (ie, radon exposure or occupational exposure or cancer history or family history of lung cancer or history of COPD or history of pulmonary fibrosis). Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography chest	Usually Not Appropriate	⊕
MRI chest without and with IV contrast	Usually Not Appropriate	○
MRI chest without IV contrast	Usually Not Appropriate	○
CT chest with IV contrast	Usually Not Appropriate	⊕⊕⊕
CT chest without and with IV contrast	Usually Not Appropriate	⊕⊕⊕
CT chest without IV contrast screening	Usually Not Appropriate	⊕⊕⊕
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	⊕⊕⊕⊕

Variant 3: Lung cancer screening. Patient of any age with less than 20 packs per year history of smoking, and no additional risk factor (ie, radon exposure or occupational exposure or cancer history or family history of lung cancer or history of COPD or history of pulmonary fibrosis). Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography chest	Usually Not Appropriate	⊕
MRI chest without and with IV contrast	Usually Not Appropriate	○
MRI chest without IV contrast	Usually Not Appropriate	○
CT chest with IV contrast	Usually Not Appropriate	⊕⊕⊕
CT chest without and with IV contrast	Usually Not Appropriate	⊕⊕⊕
CT chest without IV contrast screening	Usually Not Appropriate	⊕⊕⊕
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	⊕⊕⊕⊕

LUNG CANCER SCREENING

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Summary of Literature Review

Introduction/Background

Lung cancer remains the leading cause of cancer-related mortality for men and women in the United States [1]. Screening for lung cancer with annual low-dose CT (LDCT) is saving lives, and the continued implementation of lung cancer screening in clinical practice can save many more [2]. Since the publication of the National Lung Screening Trial (NLST) in 2011, which demonstrated a 20% reduction in lung cancer mortality with annual lung cancer screening [3], multiple clinical trials have demonstrated similar if not superior results [4-10]. Although there are known potential harms of lung cancer screening, including overdiagnosis and false positive results, the growing evidence has shown that correct implementation of lung cancer screening can provide substantial benefit at low clinical risk [2]. Retrospective analysis of the NLST data using updated standardized reporting specifically has been shown to substantially reduce false-positive rates of this screening test [11].

In 2015, the CMS began covering annual lung cancer screening for those who qualified based on the original United States Preventive Services Task Force (USPSTF) lung cancer screening criteria, which included patients 55 to 77 years of age with a 30 pack-year history of smoking, who were either currently using tobacco or who had smoked within the previous 15 years. In 2021, the USPSTF issued new screening guidelines, decreasing the age of eligibility to 50 years and pack years to 20 [12,13]. The recommendation was made following a systematic review of the lung cancer screening literature comprised of 223 publications that included 7 randomized clinical trials [14]. New guidelines are estimated to have doubled the population eligible for lung cancer screening in the United States and, importantly, will increase the number of women, underrepresented minorities, and those of lower socioeconomic status who qualify for this life-saving examination [15,16]. Although there has been some variation in eligibility for screening trials, studies have consistently excluded participants over 80 years of age.

Special Imaging Considerations

Acceptable low-dose lung cancer screening guidelines are available in the [ACR-STR Practice Parameter for the Performance and Reporting of Lung Cancer Screening Thoracic Computed Tomography \(CT\)](#) [17].

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

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- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1: Lung cancer screening. Patient 50 to 80 years of age and 20 or more packs per year smoking history and currently smoke or have quit within the past 15 years. Initial imaging.

CT Chest With IV Contrast

There is no relevant literature regarding the use of CT with intravenous (IV) contrast for lung cancer screening.

CT Chest Without and With IV Contrast

There is no relevant literature regarding the use of CT without and with IV contrast for lung cancer screening.

CT Chest Without IV Contrast Screening

The population described in this variant exactly matches the updated USPSTF eligibility guidelines for lung cancer screening [12]. These guidelines were expanded from the original eligibility criteria studied in the NLST. The NLST enrolled 53,454 participants 55 to 74 years of age with a 30 pack-year history of smoking, who were either currently using tobacco or had tobacco use in the previous 15 years. This randomized controlled study demonstrated a 20% reduction lung cancer mortality with annual CT imaging [3].

The second largest randomized controlled trial to demonstrate mortality benefit with lung cancer screening was the Netherlands–Leuven Longkanker Screenings Onderzoek or NELSON trial. The NELSON trial enrolled 13,195 men and 2,594 women, 50-74 years of age to undergo CT screening at T0 (baseline), year 1, year 3, and year 5.5, or to not undergo screening. Participants were either currently smoking or had quit smoking within the previous 10 years. At 10 years, the cumulative rate ratio for death from lung cancer was 0.76 [18]. The USPSTF sites modeling studies from the Cancer Intervention and Surveillance Modeling Network (CISNET) suggest that annual screening for lung cancer leads to a greater benefit than biennial screening. In the NELSON trial specifically, the 2.5 year interval reduced the benefit of screening with a higher interval cancer rate and higher proportion of advanced disease than in the 1 year and 2 year intervals [19]. Therefore, annual lung cancer screening is recommended and should be continued following negative baseline results [20,21]. Models from CISNET also provided information about the optimal age to begin and end screening [12].

Screening for lung cancer at an earlier age and with less tobacco exposure than suggested with the original guidelines may help to improve racial and gender disparities in lung cancer screening eligibility [15]. In fact, the original guidelines may have exacerbated disparities in lung cancer morbidity and mortality for women, underrepresented minorities, and vulnerable patients of low socioeconomic status [22-24]. A retrospective examination of lung cancer incidence among the predominantly Black population in the Southern Community Cohort Study demonstrated a much smaller percentage of Black patients with lung cancer met screening eligibility criteria (32%) compared with White patients (56%). The lower percentage of eligibility was primarily associated with lower pack years [25]. Additionally, the expansion of lung cancer screening guidelines will improve eligibility of women for lung cancer screening compared with men [15].

FDG-PET/CT Skull Base to Mid-Thigh

The role of fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET/CT skull base to mid-thigh as a lung cancer screening modality has not been adequately studied. The body of evidence for this modality is growing but remains limited [26,27].

MRI Chest Without and With IV Contrast

The role of MRI, chest without or with IV contrast, as a lung cancer screening modality has not been adequately studied.

MRI Chest Without IV Contrast

The role of MRI chest without IV contrast as a lung cancer screening modality has not been adequately studied. There is a growing body of evidence suggesting MRI without IV contrast may have a role in screening for lung cancer [28-30].

Radiography Chest

Chest radiography screening does not reduce lung cancer mortality in this population [3].

Variant 2: Lung cancer screening. Patient younger than 50 years of age and 20 or more packs per year history of smoking and one additional risk factor (ie, radon exposure or occupational exposure or cancer history or family history of lung cancer or history of COPD or history of pulmonary fibrosis). Initial imaging.

CT Chest With IV Contrast

There is no evidence to support screening in this population with chest CT with IV contrast.

CT Chest Without and With IV Contrast

There is no evidence to support screening in this population with chest CT without and with IV contrast.

CT Chest Without IV Contrast Screening

Smoking is the leading cause of lung cancer, accounting for approximately 90% of lung cancer cases in the United States [12]. Increased age is also associated with an increased risk for lung cancer, with most patients diagnosed after age 50 [1]. Currently screening for lung cancer is not recommended for those <50 years of age. Additional data are needed to determine if screening younger patients with additional risk factors such as radon exposure, occupational exposure, cancer history, family history of lung cancer, chronic obstructive pulmonary disease (COPD), or emphysema is of appropriate benefit. These criteria have been included in previous evaluation of eligibility in multiple models and in the National Comprehensive Cancer Network Guidelines (High-Risk Group 2) [31].

Patients with a history of cancer are at increased risk for developing a second primary cancer, and the most common second primary cancer is lung cancer. Within the NLST, 1,071 study participants had a prior history of cancer. These patients were found to have a higher age-adjusted cancer-detection rate on baseline LDCT than those without a cancer history [32]. A retrospective study within a clinical lung cancer screening program has shown that those eligible for screening with a previous cancer history have a higher risk for cancer than those without a cancer history who are screening eligible [33]. A retrospective cohort study of 276 patients with a history of hepato-gastrointestinal cancer and second primary lung cancer suggests that screening for lung cancer in this patient population may improve mortality [34]. Although these results suggest a possible benefit for screening for lung cancer in those with a history of cancer, this is not recommended for cancer survivors without tobacco exposure of at least 20 pack years.

A real-world cohort study in China evaluated 15,996 participants with LDCT and found 142 cases of lung cancer. In this study, only 9.2% of individuals met the 2021 USPSTF lung cancer screening eligibility criteria. Among male patients with lung cancer, 23.2% were <50 years of age. In female patients with lung cancer, 33.3% were <50 years of age [35]. This study suggests that further evaluation of screening may be warranted in younger individuals, although more research is needed to assess the utility of screening in this population.

Several studies have evaluated LDCT in patients with occupational exposures. In a cohort of 2,433 men exposed to asbestos, both lung cancer-related mortality and all-cause mortality was reduced amongst participants who underwent lung cancer screening [36]. A separate cohort study of LDCT among 7,189 nuclear weapons workers also demonstrated favorable results, detecting 80 lung cancers, of which 59% were stage I and an additional 10% were stage II [37]. As with the populations above, additional investigation is needed to assess screening in individuals with occupational exposures.

FDG-PET/CT Skull Base to Mid-Thigh

There is no evidence to support screening in this population with FDG-PET/CT.

MRI Chest Without and With IV Contrast

There is no evidence to support screening in this population with MRI chest without and with IV contrast.

MRI Chest Without IV Contrast

There is no evidence to support screening in this population with MRI chest without IV contrast.

Radiography Chest

There is no evidence to support screening in this population with chest radiography.

Variant 3: Lung cancer screening. Patient of any age with less than 20 packs per year history of smoking, and no additional risk factor (ie, radon exposure or occupational exposure or cancer history or family history of lung cancer or history of COPD or history of pulmonary fibrosis). Initial imaging.

CT Chest With IV Contrast

There is no evidence to support screening in this population with chest CT with IV contrast.

CT Chest Without and With IV Contrast

There is no evidence to support screening in this population with chest CT without and with IV contrast.

CT Chest Without IV Contrast Screening

Screening for lung cancer is routinely performed with noncontrast LDCT in individuals who are eligible based on age and smoking history. LDCT for lung cancer screening is not currently useful for those without a significant smoking history.

A retrospective study of 28,807 patients that included 12,176 who had not smoked; however, showed that LDCT helped to detect a significant number of lung cancers suggesting that more study is needed to evaluate screening in this population [38]. This study and others are part of a growing body of literature evaluating the use of lung cancer screening in patients without a history of smoking. In South Korea, 37,436 asymptomatic adults (17,968 without a smoking history and 19,468 with a smoking history) were screened for lung cancer using LDCT. The lung cancer rate was lower in those who had not smoked; however, no significant differences were seen in the number of false positives or the complication rates between the 2 groups [39].

There is particular interest in evaluating lung cancer in women, because the incidence of lung cancer in women without a significant smoking history is greater than in men [40,41]. In a retrospective study of 2,170 patients in the UK with lung cancer, the annual frequency of lung cancer development in those without a smoking history increased from 13% to 28%. Of those patients with lung cancer who had not smoked, 67% were women [42]. In a real-world cohort study of lung cancer screening in China, a total of 15,996 participants underwent LDCT. Among male patients with lung cancer in this study, 75% had a history of tobacco use. Among female patients with lung cancer in this cohort, only 5.8% reported a history of smoking [35]. Additional studies of women without histories of smoking have advocated for screening based on risk prediction that incorporates genetic markers [43,44]. A retrospective study of LDCT in women without a smoking history suggests that although screening may be effective, the optimal screening interval may be up to 5 years rather than annual [45]. Although these results suggest a possible role for screening in those without a significant smoking history, more research is needed to assess the benefit of screening in this population. Future efforts should focus on combining imaging, clinical history, and biomarkers when determining the ideal population for lung cancer screening.

FDG-PET/CT Skull Base to Mid-Thigh

There is no evidence to support screening in this population with FDG-PET/CT.

MRI Chest Without and With IV Contrast

There is no evidence to support screening in this population with MRI chest without or with IV contrast.

MRI Chest Without IV Contrast

There is no evidence to support screening in this population with MRI chest without IV contrast.

Radiography Chest

There is no evidence to support screening in this population with chest radiography.

Summary of Recommendations

- **Variation 1:** CT chest without IV contrast screening is usually appropriate for the initial imaging of patients who are 50 to 80 years of age with 20 or more packs per year smoking history and currently smoke or have quit within the past 15 years.
- **Variation 2:** Imaging is usually not appropriate for the initial imaging of patients who are <50 years of age with 20 or more packs per year history of smoking and one additional risk factor (ie, radon exposure or occupational exposure or cancer history or family history of lung cancer or history of COPD or history of pulmonary fibrosis).
- **Variation 3:** Imaging is usually not appropriate for the initial imaging of patients of any age with <20 packs per year history of smoking, and no additional risk factor (ie, radon exposure or occupational exposure or cancer history or family history of lung cancer or history of COPD or history of pulmonary fibrosis).

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at <https://acsearch.acr.org/list>. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document [46].

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
○	0 mSv	0 mSv
☼	<0.1 mSv	<0.03 mSv
☼☼	0.1-1 mSv	0.03-0.3 mSv
☼☼☼	1-10 mSv	0.3-3 mSv
☼☼☼☼	10-30 mSv	3-10 mSv
☼☼☼☼☼	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

References

1. Siegel RL, Miller KD, Fuchs HE, Jemal A. Cancer statistics, 2022. *CA Cancer J Clin* 2022;72:7-33.

2. Gierada DS, Black WC, Chiles C, Pinsky PF, Yankelevitz DF. Low-Dose CT Screening for Lung Cancer: Evidence from 2 Decades of Study. *Radiol Imaging Cancer* 2020;2:e190058.
3. Aberle DR, Adams AM, Berg CD, et al. Reduced lung-cancer mortality with low-dose computed tomographic screening. *N Engl J Med* 2011;365:395-409.
4. Becker N, Motsch E, Trotter A, et al. Lung cancer mortality reduction by LDCT screening-Results from the randomized German LUSI trial. *Int J Cancer* 2020;146:1503-13.
5. Field JK, Baldwin DR, Devaraj A, Oudkerk M. EUPS-argues that lung cancer screening should be implemented in 18 months. *Br J Radiol* 2018;91:20180243.
6. Leleu O, Basille D, Auquier M, et al. Lung Cancer Screening by Low-Dose CT Scan: Baseline Results of a French Prospective Study. *Clin Lung Cancer* 2020;21:145-52.
7. Paci E, Puliti D, Lopes Pegna A, et al. Mortality, survival and incidence rates in the ITALUNG randomised lung cancer screening trial. *Thorax* 2017;72:825-31.
8. Pastorino U, Sverzellati N, Sestini S, et al. Ten-year results of the Multicentric Italian Lung Detection trial demonstrate the safety and efficacy of biennial lung cancer screening. *Eur J Cancer* 2019;118:142-48.
9. Sadate A, Ocean BV, Beregi JP, et al. Systematic review and meta-analysis on the impact of lung cancer screening by low-dose computed tomography. *Eur J Cancer* 2020;134:107-14.
10. Yang W, Qian F, Teng J, et al. Community-based lung cancer screening with low-dose CT in China: Results of the baseline screening. *Lung Cancer* 2018;117:20-26.
11. Kastner J, Hossain R, Jeudy J, et al. Lung-RADS Version 1.0 versus Lung-RADS Version 1.1: Comparison of Categories Using Nodules from the National Lung Screening Trial. *Radiology* 2021;300:199-206.
12. Krist AH, Davidson KW, Mangione CM, et al. Screening for Lung Cancer: US Preventive Services Task Force Recommendation Statement. *JAMA* 2021;325:962-70.
13. Lim LS. In high-risk adults aged 50 to 80 y, USPSTF recommends annual lung cancer screening with LDCT (moderate certainty). *Ann Intern Med* 2021;174:JC86.
14. Jonas DE, Reuland DS, Reddy SM, et al. Screening for Lung Cancer With Low-Dose Computed Tomography: Updated Evidence Report and Systematic Review for the US Preventive Services Task Force. *JAMA* 2021;325:971-87.
15. Ritzwoller DP, Meza R, Carroll NM, et al. Evaluation of Population-Level Changes Associated With the 2021 US Preventive Services Task Force Lung Cancer Screening Recommendations in Community-Based Health Care Systems. *JAMA Netw Open* 2021;4:e2128176.
16. Reese TJ, Schlechter CR, Potter LN, et al. Evaluation of Revised US Preventive Services Task Force Lung Cancer Screening Guideline Among Women and Racial/Ethnic Minority Populations. *JAMA Netw Open* 2021;4:e2033769.
17. American College of Radiology. ACR–STR Practice Parameter for the Performance and Reporting of Lung Cancer Screening Thoracic Computed Tomography (CT). Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/CT-LungCaScr.pdf>. Accessed September 30, 2022.
18. de Koning HJ, van der Aalst CM, de Jong PA, et al. Reduced Lung-Cancer Mortality with Volume CT Screening in a Randomized Trial. *N Engl J Med* 2020;382:503-13.
19. Yousaf-Khan U, van der Aalst C, de Jong PA, et al. Final screening round of the NELSON lung cancer screening trial: the effect of a 2.5-year screening interval. *Thorax* 2017;72:48-56.
20. Kavanagh J, Liu G, Menezes R, et al. Importance of Long-term Low-Dose CT Follow-up after Negative Findings at Previous Lung Cancer Screening. *Radiology* 2018;289:218-24.
21. Meza R, Jeon J, Toumazis I, et al. Evaluation of the Benefits and Harms of Lung Cancer Screening With Low-Dose Computed Tomography: Modeling Study for the US Preventive Services Task Force. *JAMA* 2021;325:988-97.
22. Annangi S, Nutalapati S, Foreman MG, Pillai R, Flenaugh EL. Potential Racial Disparities Using Current Lung Cancer Screening Guidelines. *J Racial Ethn Health Disparities* 2019;6:22-26.
23. Japuntich SJ, Krieger NH, Salvas AL, Carey MP. Racial Disparities in Lung Cancer Screening: An Exploratory Investigation. *J Natl Med Assoc* 2018;110:424-27.
24. Li CC, Matthews AK, Rywant MM, Hallgren E, Shah RC. Racial disparities in eligibility for low-dose computed tomography lung cancer screening among older adults with a history of smoking. *Cancer Causes Control* 2019;30:235-40.
25. Aldrich MC, Mercaldo SF, Sandler KL, Blot WJ, Grogan EL, Blume JD. Evaluation of USPSTF Lung Cancer Screening Guidelines Among African American Adult Smokers. *JAMA Oncol* 2019;5:1318-24.

26. Schaefferkoetter JD, Yan J, Sjöholm T, et al. Quantitative Accuracy and Lesion Detectability of Low-Dose (18)F-FDG PET for Lung Cancer Screening. *J Nucl Med* 2017;58:399-405.
27. Schwyzer M, Ferraro DA, Muehlematter UJ, et al. Automated detection of lung cancer at ultralow dose PET/CT by deep neural networks - Initial results. *Lung Cancer* 2018;126:170-73.
28. Allen BD, Schiebler ML, Sommer G, et al. Cost-effectiveness of lung MRI in lung cancer screening. *Eur Radiol* 2020;30:1738-46.
29. Biederer J, Ohno Y, Hatabu H, et al. Screening for lung cancer: Does MRI have a role? *Eur J Radiol* 2017;86:353-60.
30. Meier-Schroers M, Homsy R, Gieseke J, Schild HH, Thomas D. Lung cancer screening with MRI: Evaluation of MRI for lung cancer screening by comparison of LDCT- and MRI-derived Lung-RADS categories in the first two screening rounds. *Eur Radiol* 2019;29:898-905.
31. McKee BJ, Regis S, Borondy-Kitts AK, et al. NCCN Guidelines as a Model of Extended Criteria for Lung Cancer Screening. *J Natl Compr Canc Netw* 2018;16:444-49.
32. Henderson LM, Durham DD, Tammemagi MC, Benefield T, Marsh MW, Rivera MP. Lung Cancer Screening With Low Dose Computed Tomography in Patients With and Without Prior History of Cancer in the National Lung Screening Trial. *J Thorac Oncol* 2021;16:980-89.
33. O'Dwyer E, Halpenny DF, Ginsberg MS. Lung cancer screening in patients with previous malignancy: Is this cohort at increased risk for malignancy? *Eur Radiol* 2021;31:458-67.
34. Huang HY, Lu MW, Chen MC, et al. Clinic image surveillance reduces mortality in patients with primary hepato-gastrointestinal cancer who develop second primary lung cancer: A STROBE-compliant retrospective study. *Medicine (Baltimore)* 2020;99:e23440.
35. Ji G, Bao T, Li Z, et al. Current lung cancer screening guidelines may miss high-risk population: a real-world study. *BMC Cancer* 2021;21:50.
36. Barbone F, Barbiero F, Belvedere O, et al. Impact of low-dose computed tomography screening on lung cancer mortality among asbestos-exposed workers. *Int J Epidemiol* 2018;47:1981-91.
37. Markowitz SB, Manowitz A, Miller JA, et al. Yield of Low-Dose Computerized Tomography Screening for Lung Cancer in High-Risk Workers: The Case of 7189 US Nuclear Weapons Workers. *Am J Public Health* 2018;108:1296-302.
38. Kang HR, Cho JY, Lee SH, et al. Role of Low-Dose Computerized Tomography in Lung Cancer Screening among Never-Smokers. *J Thorac Oncol* 2019;14:436-44.
39. Kim YW, Kang HR, Kwon BS, et al. Low-dose chest computed tomographic screening and invasive diagnosis of pulmonary nodules for lung cancer in never-smokers. *Eur Respir J* 2020;56.
40. Lin KF, Wu HF, Huang WC, Tang PL, Wu MT, Wu FZ. Propensity score analysis of lung cancer risk in a population with high prevalence of non-smoking related lung cancer. *BMC Pulm Med* 2017;17:120.
41. Wakelee HA, Chang ET, Gomez SL, et al. Lung cancer incidence in never smokers. *J Clin Oncol* 2007;25:472-8.
42. Cufari ME, Proli C, De Sousa P, et al. Increasing frequency of non-smoking lung cancer: Presentation of patients with early disease to a tertiary institution in the UK. *Eur J Cancer* 2017;84:55-59.
43. Chien LH, Chen CH, Chen TY, et al. Predicting Lung Cancer Occurrence in Never-Smoking Females in Asia: TNSF-SQ, a Prediction Model. *Cancer Epidemiol Biomarkers Prev* 2020;29:452-59.
44. Lebrecht MB, Crosbie EJ, Smith MJ, Woodward ER, Evans DG, Crosbie PAJ. Targeting lung cancer screening to individuals at greatest risk: the role of genetic factors. *J Med Genet* 2021;58:217-26.
45. Kim HY, Jung KW, Lim KY, et al. Lung Cancer Screening with Low-Dose CT in Female Never Smokers: Retrospective Cohort Study with Long-term National Data Follow-up. *Cancer Res Treat* 2018;50:748-56.
46. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: <https://www.acr.org/-/media/ACR/Files/Appropriateness-Criteria/RadiationDoseAssessmentIntro.pdf>. Accessed September 30, 2022.

The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.