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Characterizing the Design of and Emerging Evidence for Health Care Organization–Based Lung Cancer Screening Interventions: A Systematic Review

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Abstract

Background. Implementing a lung cancer screening (LCS) program with low-dose computed tomography (LDCT) is complex, requiring health care organizations to consider several steps along the screening continuum from eligibility assessment to recommended follow-up testing adherence. The evidence to support LDCT screening implementation remains unclear. **Purpose.** To summarize interventions facilitating LCS initiation, adoption, or improvement within health care organizations. **Data Sources.** Librarian-assisted literature reviews identified published studies between January 1, 2011, and December 31, 2023, using CINAHL, Cochrane Library, Embase, Ovid Medline, PsycINFO, and Scopus. **Study Selection.** Published interventions focusing on any step in the LCS process before lung cancer diagnosis, including risk/eligibility assessment, shared decision making (SDM), and annual screening or diagnostic testing. **Data Abstraction.** We used a title/abstract review process, full-text review, and risk-of-bias assessments. We characterized studies by design, unit of observation, participant sociodemographic characteristics, primary outcome, and step in the LCS process. DistillerSR and Covidence were used for data management. **Data Synthesis.** We identified 64 study-eligible published articles, including 19 randomized and 45 nonrandomized studies. SDM interventions were most frequently studied ($n = 20$) followed by initial LCS uptake ($n = 12$). Most studies ($n = 33$) evaluated educational interventions, typically in one-on-one settings. Studies assessed at either low or moderate/some risk of bias reported statistically significant findings in the domains of improved knowledge ($n = 7$) and other aspects of decision making ($n = 8$), such as perceived risk or decisional conflict. Findings regarding LCS uptake were more variable. **Limitations.** The review includes only English-language studies published prior to 2024. The risk of bias was high among 5 of the randomized clinical trials and serious among 27 of the quasi-experimental design studies. **Conclusions.** LCS intervention strategies have focused on SDM and initial LCS uptake, leaving gaps in knowledge about how to support risk and eligibility assessment, adherence to annual screening, or diagnostic testing. Expanding interventions beyond those that are education focused and with single-level targets would expand the LDCT screening implementation evidence base.

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Highlights

- Most lung cancer screening (LCS) interventions evaluated to date have been educational in nature and focused primarily on shared decision making or the initial uptake of screening, with some interventions demonstrating statistically significant improvements in patient knowledge and initial LCS order/uptake.
- A critical gap in knowledge remains regarding how to effectively support LCS eligibility assessment as well as adherence to annual screening and appropriate diagnostic testing.
- Findings underscore the need for the field to expand beyond education-focused interventions and incorporate multilevel targets when designing interventions to support high-quality LCS in practice.

Keywords
health behavior, cancer screening, adherence, compliance, shared decision making, education, eligibility, risk assessment, evidence-based medicine, guidelines, lung cancer

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Background and Purpose

In 2011, the US-based National Lung Screening Trial (NLST)[1] and again in 2020 the Nederlands–Leuvens Longkanker Screenings Onderzoek (NELSON) Trial[2] found that annual lung cancer screening with low-dose computed tomography (LDCT) substantially reduces mortality from lung cancer.[1] In 2013, the US Preventive Services Task Force (USPSTF) released its first recommendation for offering lung cancer screening (LCS) to asymptomatic adults aged 55 to 80 y who have a 30-pack-year history of cigarette smoking and who either currently smoke or quit smoking within the past 15 y. Yet, because of the inherent risks associated with LDCT screening for LCS, including the risks associated with radiation exposure, false-positive results, overdiagnosis, and invasive follow-up procedures, LDCT screening is considered a preference-sensitive decision.[3] As recommended by the USPSTF guidelines, LDCT screening should therefore be offered in the context of shared decision making (SDM) and include counseling regarding either smoking cessation or continued abstinence. Based on new scientific evidence and in an attempt to mitigate known lung cancer disparities, the 2021 update to the USPSTF guidelines expanded eligibility to those aged 50 to 80 y who have a 20 pack-year smoking history and currently smoke or have quit within the past 15 y.[4] Consistent with the preference-sensitive nature of the LDCT screening decision, per benefit requirements, Medicare beneficiaries need to review a decision aid and undergo SDM counseling regarding LDCT screening risks and benefits and the importance of

adherence to annual screening prior to an initial LDCT screening.[4] Counseling on either tobacco cessation or maintaining tobacco abstinence are also prerequisites for Medicare reimbursement among screening-eligible people.

As such, the implementation of LCS is complex, requiring organizations to consider a number of steps along the screening process, including how they will identify and recruit people for screening, assess screening eligibility, engage eligible people in SDM, provide appropriate tobacco cessation counseling, ensure an order/referral for screening is made for those deciding to screen, support those electing to undergo screening with the completion of testing via LDCT, and prompt and monitor appropriate annual screening or diagnostic testing based on test results.[5,6] The complexity of LCS means that organizations wanting to implement comprehensive LCS programs must consider and decide how to achieve multiple micro-processes simultaneously.

To our knowledge, the evidence upon which to make such implementation-related decisions has not been summarized previously. The overarching goal of this systematic review is to inform strategies for supporting the continuum of activities needed for health care organizations to implement LDCT screening for lung cancer. We sought to identify interventions designed to facilitate the initiation, adoption, or improvement of the LCS process within health care organizations regardless of the intervention's target population (e.g., patient, provider, or otherwise). Evaluations of interventions were included if they focused on any step in the LCS process prior to a diagnosis of lung cancer, including risk or eligibility assessment, SDM, adherence to initial or annual screening, or abnormal follow-up testing. The specific research questions of interest included the following:

- What are the key components of interventions that have been used to initiate, adopt, or improve LCS processes, and where along the LCS continuum are these interventions focused?
- What behavioral frameworks, models, and theories have been used in the design and evaluation of these interventions?
- What are the types and levels of outcomes that have been evaluated within the context of these LCS interventions?
- Which patient populations have been targeted by these interventions, and how have interventions addressed (or not addressed) issues of equity in LCS?
- What is the emerging evidence regarding the effects of interventions designed to facilitate the initiation, adoption, or improvement of the LCS process on patient- and other-level outcomes?

Methods

Data Sources

We searched CINAHL, Cochrane Library, Embase, Ovid Medline, PsycINFO, and Scopus to identify relevant studies. Database searches were originally performed in 2020 and updated in the first quarter of 2024, enabling the inclusion of papers published January 1, 2011, through December 31, 2023. In addition to published articles, we searched conference proceedings and abstracts to identify relevant items. We also manually reviewed the reference lists of any systematic reviews identified during the search process to identify additional relevant studies. Databases were searched by combining the MeSH terms and other search terms related to lung cancer ("Lung Neoplasms" OR "lung cancer" OR "lung tumor") with those specific to cancer screening (e.g., "Cancer Screening," "Early Detection of Cancer") and behavioral and other interventions (e.g., "Health Behavior," "Health Promotion," "Intervention Trials"). We worked with a health sciences librarian to tailor terms to be appropriate to each specific database searched, but the terms covered similar group-level concepts: 1 = lung cancer, 2 = cancer screening, 3 = low-dose CT, and 4 = behavior and intervention terms. Full search strategies are available in the appendix.

For the search update, we used an artificial intelligence (AI) tool to expedite the updating process. There is substantial evidence on the application of AI, specifically machine learning (ML) tools, to systematic reviews and other literature-based research across the health sciences.[7–11] This ML tool, the Document Classification and Topic Extraction Resource or DoCTER,[12] is a predictive application in which articles are classified using algorithms such as naïve Bayes and support vector machine. While AI tools typically require a large amount of training data, applying ML to a systematic review update allows the original screening decisions and included papers to be used as the training dataset.[13,14]

For the update, a health sciences librarian (R.B.C.) used the studies found relevant and irrelevant during the first level of the initial review process conducted in 2020 as training data. All citations in the search update were run through the ML tool and then put in priority order from most likely to least likely to be relevant according to the algorithms. Using the same 2-level review process

outlined below, the team then manually screened all the newly identified studies in priority order based on probability score. The studies screened in probability order were graphed against the screening decisions to ensure that screening precision was declining precipitously as expected and that the recall threshold would be met.[15] Once the team perceived the remaining identified studies were no longer relevant, an additional 500 citations were screened to ensure no relevant citations would be lost. While AI was used to augment the search update, it did not replace the screening decisions and expertise of the research team.

Study Selection

We included studies that explicitly evaluated an intervention or specific component of an intervention to initiate, adapt, or improve LCS and its relationship to at least 1 quantitatively measured outcome. Only studies that reported the use of a comparator group were included regardless of whether an experimental or quasi-experimental design was used. Comparators could include usual care (within which an organized LCS intervention may or may not have been available), a different type of LCS screening intervention, or historical controls, including single-arm pre–post designs. Because of the limited number of such studies thought to be available when we initiated our review, we elected to include any English-language study, regardless of country context. We excluded studies targeting people who did not meet currently accepted LCS eligibility criteria (e.g., eligibility as endorsed by Medicare[16] or the US Preventive Services Task Force[17]) unless the study was attempting to identify people who were LCS eligible. We also excluded studies for which the only outcome mentioned within the published abstract was "smoking cessation" as well as studies that did not report a measured relationship between an intervention or specific intervention component(s) and a patient- or other-level outcome. We limited searches to items published in print or online in English between January 1, 2011, and December 31, 2023, and included only those studies for which a full text was available. We did so to ensure the inclusion of a broad array of interventions that collectively would be of interest to those attempting to implement LCS within health care organizations, particularly those wanting to target adults for whom LCS was compatible with current US-based reimbursement policies.

We used a 2-level review process followed by data extraction among eligible studies. We used DistillerSR[18] and Covidence[19] for literature management. For the first-level review, 2 members of the study team independently reviewed each identified title and abstract. Any study marked for inclusion by at least 1 team member was included in the second-level review. For the second-level review, 2 members of the study team independently reviewed full texts of all studies marked for inclusion in the level 1 review. Disagreements during the level 2 review were resolved by consensus among study team members during regular research team meetings.

Data Extraction

Once a study was determined as eligible for inclusion, 2 reviewers independently conducted data extraction using the configurable forms available within the literature management software. The abstraction form contained items for study characteristics (e.g., author, publication year, country of study, funding source, and study design), participant characteristics (e.g., sample size and demographic characteristics), a description of the intervention, and study outcomes (e.g., primary and other outcomes, level of measurement, and data source). Each identified intervention was characterized by the steps along the LCS process being targeted. These steps were categorized as risk and eligibility assessment, SDM, initial screening uptake, annual screening adherence, or abnormal LCS screening follow-up. Study forms also contained fields to capture any behavioral framework, model, or theory used to guide the design of the intervention or its implementation. Conflicts were resolved by discussion and consensus among investigators during research team meetings.

We assessed the quality and risk of bias among included studies using the Cochrane Collaboration's risk of bias tools, ROB 2.0[20] or ROBINS-I,[21] respectively, for randomized trials and nonrandomized studies. Each of these tools assesses the risk of bias across a set of domains that reflect aspects of study design. The ROB 2.0 assesses quality across the 5 domains of randomization process, intervention fidelity, missing outcome data, outcome measurement, and selection of the reported results.[20] The ROBINS-I tool assesses quality across the 7 domains of confounding, selection of participants, classification of interventions, fidelity of interventions, missing data, measurement of outcomes, and selection of reported results.[21] In general, results from studies assessed to have high risk of bias (ROB-2) or serious or critical risk of bias (ROBINS-I) should be interpreted with caution. Two team members independently completed these assessments for each included study. Discrepancies were resolved by consensus at research

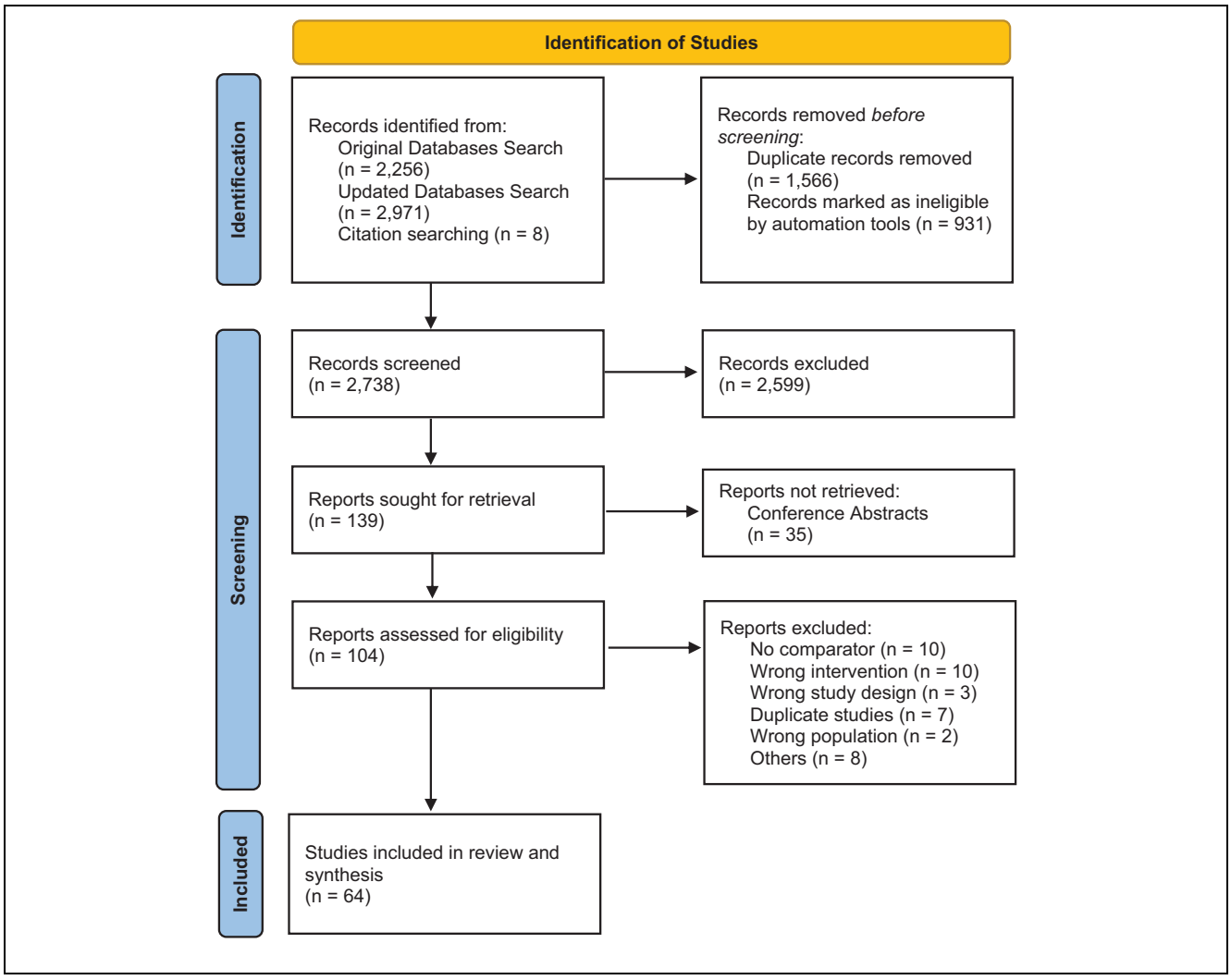

Figure 1 PRISMA 2020 flow diagram for systematic reviews.
Source: Page MJ, et al. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71.

team meetings. The protocol for this systematic review was registered with PROSPERO.[22] We follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for reporting results.[23]

Results and Data Synthesis

Study Selection and Characteristics

Following PRISMA,[24] the flow diagram of study disposition and inclusion is depicted in Figure 1. Sixty-four published articles (Table 1) were identified as study eligible.[25–88] As depicted in the table, 19 of the included studies were randomized trials. The remainder used a quasi-experimental approach, most frequently a single-arm pre–post design. Fifty-five studies (15 of the 19 randomized trials and 40 of the 45 quasi-experiments) were conducted within the United States. The remaining studies were conducted within the United Kingdom ($n = 4$), Australia ($n = 1$), Austria ($n = 1$), Canada ($n = 1$), South Korea ($n = 1$), or Turkey ($n = 1$).

Characteristics of Study Participants

Included studies ranged in size from 16 to more than 48,000 participants, with almost a third ($n = 21$) enrolling fewer than 100 people. As illustrated in Table 2, all

Table 1 Included Studies.

Study	Country	Funding Source
Randomized		
Begnaud et al.[55]	United States	Government
Carter-Harris et al.[30]	United States	Academic medical institution; foundation/nonprofit
DiCarlo et al.[61]	United States	Pharmaceutical company; foundation/nonprofit; health system
Fraenkel et al.[34]	United States	Government
Kathuria et al.[78]	United States	Government/foundation
Kinsey et al.[65]	United States	Not indicated
Lillie et al.[40]	United States	Government
Lowery et al.[68]	United States	Government
Monu et al.[79]	United States	Government
O'Brien et al.[43]	Canada	Other (Ontario Cancer Screening Research Network)
Percac-Lima et al.[45]	United States	Foundation/nonprofit
Quaife et al.[57]	United Kingdom	Foundation/nonprofit; government
Raz et al.[80]	United States	Foundation/nonprofit
Ruparel et al.[48]	United Kingdom	Foundation/nonprofit; government
Sferra et al.[81]	United States	Government
Schmidt et al.[50]	Austria	Not indicated
Sharma et al.[87]	United States	Academic medical institution; government
Volk et al.[53]	United States	Academic medical institution; foundation/nonprofit; government
Webster et al.[77]	United States	Foundation/nonprofit
Quasi-experimental		
Akhtar et al.[85]	United States	Government; pharmaceutical company
Azubuike et al.[25]	United States	Not indicated
Barett et al.[26]	United States	Not indicated
Bartlett et al.[27]	United Kingdom	Government
Fagan et al.[88]	United States	Academic medical institution; government; health system
Cardarelli et al.[28]	United States	Academic medical institution; government
Carroll et al.[29]	United States	Government
Choi et al.[58]	United States	Academic medical institution; foundation/nonprofit
Colamonici et al.[59]	United States	Government
Cole et al.[31]	United States	Government
Currier et al.[60]	United States	Not indicated
Dickson et al.[62]	United Kingdom	Foundation/nonprofit; government; other: Grail LLC
Fabbrini et al.[32]	United States	Government
Fagan et al.[33]	United States	Government; health system
Fetters et al.[63]	United States	Not indicated
Han et al.[35]	United States	Foundation/nonprofit; pharmaceutical company
Hoffman et al.[36]	United States	Academic medical institution; foundation/nonprofit
Ito Fukunaga et al.[64]	United States	Foundation/nonprofit; government
Jessup et al.[37]	United States	Authors reported no funding
Koroscil et al.[38]	United States	Authors reported no funding
Kukhareva et al.[66]	United States	Government
Lau et al.[39]	United States	Academic medical institution
Lau et al.[67]	United States	Government; academic medical center
Lowenstein et al.[56]	United States	Academic medical institution; government
Magarinos et al.[69]	United States	Government; academic medical institution; foundation/nonprofit; pharmaceutical company
Manners et al.[41]	Australia	Government

(continued)

Table 1 (continued)

Study	Country	Funding Source
Mazzone al.[42]	United States	Authors reported no funding
Cam et al.[86]	South Korea	Government
Olazagasti et al.[70]	United States	Authors reported no funding
Ortmeyer et al.[44]	United States	Academic medical institution
Raz et al.[46]	United States	Government
Reuland et al.[47]	United States	Government
Sağınç and Taşköylü[71]	Turkey	Not indicated
Sakoda et al.[49]	United States	Government
Schlabach et al.[72]	United States	Not indicated
Smith et al.[73]	United States	Other - Eon Direct
Steinberg et al.[74]	United States	Authors reported no funding
Strong and Renaud[82]	United States	Not indicated
Tanner et al.[51]	United States	Foundation/nonprofit; government
Thuppal et al.[75]	United States	Academic medical institution
Urrutia Argueta and Hanna[76]	United States	Not indicated
Volk et al.[52]	United States	Not indicated
Watson et al.[54]	United States	Not indicated
Williams et al.[83]	United States	Foundation/nonprofit; pharmaceutical company
Williams et al.[84]	United States	Government

but 9 studies used patients as the only unit of observation. Those using the patient as the unit of observation tended to include people who currently smoked and previously smoked, but 1 of the randomized trials included only people who previously smoked[55] and 2 included only people who currently smoked.[45,78] Most studies reported information on participant sex or gender (n = 50), and each of the 41 studies that reported information on participant race included participants from multiple racial groups, albeit always with substantially more White than other race participants. Notably, the patient samples used among the more recently published studies were relatively more racially and ethnically diverse. Also of note was the fact that barely one-third of the studies reported information regarding participants' health insurance coverage.

Characteristics of the Interventions Evaluated

Of note, all but 15 studies evaluated interventions that targeted the patient alone (Table 3). Among those 15 studies, 11 targeted providers alone,* 2 targeted both patients and providers,[37,54] and 2 targeted communities as defined by a geographical area in the case of one and the social networks of community health workers as defined by the other.[28,84] Except for 2 studies,[50,68] none of these latter interventions were studied in the context of a randomized trial.

Almost 60% of studies (n = 38) targeted 1 specific step of the LCS process, while the remainder targeted 2 or more steps (Table 3). SDM was most often targeted (n = 36), with most of these studies (n = 21) focused solely on that 1 step of the LCS process. Twenty-seven studies focused on interventions to enhance initial screening uptake, again with most focused on that 1 step alone (n = 14). Nineteen studies evaluated interventions focused on screening risk or eligibility assessment (n = 19). Those doing so typically included a focus on at least 1 additional step of the LCS process (n = 13). Only 5 studies[38,60,63,65,73] included a focus on follow-up testing, most often using an outcome defined as "recommended follow-up," regardless of what that follow-up entailed. Only 1 study[73] focused on follow-up after a normal scan alone (i.e., repeat screening).

Most studies (n = 50) evaluated educational interventions, whether one-on-one education, group education, or mass media, and whether alone (n = 40) or in combination with something else (n = 10). Twenty-two interventions addressed structural barriers to LCS, often using or in combination with educational interventions. Such interventions provided patient navigators,[26,45,65] electronic forms to determine and/or identify LCS eligibility,[31,43,66,74] and community health workers to connect eligible persons to LCS services.[78,83]

Use of Behavioral Theories, Frameworks, or Models

The use of a specific behavioral theory, model, or framework was relatively rare among published studies.

Table 2 Participant Characteristics.

Author and Year	Unit of Observation	*N*	Age, y	Race/Ethnicity	Sex/Gender	Insurance Status	Smoking Status
Randomized							
Begnaud et al. (2017)[55]	Patients	200	Mean (range) 62 (55–79)	NR	Female Con (n = 46) Inter (n = 50) Male: Con (n = 60) Inter (n = 49)	NR	Former
Carter-Harris et al. (2020)[30]	Patients	60	Mean (s) 62.2 (5.2)	Black (n = 10) White (n = 48) Other (n = 2)	Female (n = 31) Male (n = 29)	Medicare only (n) 14 Medicaid (n = 8) Private (n = 18) Medicare and other (n = 8) Other (n = 2) Multiple (n = 8)	Current, former
DiCarlo et al. (2022)[61]	Patients	2,347	Range 50–80	White (n = 1274) Black (n = 732) Chinese (n = 99) Korean (n = 88) Hispanic (n = 60) Other Asian (n = 39) American Native (n = 3) Unknown (n = 52)	Female (n = 1,240) Male (n = 1,107)	NR	Current, former
Fraenkel et al. (2016)[34]	Patients	254	Mean (s) 60.9 (8.8)	White (n = 233) Hispanic (n = 13)	Female (n = 137)	NR	Current, former, never
Kathuria et al. (2022)[78]	Patients	Pilot 1, 100 Pilot 2, 21	Pilot 1 Mean (s) 62.1 (5.0)/61.6 (5.8) Pilot 2 Mean (s) 64.0 (6.1)/64.0 (5.62)	Pilot 1 Black (n = 60) White (n = 30) Multi (n = 2) Other (n = 8) Hispanic or Latino (n = 5) Pilot 2 Black (n = 14) White (n = 5) Multi (n = 0) Other (n = 2) Hispanic or Latino (n = 2)	Pilot 1 Female (n = 35) Pilot 2 Female (n = 6)	Pilot 1 Medicaid (n = 86) Pilot 2 Medicaid (n = 18)	Pilot 1 Current Pilot 2 Current

(continued)

Table 2 (continued)

Author and Year	Unit of Observation	*N*	Age, y	Race/Ethnicity	Sex/Gender	Insurance Status	Smoking Status
Kinsey et al. (2022)[65]	Patients	200	Range 55–77	White (79.5%) Black (7.5%) Asian (3%) Unknown (10%) Hispanic (0.5%)	Female (45%) Male (55%)	NR	Current, former
Lillie et al. (2017)[40]	Patients	588	< 65 (*n* = 269) 65+ (*n* = 319)	AN/AI (*n* = 10) Black (*n* = 43) White (*n* = 531) Hispanic (*n* = 2)	Female (*n* = 557) Male (*n* = 31)	NR	Current, former
Lowery et al. (2022)[68]	Medical centers	8	NA	NA	NA	NA	NA
Monu et al. (2022)[79]	Patients	191	Median (IQR) 60 (7)	Asian (*n* = 2) Black (*n* = 8) NA/AN (*n* = 2) White (*n* = 174) Other/unknown (*n* = 6) Hispanic (*n* = 3)	Female (*n* = 132)	Medicaid (*n* = 27) Medicare (*n* = 42) Private (*n* = 90) TRICARE/VA/ military (*n* = 12) Uninsured (*n* = 17) Other (*n* = 1)	Current, former
O'Brien et al. (2017)[43]	Patients	6 practices and 831 patients	Range 55–74	NR	Female (*n* = 426) Male (*n* = 300)	Alternative payment plan (*n* = 831)	Current, former
Percac-Lima et al. (2018)[45]	Patients	1,200	Mean (*s*) 62.3 (5.6)	Black (*n* = 43) White (*n* = 977) Hispanic (*n* = 67) Other: (*n* = 73)	Female (*n* = 630) Male (*n* = 570)	Commercial (*n* = 408) Medicare (*n* = 131) Medicaid (*n* = 332) Medicare/ Medicaid (*n* = 328) Self (*n* = 1)	Current
Quaife et al. (2020)[57]	Patients	2,012	Mean (*s*; Range) 66.0 (4.3; 60–75)	Asian (*n* = 42) Black (*n* = 193) White (*n* = 1,604) Other (*n* = 59) Multiple (*n* = 34) Unknown/missing 80	Female (*n* = 931) Male (*n* = 1,081)	NR	Current, former

(continued)

Table 2 (continued)

Author and Year	Unit of Observation	*N*	Age, y	Race/Ethnicity	Sex/Gender	Insurance Status	Smoking Status
Raz et al. (2021)[80]	Patients	1,281	Mean (*s*) 63.9 (6.0)	Asian (*n* = 42) Black (*n* = 179) Hispanic (*n* = 177) AI/AN (*n* = 2) NH/PI (*n* = 2) White (*n* = 846) Other/unknown (*n* = 33)	Female (*n* = 646) Male (*n* = 635)	NR	Current, former
Ruparel et al. (2019)[48]	Patients	246	60–63 (*n* = 84) 64–67 (*n* = 65) 68–71 (*n* = 53 72–76 (*n* = 27)	Asian (*n* = 7) Black (*n* = 21) White (*n* = 190) Other (*n* = 11)	Female (*n* = 119) Male (*n* = 109)	NR	Current, former
Sferra et al. (2021)[81]	Patients	237	Mean 64	Asian (*n* = 3) Black (*n* = 146) Hispanic (*n* = 17) White (*n* = 69) Other/unknown (*n* = 2)	Female (*n* = 122) Male (*n* = 115)	NR	Current, former
Schmidt et al. (2018)[50]	Providers	161	Mean (95% CI) Con: 47 (44–50) Inter: 46 (44–48)	NR	Male (*n* = 160) Female (*n* = 1)	NR	NR
Sharma et al. (2018)[87]	Patients	1,000 (baseline), 428 (follow-up)	Median (*s*) 61.0 (5.6)	Black (*n* = 121) White (*n* = 682) Other/unknown (*n* = 197)	Female (*n* = 537) Male (*n* = 463)	Medicaid (*n* = 479) Medicare (*n* = 271) Private (*n* = 179) Uninsured/ unknown (*n* = 71)	Current, former
Volk et al. (2020)[53]	Patients	516	Range 55–77	AI/AN (*n* = 2) Black (*n* = 138) NH/PI (*n* = 1) White (*n* = 362) Hispanic (*n* = 8) >1 category (*n* = 2) Other (*n* = 2) Unknown/missing (*n* = 1)	Female (*n* = 320) Male (*n* = 196)	Insured (*n* = 469) Uninsured (*n* = 47)	Current, former

(continued)

Table 2 (continued)

Author and Year	Unit of Observation	*N*	Age, y	Race/Ethnicity	Sex/Gender	Insurance Status	Smoking Status
Webster et al. (2023)[77]	Patients	298	Mean (*s*) 61.7 (6.3)	Black (*n* = 161) White (n = 122) Other/multirace (*n* = 14) Refused (*n* = 1) Hispanic or Latino (*n* = 5)	Female (*n* = 197) Male (*n* = 101)	Private insurance only (*n* = 76) Public insurance only (*n* = 155) Both public and private (*n* = 44) No insurance or self-pay (*n* = 13) Not sure or refused (*n* = 10)	Current, former
Quasi-experimental							
Akhtar et al. (2022)[85]	Providers	29	NR	NR	NR	NA	NA
Azubuike et al. (2020)[25]	Providers	27	Range 55–80	NR	NR	NR	Current, former
Barett et al. (2016)[26]	Patients	109	Mean (*s*) Con: 64.8 (6.5) Inter: 62.0 (6.4)	Asian (*n* = 1) Black (*n* = 5) White (*n* = 100) Hispanic (*n* = 3)	Female (*n* = 55) Male (*n* = 54)	NR	NR
Bartlett et al. (2020)[27]	Patients	8,366	Median (IQR) Hospital 67 (63, 71) Mobile 68 (64, 72)	Asian (*n* = 107) Black (*n* = 45) White (*n* = 1,307) Hispanic (*n* = 7) Other (*n* = 70) Unknown/missing (*n* = 6) (note: data on race among 1,542 patients with calculated risk score)	Female Hospital (*n* = 555) Mobile (*n* = 339) Male Hospital (*n* = 492) Mobile (*n* = 303)	NHS (*n* = 8,366)	Current, former
Fagan et al. (2024)[88]	Patients	80	Mean (*s*) 64.1 (6.0)	White (*n* = 66) Black (*n* = 12) Asian (*n* = 1) Other (*n* = 1) Hispanic or Latino (*n* = 1)	Female (*n* = 40) Male (*n* = 40)	Private (*n* = 31) Public (*n* = 46) Uninsured (*n* = 3)	Current
Cardarelli et al. (2017)[28]	Community	NR	NR	NR	NR	NR	NR

(continued)

Table 2 (continued)

Author and Year	Unit of Observation	*N*	Age, y	Race/Ethnicity	Sex/Gender	Insurance Status	Smoking Status
Carroll et al. (2020)[29]	Patients	3,375	Median (IQR) 67 (6,272)	Asian (*n* = 69) Black (*n* = 144) White (*n* = 2,770) Hispanic (*n* = 336) Other (*n* = 160) Unknown/missing: (*n* = 232)	Female (*n* = 1,492) Male (*n* = 1,883)	Managed care (*n* = 2,192) Deductible (*n* = 931) Other (*n* = 252)	Current, former, never
Choi et al. (2022)[58]	Providers	152	Median (IQR) 47.0 (40–53)	NR	Female (72.4%)	NA	NA
Colamonici et al. (2023)[59]	Patients	341 (enrolled) 337 (eligible)	Mean (*s*) 66.0 (6.5) Range 50–80	Black (*n* = 223) White (*n* = 95) Hispanic (*n* = 8) Other (*n* = 7) Unknown (*n* = 4)	Male (*n* = 324)	NR	Current, former
Cole et al. (2018)[31]	Patients	24	50–59 (*n* = 8) 60–69 (*n* = 8) 70–79 (*n* = 8)	NR	NR	NR	Current, former
Currier et al. (2022)[60]	Patients	567	50–64 (*n* = 222) 65–74 (*n* = 301) ≥75 (*n* = 44)	White (*n* = 404) Hispanic (*n* = 4) Asian (*n* = 9) NR (*n* = 134) Unknown (*n* = 16)	NR	NR	Current, former
Dickson et al. (2022)[62]	Patients	30,759 (enrolled) 14,714 (responders)	55–59 (3,643) 60–64 (3,727) 65–69 (3,541) 70–74 (2,718) 75+ (1,041) Missing (44)	White (*n* = 11,590) Black (*n* = 796) Asian (*n* = 1,343) Mixed (*n* = 365) Other (*n* = 629)	NR	NR	Current, former
Fabbrini et al. (2018)[32]	Patients	926	Mean (*s*) 64.6 (5.6)	AI/AN 1.4% Black 5.3% NH/PI 0.2% White 77.3% Unknown/missing 15.8% (Baseline)	Male (*n* = 926)	NR	Current, former
Fagan et al. (2020)[33]	Patients	28	Mean 62.64 55–64 y (*n* = 18) ≥65 y (*n* = 10)	Black (*n* = 5) White (*n* = 22) Other (*n* = 1)	Female (*n* = 15) Male (*n* = 13)	Private (*n* = 10) Public (*n* = 17) Uninsured (*n* = 1)	Current, former

(continued)

Table 2 (continued)

Author and Year	Unit of Observation	*N*	Age, y	Race/Ethnicity	Sex/Gender	Insurance Status	Smoking Status
Fetters et al. (2022)[63]	Patients	276 patients	50–80	NR	NR	NR	Current, former
Han et al. (2019)[35]	Patients	60	Mean (range) 63.2 (55–80)	NR	Female 41% Male 59%	NR	Current, former
Hoffman et al. (2018)[36]	Patients	30	Mean 61.5	White (n = 19) Non-White (n = 11)	Female (n = 15) Male (n = 15)	Private (n = 11)	Current, former
Ito Fukunaga et al. (2022)[64]	Patients	23	Mean 65.8	NR	Female (43%)	NR	Current, former
Jessup et al. (2018)[37]	Patients and providers	NA	Patients 55+ y Providers 18+ y	NR	NR	NR	NR
Koroscil et al. (2018)[38]	Patients	101	Patients aged >35 y	NR	NR	NR	NR
Kukhareva et al. (2023)[66]	Patients and providers	1,090 (pre) 1,026 (post)	Pre: mean (*s*) 65.2 (6.6) Post: mean (*s*) 65.3 (6.6)	Pre: Non-Hispanic White (n = 944) Non-Hispanic Black (n = 17) Hispanic (n = 68) Other (n = 61) Post: Non-Hispanic White (n = 902) Non-Hispanic Black (n = 17) Hispanic (n = 57) Other (n = 50)	Pre: Female (n = 458) Post: Female (n = 441)	Pre: Commercial (n = 330) Government (n = 711) Self-pay (n = 49) Post: Commercial (n = 301) Government (n = 694) Self-pay (n = 31)	Current, former
Lau et al. (2015)[39]	Patients	60	Mean (*s*) 60.6 (7.3)	Black (n = 7) White (n = 53)	Female (n = 30) Male (n = 30)	NR	Current, former
Lau et al. (2021)[67]	Patients	74	Mean (*s*) 62.7 (6.84) Range 45−77	African American (n = 74)	Female (n = 36) Male (n = 38)	NR	Current, former
Lowenstein et al. (2020)[56]	Patients	81	NR	NR	NR	NR	NR

(continued)

Table 2 (continued)

Author and Year	Unit of Observation	*N*	Age, y	Race/Ethnicity	Sex/Gender	Insurance Status	Smoking Status
Magarinos et al. (2023)[69]	Patients	1,113	Range 40–85	In-person: African American (n = 353) White (n = 261) Hispanic (n = 55) Asian (n = 2) Other (n = 2) Telemedicine: African American (n = 164) White (n = 156) Hispanic (n = 34) Asian (n = 7) Indian (n = 2) Other (n = 81)	In-person: Female (n = 284) Male (n = 389) Telemedicine: Female (n = 210) Male (n = 230)	NR	Current, former, never, unknown
Manners et al. (2019)[41]	Patients	55	Mean (*s*) LCS Eligible 67.7 (6.6) LCS ineligible 65.4 (6.1)	NR	Female LCS eligible (n = 15) LCS ineligible (n = 8) Male LCS eligible (n = 21) LCS ineligible (n = 11)	NR	Current, former
Mazzone et al. (2017)[42]	Patients	125	Mean (range) 64.4 (55–77)	NR	Female 33.9%	NR	Current, former
Cam et al. (2015)[86]	Patients	414	40–49 y 35.0% 50–59 y 37.9% 60–74 y 27.1%	NR	Male (n = 414)	NHI (n = 400) Medical aid (n = 14)	Current, former, never
Olazagasti et al. (2023)[70]	Patients	Pre: 121 Post: 163	Median 62	Pre: Hispanic (n = 56) Non-Hispanic (n = 65) Post: Hispanic (n = 78) Non-Hispanic (n = 85)	Pre: Male (n = 67) Female (n = 54) Post: Male (n = 85) Female (n = 78)	NR	Current, former
Ortmeyer et al. (2022)[44]	Providers	709	NR	NR	NR	NR	NA

(continued)

Table 2 (continued)

Author and Year	Unit of Observation	*N*	Age, y	Race/Ethnicity	Sex/Gender	Insurance Status	Smoking Status
Raz et al. (2018)[46]	Patients	16	Mean (*s*) Con 62.5 (8.83) Inter 67.2 (8.15)	White: Con (*n* = 7) Inter (*n* = 8) Other: Con (*n* = 1) Inter (*n* = 0)	Female Con (*n* = 5) Inter (*n* = 7)	NR	Current, former
Reuland et al. (2018)[47]	Patients	50	Mean 63	Black 30% White 58% Other 12%	Female (48%) Male (52%)	Uninsured (*n* = 4) Private only (*n* = 14) Medicare only (*n* = 15) Medicaid only (*n* = 4) Medicare and other (*n* = 13)	Current, former
Sağınç and Taşköylü (2022)[71]	Providers	60	18–40 (*n* = 28) >40 (*n* = 32)	NR	Female (*n* = 57) Male (*n* = 3)	NR	NA
Sakoda et al. (2020)[49]	Patients	680	Median (IQR) 64.3 (59–69) <55, *n* = 11 55–80, *n* = 526 >80, *n* = 1 NR, *n* = 142	Asian (*n* = 63) Black (*n* = 23) White (*n* = 448) Hispanic (*n* = 41) Other (*n* = 15) Unknown/missing (*n* = 90)	Female (*n* = 235) Male (*n* = 350) NR (*n* = 95)	NR	Current, former, never
Schlabach et al. (2022)[72]	Patients	NR	NR	NR	NR	NR	Current, former
Smith et al. (2022)[73]	Patients	1,117	Mean 67.5 Range 40–84	Minority group (*n* = 358) Non-Hispanic White (*n* = 759)	Female (*n* = 556) Male (*n* = 561)	Medicaid (*n* = 151) Medicare or TRICARE (*n* = 695) Private (*n* = 583) Self-pay or unknown (*n* = 33)	Current, former, unknown

(continued)

Table 2 (continued)

Author and Year	Unit of Observation	*N*	Age, y	Race/Ethnicity	Sex/Gender	Insurance Status	Smoking Status
Steinberg et al. (2023)[74]	Patients	48,704 Before prompt: *n* = 24,348; After prompt: *n* = 24,356	Mean Before prompt: 64.72 After prompt: 64.82	Before prompt: NH White (*n* = 10,341) NH Black (*n* = 5,929) Hispanic (*n* = 5,659) NH Asian (*n* = 1,299) NH Other (*n* = 132) Missing (*n* = 988) After prompt: NH White (*n* = 9,945) NH Black (*n* = 5,769) Hispanic (*n* = 6,057) NH Asian (*n* = 1,379) NH Other (*n* = 115) Missing (*n* = 1,090)	Before prompt: Female (*n* = 14,779) Male (*n* = 9,541) Missing (*n* = 28) After prompt: Female (*n* = 14,627) Male (*n* = 9,695) Missing (*n* = 34)	Before prompt: Medicare (*n* = 4,121) Medicaid (*n* = 10,695) Private (*n* = 6,732) Uninsured (*n* = 2,025) Missing (*n* = 775) After prompt: Medicare (*n* = 4,315) Medicaid (*n* = 10,027) Private (*n* = 7,212) Uninsured (*n* = 2,057) Missing (*n* = 745)	Current, former, never, missing
Strong and Renaud (2020)[82]	Patients	31	Median (range) 59 (55–74)	Black (*n* = 1) White (*n* = 29) Other (*n* = 1)	Female (*n* = 19) Male (*n* = 12)	Insured (*n* = 24) Uninsured (*n* = 7)	Current, former
Tanner et al. (2019)[51]	Patients	145	Mean 64.7	AI/AN (*n* = 2) Black (*n* = 39) White (*n* = 88) Hispanic (*n* = 7) Other (*n* = 1)	Female (*n* = 40) Male (*n* = 97)	NR	Current, former
Thuppal et al. (2023)[75]	Patients	451	Median (IQR) 61 (58–66) Range 55–80	White (75%) Black (24%) Other (1.2%) Non-Hispanic or Latine (99%)	Female (54.4%)	NR	Current, former
Urrutia Argueta and Hanna (2021)[76]	Providers	60	NR	NR	NR	NR	NA
Volk et al. (2014)[52]	Patients	52	Mean (range) 58.5 (45–75)	White (*n* = 39) Black (*n* = 10) Hispanic (*n* = 3)	Female (*n* = 34)	NR	Current, former

(continued)

Table 2 (continued)

Author and Year	Unit of Observation	*N*	Age, y	Race/Ethnicity	Sex/Gender	Insurance Status	Smoking Status
Watson et al. (2020)[54]	Patients	211	Range 55–77	AI/AN (*n* = 2) Black (*n* = 21) White (*n* = 173) Hispanic (*n* = 8) Other (*n* = 5) Unknown/missing (*n* = 2)	Female (*n* = 87) Male (*n* = 124)	Managed care (*n* = 121) Medicare (*n* = 85) Other (*n* = 5)	Current, former
Williams et al. (2021)[83]	Patients	481	Mean (*s*; range) 58.3 (14.6; 24–80)	White 20 Black 444 Other 17	Female (*n* = 352) Male (*n* = 129)	Medicare (*n* = 134) Medicaid (*n* = 39) Private (*n* = 214) Military (*n* = 53) Uninsured (*n* = 41)	Current, former, never
Williams et al. (2021)[84]	Community	77	Mean (*s*) 44.8 (14.6)	White (*n* = 35) Black (*n* = 27) Hispanic (*n* = 16) Other (*n* = 15)	Female (*n* = 52) Male (*n* = 24) Other (*n* = 1)	Medicare/ Medicaid (*n* = 38) Private/Military (*n* = 17) Uninsured (*n* = 18)	Current, former, never

AI/AN, American Indian/Alaskan Native; Con, control group; IQR, interquartile range; Inter, intervention group; LCS, lung cancer screening; NA, not applicable; NR, not reported; NHS, National Health Service; NHI, national health insurance; NH/PI, Native Hawaiian/Pacific Islander; NR, not reported; VA, Veterans Affairs.

Table 3 Characteristics of Lung Cancer Screening (LCS) Interventions Evaluated.

Author and Year	Intervention Target(s)	Step(s) Targeted in the Screening Process	Intervention Categories	Intervention Description
Randomized				
Begnaud et al. (2017)[55]	Patients	Risk assessment; eligibility; initial LCS uptake	One-on-one education, reduction of structural barriers	Messages sent through patient portal to promote LCS with link to complete detailed smoking history in the EHR
Carter-Harris et al. (2020)[30]	Patients	SDM	One-on-one education	Computer-tailored decision support tool for LCS
DiCarlo et al. (2022)[61]	Patients	Initial LCS uptake	One-on-one education	Patient outreach alone and patient outreach plus decision counseling
Fraenkel et al. (2016)[34]	Patients	SDM	One-on-one education	Probability formats to compare number of normal scans, false-positive scans with benign nodules found, cancers leading to life saved, and cancers leading to death despite screening
Kathuria et al. (2022)[78]	Patients	Pilot 1: SDM, initial LCS uptake Pilot 2: shared decision and initial LCS uptake	Pilot 1: One-on-one education and reduction of structural barriers Pilot 2: One-on-one education and reduction of structural barriers	SDM conversations that were initiated in the inpatient setting with and without community health workers to address structural barriers to LCS
Kinsey et al. (2022)[65]	Patients	Follow-up testing	Reduction of structural barriers	Navigator-led centralized screening program
Lillie et al. (2017)[40]	Patients	SDM	On-on-one education	Direct LCS invitation mailed with an LCS decision aid
Lowery et al. (2022)[68]	Providers	SDM	Group education	Enhanced implementation strategies (i.e., training/support) for EHR-embedded decision support
Monu et al. (2022)[79]	Patients	Initial LCS uptake	One-on-one education	LCS advertisements with different construal level and regulatory foci on crowd-sharing platform
O'Brien et al. (2017)[43]	Patients	Risk assessment; eligibility	Reduction of structural barriers	Two forms to assess LCS eligibility: 1) e-form sent electronically, 2) p-form asked patients to complete paper version in waiting room
Percac-Lima et al. (2018)[45]	Patients	Initial LCS uptake	Reduction of structural barriers	LCS navigators
Quaife et al. (2020)[57]	Patients	Initial LCS uptake	One-on one education	Booklet targeting psychological barriers to attending a health lung check
Raz et al. (2021)[80]	Patients	Initial LCS uptake	One-on-one education	30-min, online educational video about LCS
Ruparel et al. (2019)[48]	Patients	Risk assessment; eligibility; SDM; initial LCS uptake	One-on-one education	Information film and booklet or booklet alone on informed decision making for LCS

(continued)

Table 3 (continued)

Author and Year	Intervention Target(s)	Step(s) Targeted in the Screening Process	Intervention Categories	Intervention Description
Schmidt et al. (2018)[50]	Providers	Risk assessment; eligibility	One-on-one education	Epidemiologic data presented on LCS including preventable deaths, prevalence of lung cancer and false-positive screening tests, and LCS test characteristics
Sferra et al. (2021)[81]	Patients	SDM	One-on-one education	Comparison of 2 different SDM decision aids (Option Grid and Shouldiscreen.com)
Sharma et al. (2018)[87]	Patients	SDM	One-on-one education	Coach delivered messaging regarding LCS delivered by telephone
Volk et al. (2020)[53]	Patients	SDM	One-on-one education	Video patient decision aid on LCS delivered by DVD and link to video
Webster et al. (2023)[77]	Patients	Risk assessment; eligibility; SDM; initial LCS uptake	One-on-one education	Tobacco Quitline callers deemed eligible for the study were given either a printed "Should I Screen?" booklet or the Web-based version to learn more about LCS
Quasi-experimental				
Akhtar et al. (2022)[85]	Providers	Eligibility; SDM	Group education	Physician and smoking cessation nurse-led 45–60 sessions that covered NSCLC basics, LCS eligibility criteria, risks and benefits of LCS, SDM, and billing
Azubuike et al. (2020)[25]	Providers	Initial LCS uptake	Group education, one-on-one education, reduction of structural barriers	1-h educational session for providers, new telephone script patient screening tool
Barett et al. (2016)[26]	Patients	Initial LCS uptake	Reduction of structural barriers	LCS navigator
Bartlett et al. (2020)[27]	Patients	Risk assessment; eligibility	One-on-one education	Consultation evaluating health history and calculations of 2 lung cancer risk scores
Fagan et al. (2024)[88]	Patients	SDM, initial LCS uptake	Reduction of structural barriers, one-on-one education	A trained decision counselor used an online decision-aid program to guide the participant through an interactive conversation that focused on patient education, LCS values elicitation, and LCS preference clarification
Cardarelli et al. (2017)[28]	Community	Initial LCS uptake	Mass media	Postcards, mailed information, Website with links and resources, roundtable events, newspaper articles, newspaper ads, public radio
Carroll et al. (2020)[29]	Patients	Risk assessment; eligibility	Reduction of structural barriers	Modifications to LCS implementation including confirmation of age and smoking status and documentation of SDM and smoking cessation counseling

(continued)

Table 3 (continued)

Author and Year	Intervention Target(s)	Step(s) Targeted in the Screening Process	Intervention Categories	Intervention Description
Choi et al. (2022)[58]	Providers	Risk assessment; eligibility; SDM	One-on-one education	E-curriculum for primary care providers on breast and colorectal cancer surveillance and LCS
Colamonici et al. (2023)[59]	Patients	SDM	Reduction of structural barriers, one-on-one education	Patient education and SDM
Cole et al. (2018)[31]	Patients	Risk assessment; eligibility	Reduction of structural barriers	Compared EHR data with patient self-report to identify patients eligible for LCS; if found eligible, order for LCS placed in chart and patient provided scheduling information
Currier et al. (2022)[60]	Patients	Initial LCS uptake, follow-up testing	Reduction of structural barriers, one-on-one education	Implementation of LCS program in rural setting
Dickson et al. (2022)[62]	Patients	Risk assessment, eligibility	Reduction of structural barriers	Phone screeners and "Lung Health Check" appointments
Fabbrini et al. (2018)[32]	Patients	SDM, initial LCS uptake	One-on-one education, reduction of structural barriers	Mailed SDM materials and letters inviting them to call the LCS program, discuss LCS, and schedule an LDCT
Fagan et al. (2020)[33]	Patients	SDM	One-on-one education	Telephone-based SDM session with a trained decision counselor using an online decision counseling program
Fetters et al. (2022)[63]	Patients	Risk assessment; eligibility; SDM; initial LCS uptake; follow-up testing	One-on-one education (patients), group education (providers)	Educational presentations to providers, discussion of educational brochure with patients
Han et al. (2019)[35]	Patients	Initial LCS uptake	One-on-one education	Patient decision aid and personalized cancer risk information
Hoffman et al. (2018)[36]	Patients	SDM	One-on-one education	LCS patient decision aid video
Ito Fukunaga et al. (2022)[64]	Patients	SDM	One-on-one education	Single-page encounter decision aid delivered by a pulmonologist
Jessup et al. (2018)[37]	Patients and Providers	Initial LCS uptake	Mass media	Digital platforms including social media—Google and Facebook (patients), LinkedIn and Twitter (health care providers)
Koroscil et al. (2018)[38]	Patients	Follow-up testing	One-on-one education	Pulmonary nodule fact sheet
Kukhareva et al. (2023)[66]	Providers	SDM; initial LCS uptake	Reduction of structural barriers	Clinician-facing EHR prompts and an EHR-integrated SDM tool
Lau et al. (2015)[39]	Patients	SDM	One-on-one education	Personalized Web-based decision aid for lung cancer screening
Lau et al. (2021)[67]	Patients	Risk assessment; SDM	One-on-one education	Web-based decision aid that included information about LDCT screening and risk factors and calculated personalized risk

(continued)

Table 3 (continued)

Author and Year	Intervention Target(s)	Step(s) Targeted in the Screening Process	Intervention Categories	Intervention Description
Lowenstein et al. (2020)[56]	Patients	SDM	One-on-one education	Previsit decision aid and in-person coaching module for LCS
Magarinos et al. (2023)[69]	Patients	Risk assessment; eligibility; SDM; initial LCS uptake	Reduction of structural barriers	A single-encounter, telemedicine LCS whereby patients receive LDCT in person but counseling regarding results, coordination of follow-up care, and smoking cessation is delivered using telemedicine
Manners et al. (2019)[41]	Patients	SDM	One-on-one education	Recruitment pamphlet with brief information on LCS and an LCS risk assessment followed by a patient decision aid tailored to risk assessment
Mazzone et al. (2017)[42]	Patients	SDM	One-on-one education	Counseling and SDM visit including review of eligibility, narrated video, and patient decision aid
Cam et al. (2015)[86]	Patients	SDM	One-on-one education	Information about harms of radiation exposure from LCS
Olazagasti et al. (2023)[70]	Providers	Initial LCS uptake	Group education	60-min physician-led educational session discussing incidence and mortality of lung cancer and the history of screening as well as LCS guidelines, including SDM
Ortmeyer et al. (2022)[44]	Providers	SDM	Group education	Interactive group-based learning curriculum about LCS
Raz et al. (2018)[46]	Patients	SDM, initial LCS uptake	One-on-one education	Video-intervention to reduce anxiety and prepare patients for LCS; 5-min video and 9-page handbook
Reuland et al. (2018)[47]	Patients	SDM	One-on-one education	Video decision aid
Sağınç and Taşköylü (2022)[71]	Providers	Risk assessment; eligibility; SDM	Group education	Planned training of health care workers to increase awareness of cancer prevention and early screening programs
Sakoda et al. (2020)[49]	Patients	Risk assessment; eligibility; SDM	Group education	Group education class on LCS taught by clinician specialists
Schlabach et al. (2022)[72]	Patients	Initial LCS uptake	Reduction of structural barriers	Implementation of a nurse practitioner–led LCS clinic
Smith et al. (2022)[73]	Patients	Adherence to annual testing	Reduction of structural barriers	Individuals were screened either using a decentralized approach managed by the primary care providers or centralized approach managed by a dedicated program coordinator
Steinberg et al. (2023)[74]	Providers	Risk assessment; eligibility; initial LCS uptake	Reduction of structural barriers	EHR workflow prompts designed to improve tobacco use data entry, allowing for better LCS eligibility identification

(continued)

Table 3 (continued)

Author and Year	Intervention Target(s)	Step(s) Targeted in the Screening Process	Intervention Categories	Intervention Description
Strong and Renaud (2020)[82]	Patients	SDM	One-on-one education	LCS educational video hosted on YouTube and delivered via social media (Facebook advertisement)
Tanner et al. (2019)[51]	Patients	SDM	One-on-one education	SDM visit using an LCS patient decision aid
Thuppal et al. (2023)[75]	Patients	Risk assessment; eligibility; initial LCS uptake	Reduction of structural barriers, one-on-one education	Patients were proactively contacted by a nurse navigator to discuss eligibility and prescreening; eligible and willing patients were referred to their primary care physician
Urrutia Argueta and Hanna (2021)[76]	Providers	SDM	One-on-one education	Infographic with trial and guideline data on LCS
Volk et al. (2014)[52]	Patients	Risk assessment; SDM	One-on-one education	Online, video patient decision aid about LCS
Watson et al. (2020)[54]	Patients and providers	Initial LCS uptake	One-on-one education, reduction of structural barriers	Oncology nurse navigator, patient and provider facing interventions
Williams et al. (2021)[83]	Patients	Risk assessment; eligibility; SDM	Group education, reduction of structural barriers	Four 90-min group education sessions delivered weekly by community health workers to assist connecting participants to LCS or tobacco cessation services
Williams et al. (2021)[84]	Community	Initial LCS uptake	Group education	Community health worker delivered 90-min group curriculum on LCS

EHR, electronic health record; LCS, lung cancer screening; LDCT, low-dose computed tomography; NSCLC, non-small-cell lung cancer; SDM, shared decision making.

Exceptions were 2 studies that reported using the Precaution Adoption Process Model alone[57] or linked with the Health Belief Model[30] and those that reported using the Health Belief Model,[83,84] the Integrated Model of Health Behavior,[36] or motivational interviewing techniques.[45]

In addition, 3 studies[56,60,68] reported using guidance from implementation frameworks, and one evaluated different screening messages grounded in communication theories.[79] Some studies testing decision aids reported using the International Patient Decision Aid Standards[41,53] or the Option Grid[35] to guide decision aid content or the Ottawa Decision Support Framework to combine decision aids with personal coaching or online decision support to guide their work,[39,56] and a few educational intervention studies referenced specific educational approaches (i.e., repetitive review methods,[58] small-group interactive learning,[44] and teachable moments).[77,78]

Evaluation of Intervention Effects

Two-thirds of the studies ($n = 43$) reported statistically significant findings (Table 4). Approximately one-third of those ($n = 16$) focused on improving knowledge as the study's primary outcome, primarily patient knowledge. Most of these studies did not use a randomized design ($n = 13$), and while none of the randomized trials were assessed to have a high risk of bias, 5 of the quasi-experimental design studies were determined to face serious risk of bias. Ten studies with statistically significant findings focused on initial LCS uptake,† 3 of which used a randomized design.[45,65,78] While 1 of those studies was determined to be of high risk of bias,[78] all but one[66] of the quasi-experimental design studies were classified as serious risk of bias. Other studies with statistically significant findings that used a randomized design focused on the patient[40,53,81] and provider[68] decision making or patient behavioral intent.[79] Among studies employing a quasi-experimental design that were assessed as not having a serious risk of bias, outcomes significantly affected by the tested interventions included provider confidence,[85] patient eligibility,[62] perceived risk of cancer,[35] decisional conflict,[41,64] behavioral (LCS) intent,[86] adherence to annual LCS,[73] and medical record completeness.[74] Overall, 14 of the 19 randomized trials and 18 of the 45 quasi experimental design studies (a total of half of the identified studies) were assessed to be at low or moderate/some risk of bias, and among these, most ($n = 27$) reported statistically significant findings.

Discussion

In this systematic review, we sought to summarize the evidence for interventions designed to initiate, adopt, or improve LCS and identify where in the LCS continuum interventions have been focused. We also sought to characterize this literature in terms of the target populations of the interventions and the outcomes that have been assessed. We found 64 English-language published articles, not surprisingly with most from the United States. Less than one-third were randomized trials, with the remainder using a quasi-experimental design with the risk of bias variable within both types of design. Most interventions regardless of country context targeted only patients, with some targeting providers. Only a few targeted communities or a combination of levels, each of these among US-based populations. The most common category of intervention was education, typically provided to individuals one-on-one. Some studies targeted structural barriers, at times alongside educational interventions, and although the use of navigators and community health workers was most prevalent, there was not one common intervention used to address structural barriers. Our analysis was unique in examining the nature of interventions along steps in the LCS continuum from risk and eligibility assessment to SDM, initial screening uptake, annual screening adherence, and abnormal follow-up testing. However, rather than finding interventions targeted across this continuum, the majority, regardless of country context, targeted the early steps in this process, with only 2 studies (1 randomized trial[65] and 1 quasi-experimental design,[73] both of which were US based) found not to be of serious/high risk of bias focused on follow-up testing[65] or adherence to annual LCS.[73]

Our systematic review found support for the premise that English-language published interventions designed to improve specific steps early in the process of LCS have been successful. Six randomized controlled trials assessed to have only a low or some risk of bias found significant improvements in knowledge or preparation for decision making.[30,34,40,48,53,81] Quasi-experimental studies had similar results, with multiple studies with low or moderate risk of bias reporting that interventions increased patients' knowledge,[39,42,49,52,67] improved their perceptions of lung cancer risk,[35] or reduced decisional conflict.[41,64] Similarly, multiple studies reported increased provider confidence, knowledge, or both.[58,71,85] However, evidence was less robust regarding the outcomes of LCS uptake: only 2 randomized trials with low

Table 4 Evaluation of Outcomes and Risk of Bias.

Author and Year	Primary Outcome	Statistical Significance	Risk of Bias
Randomized			
Begnaud et al. (2017)[55]	LCS receipt	No	Low
Carter-Harris et al. (2020)[30]	Patient knowledge	Yes	Low
DiCarlo et al. (2022)[61]	LCS completion	No	High
Fraenkel et al. (2016)[34]	Patient knowledge	Yes	Some
Kathuria et al. (2022)[78]	LCS completion	No (Pilot 1) Yes (Pilot 2)	High
Kinsey et al. (2022)[65]	Compliance with follow-up LDCT scans	Yes	Some
Lillie et al. (2017)[40]	Factors important to LCS decision making	Yes	Low
Lowery et al. (2022)[68]	Use of provider-facing decision support	Yes	Some
Monu et al. (2022)[79]	Willingness to complete LDCT	Yes	Low
O'Brien et al. (2017)[43]	Completed LDCT screening form	NR	High
Percac-Lima et al. (2018)[45]	LDCT receipt	Yes	Low
Quaife et al. (2020)[57]	Attendance at lung health check appointment	No	Low
Raz et al. (2021)[80]	LDCT use	No	Low
Ruparel et al. (2019)[48]	Patient knowledge	Yes	Low
Schmidt et al. (2018)[50]	Estimated preventable deaths	No	High
Sferra et al. (2021)[81]	Decision regret	Yes	Some
Sharma et al. (2018)[87]	Speaking to a physician about LCS	No	High
Volk et al. (2020)[53]	Preparation for decision making	Yes	Low
Webster et al. (2023)[77]	LCS knowledge	No	Low
Quasi-experimental			
Akhtar et al. (2022)[85]	Provider confidence identifying patients appropriate for LCS	Yes	Moderate
Azubuike et al. (2020)[25]	LDCT order	Yes	Serious
Barett et al. (2016)[26]	Time between LDCT order and LDCT receipt	No	Serious
Bartlett et al. (2020)[27]	Attendance at lung health check appointment	No	Serious
Fagan et al. (2024)[88]	LDCT completion	Yes	Serious
Cardarelli et al. (2017)[28]	LDCT receipt	NR	Moderate
Carroll et al. (2020)[29]	Percentage of patients meeting LCS eligibility criteria	Yes	Serious
Choi et al. (2022)[58]	Provider knowledge and confidence	Yes	Moderate
Colamonici et al. (2023)[59]	LCS referrals	Yes	Serious
Cole et al. (2018)[31]	Accuracy of data within electronic health record	NR	Serious
Currier et al. (2022)[60]	LCS reach	NR	Serious
Dickson et al. (2022)[62]	Proportion of individuals eligible for LCS	Yes	Moderate
Fabbrini et al. (2018)[32]	LDCT receipt	Yes	Serious
Fagan et al. (2020)[33]	LCS receipt	Yes	Serious
Fetters et al. (2022)[63]	LCS completion	No	Serious
Han et al. (2019)[35]	Risk of lung cancer	Yes	Low
Hoffman et al. (2018)[36]	Decision-making values	NR	Serious
Ito Fukunaga et al. (2022)[64]	Decisional conflict	Yes	Low
Jessup et al. (2018)[37]	LDCT scheduled	Yes	Serious
Koroscil et al. (2018)[38]	Patient knowledge	Yes	Serious
Kukhareva et al. (2023)[66]	LDCT use	Yes	Low
Lau et al. (2015)[39]	Patient knowledge	Yes	Low
Lau et al. (2021)[67]	Patient knowledge	Yes	Low
Lowenstein et al. (2020)[56]	Shared decision-making quality	Yes	Serious
Magarinos et al. (2023)[69]	Number of patients screened	Yes	Serious
Manners et al. (2019)[41]	Decisional conflict	Yes	Low
Mazzone et al. (2017)[42]	Patient knowledge	Yes	Low
Cam et al. (2015)[86]	LCS intent	No	Low
Olazagasti et al. 2023)[70]	LDCT use	Yes	Serious
Ortmeyer et al. (2022)[44]	Provider knowledge	Yes	Serious
Raz et al. (2018)[46]	Health-related quality of life	No	Serious
Reuland et al. (2018)[47]	Patient knowledge	Yes	Serious

(continued)

Table 4 (continued)

Author and Year	Primary Outcome	Statistical Significance	Risk of Bias
Sağınç and Taşköylü (2022)[71]	Knowledge of cancer prevention and early diagnosis methods	Yes	Low
Sakoda et al. (2020)[49]	Patient knowledge	Yes	Moderate
Schlabach et al. (2022)[72]	LDCT use	Yes	Serious
Smith et al. (2022)[73]	Adherence to annual LCS	Yes	Moderate
Steinberg et al. (2023)[74]	Medical record completeness to determine LCS eligibility and LDCT ordering	Yes	Moderate
Strong and Renaud (2020)[82]	LCS knowledge	Yes	Low
Tanner et al. (2019)[51]	Decisional conflict	NR	Serious
Thuppal et al. (2023)[75]	Identification of patients eligible for LDCT screening	NR	Serious
Urrutia Argueta and Hanna (2021)[76]	Provider knowledge	No	Serious
Volk et al. (2014)[52]	Patient knowledge	Yes	Low
Watson et al. (2020)[54]	LDCT receipt	No	Serious
Williams et al. (2021)[83]	Patient knowledge	Yes	Serious
Williams et al. (2021)[84]	Community member knowledge	Yes	Serious

LCS, lung cancer screening; LDCT, low-dose computed tomography; NR, not reported.

or moderate risk of bias reported an intervention that increased LCS uptake[45] or compliance with follow-up testing.[65] In contrast, 3 randomized control trials with low or moderate risk of bias failed to have an impact on either attendance at a lung health check appointment in the United Kingdom[57] or receipt of LCS in the United States.[55,80] Similarly, 2 quasi-experimental studies with low or moderate risk of bias had an effect on LCS receipt in the United States[66] or adherence to annual LCS in the United States,[73] while 2 failed to have an impact on LCS receipt or intention to have LCS, 1 in the United States and 1 in South Korea.[28,86]

Our study highlights the relative lack of English-language published interventions that target follow-up testing or repeated annual LCS. Prior studies have found rates of follow-up testing to be suboptimal, particularly among marginalized populations.[89] As has now been well established, the benefits of cancer screening accrue from the receipt of high-quality care across the cancer screening continuum from eligible patient identification and test uptake through to adherence to guideline-concordant interval testing frequency to the follow-up of abnormal results.[90–92] For LCS to incur both individual- and population-level benefits, interventions targeted to increase adherence to follow-up and annual screening are needed.

Most studies evaluated patient-level interventions. Among these, the findings related to knowledge of LCS and preparation for decision making are consistent with the broader literature that finds patient decision aids and other types of SDM increase patient knowledge about interventions.[93,94] We identified only 3 randomized trials with low risk of bias that specifically targeted structural barriers to LCS, all based in the United States. In 2 studies,[45,65] patient navigator interventions significantly increased the receipt of LCS. This finding is consistent with evidence that patient navigation is an effective way to address structural barriers to other types of cancer screening.[95] In contrast, a third trial[55] leveraged patient portal messaging to address gaps in tobacco history within EHRs and found no significant change in LCS receipt. Given that LCS is one of the most underutilized cancer screening interventions, the reliance on one-on-one targeted interventions is unlikely to result in substantively meaningful uptake at a population level.

Our findings are noteworthy for the relative absence of commonly used interventions in the context of cancer screening such as text messaging, mHealth, the use of prompt and reminders, assessment and feedback, or the use of mass media or small media for outreach, all of which have been evaluated and found to be effective within the context of other types of cancer screening.[96–100] Nor did we find many studies that targeted multiple levels of intervention, despite the wide-held belief of their relative advantages.[90–92] In addition, we did not find studies that explicitly considered the costs associated with LCS implementation strategies. Each of these topics likely warrants further study.

We abstracted sociodemographic characteristics of participants including all categories of race and ethnicity reported in the study groups. Barely two-thirds of the identified studies reported some amount of race and

ethnicity descriptors of study participants with varied levels of race and ethnicity categories. Furthermore, barely one-third reported information regarding participants' health insurance coverage. Given historic and emerging disparities by race and ethnicity in LCS, at a minimum, it is necessary to report race, ethnicity, and socioeconomic factors among study populations to assess the generalizability of outcomes across diverse populations and to advance equity. However, to achieve equity, more than inclusive study populations and stratified reporting are necessary; rather, we will need to design studies to target determinants of disparities and achieve equity of outcomes. Designing interventions that will be both effective and equitable remains an important objective for the field.

Limitations

We focused our review on English-language studies published since 2011, when results from the National Lung Screening Trial were published,[1] through December 31, 2023, targeting studies identifiable via a variety of search engines. As such, our results exclude findings from studies that were not published and those most recently published as well as those not published in English. As evident from the volume of studies identified via the updated search, the field is rapidly expanding, and our study resources did not enable an additional rapid update through the end of 2024. As such, as with all systematic reviews for which the evidence base is evolving, care should be taken when generalizing our findings as the field expands. It should be noted, however, that while adding these newer studies diversified the sociodemographic characteristics of study populations used, it did not substantially alter the conclusions drawn from the current body of evidence. Similarly, because of our perception of the paucity of relevant studies as we began the review, we elected to include English-language studies, regardless of country context. While we did not detect notable differences between US-based and other country-based studies or their findings, care should be taken when extracting non–US-based study findings to the United States. As most non–US-based studies (like most of all the studies identified) focused on educational interventions, such a caution pertains mostly to the 3 studies that addressed structural barriers.[27,43,62] We also excluded studies focused solely on interventions targeting smoking cessation due to a separate robust literature focused on this topic.[101]

In addition, the risk of bias among the identified studies was highly variable. For example, although most randomized controlled trials had a low or some risk of bias as assessed by ROB 2.0, among studies using a quasi-experimental design, more than 40% were assessed as having a serious risk of bias using ROBINS-I criteria. Collectively, this suggests important gaps in study design, and therefore, the interpretation and future implementation are questionable. In addition, we found interventions often lack grounding within behavioral theory, model, or framework. In addition, our search criteria required a form of the term *LDCT scan* in the title, abstract, or keywords, a strategy that could miss studies referencing LCS with other terms. In the case of 1 study known to our team,[102] this search criteria failed to identify the study despite its relevance.

Conclusions

The body of literature evaluating interventions to improve the LCS process is strongest for interventions targeting improved knowledge about LCS and SDM. As such, the current body of literature is limited in its ability to help health care delivery organizations identify how to improve LCS uptake and the more distal steps in the LCS continuum. Rigorous studies of interventions targeting points across the LCS continuum are needed to support the translation of the NLST and NELSON trials into practice. Further, socioeconomic status has been found to be a mediator in racial disparities of annual LCS adherence.[89] With regard to the category of interventions developed, most have been one-on-one education, with some targeting different types of structural barriers to LCS faced by patients and, in 1 case, providers. Less well explored are interventions targeting the health system level, use of reminders or incentives, and outreach through the media. Equity remains an important issue across cancer screening interventions requiring data collection and reporting on patient- and population-level characteristics. This systematic review identifies the strengths and gaps in the published literature that can direct future efforts to help health care organizations wanting to implement effective LCS programs.

Appendix: Study Search Strategies by Database

The search ID was linked with a specific MESH/search term and/or conceptual term. Search terms were tailored to the specific database but covered similar group-level concepts: 1 = lung cancer, 2 = cancer screening, 3 = low-dose computed tomography (LDCT), and 4 = behavior and intervention terms. The final search combined groups (linked by "AND"). Included in the

CINAHL

Group	Search ID	Search Logic (using "Expanders - Apply equivalent subjects" & "Search modes - Boolean/Phrase")
1	1.1	(MH "Lung Neoplasms+") OR "lung cancer" OR "lung tumor"
AND		*All Group 2 search terms combined using OR*
2	2.1	(MH "Cancer Screening")
	2.2	(MH "Early Detection of Cancer")
	2.3	(MH "Diagnostic Imaging+") OR (MH "Biopsy, Needle") OR (MH "Biopsy+")
AND		
3	3.1	TI low dose ct OR AB low dose ct OR TI ldct OR AB ldct OR TI low dose computed tomography OR AB low dose computed tomography OR MW ldct OR MW low dose ct OR MW low dose computed tomography
AND		*All Group 4 search terms combined using OR*
4	4.1	(MH "Intervention Trials") OR (MH "Therapeutics+")
OR	4.2	(MH "Health Behavior+") OR (MH "Health Services Needs and Demand+") OR (MH "Health Promotion+") OR (MH "Attitude to Health+") OR (MH "Attitude of Health Personnel+") OR (MH "Health Promotion+") OR (MH "Health Knowledge") or (MH "Risk Assessment")
OR	4.3	(MM "Persuasive Communication") OR (MM "Communication Skills") OR (MM "Reminder Systems") OR (MH "Diffusion of Innovation+")
OR	4.4	(MH "Outcomes (Health Care)+") OR (MH "Process Assessment (Health Care)+") OR (MH "Program Evaluation") OR (MH "Evaluation and Quality Improvement Program") OR (MM "Implementation Science")
OR	4.5	(MH "Health Care Delivery+") OR (MH "Health Services Administration+") OR (MH "Patient Care+") OR (MH "Preventive Health Care+") OR (MH "Primary Health Care") OR (MH "Population Health Management")
OR	4.6	(MH "Quality Improvement+") OR (MH "Quality of Care Research") OR (MH "Quality of Health Care+") OR (MH "Quality Assessment+")
OR	4.7	(MH "Decision Making, Shared") OR (MH "Decision Making, Patient+") OR (MH "Decision Making, Family") OR (MH "Decision Making, Clinical+") OR (MH "Decision Making+") OR (MH "Decision Making, Organizational") OR (MH "Decision Making, Ethical")
OR	4.8	(MH "Smoking Cessation Programs") OR (MH "Tobacco Use Cessation Products+") OR (MH "Smoking Cessation")
OR	4.9	(MH "Patient Compliance+") OR (MH "Treatment Refusal") OR (MH "Patient Satisfaction+") OR (MH "Patient Preference") OR (MH "Motivation+")
OR	4.10	(MH "Patient Navigation") OR (MH "Patient Centered Care")
OR	4.11	(MH "Decision Support Systems, Clinical") OR (MH "Decision Support Systems, Management") OR (MH "Decision Support Techniques+") OR (MH "Patient Record Systems+") OR (MH "Radiology Information Systems+") OR (MH "Clinical Information Systems+") OR (MH "Ambulatory Care Information Systems")
OR	4.12	(MH "Telehealth+") OR (MH "Telemedicine+")

COCHRANE

Group	Search ID	Search Logic (including all word variations)
1	1.1	(("Lung cancer" OR "lung neoplasm" OR "lung tumor")):ti,ab,kw
AND		
2	2.1	("cancer screen" OR "mass screen"):ti,ab,kw
	2.2	("early detection of cancer"):ti,ab,kw
AND		
3	3.1	("LDCT" OR "low-dose CT" OR "low-dose computed tomography"):ti,ab,kw
AND		
4	4.1	("therapeutic processes" OR "intervention"):ti,ab,kw
OR	4.2	("health attitudes" OR "health behavior" OR "health knowledge" OR "health promotion" OR "health practice"):ti,ab,kw
OR	4.3	("persuasive communication"):ti,ab,kw
OR	4.4	("prevention" OR "public health" OR "program evaluation" OR "implementation" OR "diffusion" OR "dissemination"):ti,ab,kw

(continued)

OR	4.5	("health care delivery" OR "healthcare delivery" OR "delivery of care"):ti,ab,kw
OR	4.6	("guidelines" OR "quality assurance" OR "quality improvement" OR "standard of care"):ti,ab,kw
OR	4.7	("decision-making" OR "decision" OR "shared" OR "clinical decision" OR "decision support"):ti,ab,kw
OR	4.8	("cessation" OR "tobacco treatment" OR "smoking cessation" OR "tobacco use treatment" OR "tobacco use cessation"):ti,ab,kw
OR	4.9	("health policy" OR "welfare policy" OR "health plan" OR "health program"):ti,ab,kw
OR	4.10	("accept" OR "adhere" OR "apathy" OR "attend" OR "attitude" OR "aware" OR "barrier" OR "behavior" OR "compliance" OR "comply" OR "consent" OR "cooperate" OR "dropout" OR "drop out" OR "educate" OR "improve" OR "increase" OR "know" OR "motivate"):ti,ab,kw
OR	4.11	("nonattendance" OR "non-attendance" OR "nonresponse" OR "non-response" OR "participate" OR "prefer" OR "prevalent" OR "prevalence" OR "promote" OR "refuse" OR "respond" OR "satisfied" OR "takeup" OR "uptake" OR "utilize"):ti,ab,kw
OR	4.12	("adopt" OR "alert" OR "appointment" OR "assessment" OR "audit" OR "campaign" OR "community" OR "counsel" OR "decision aid" OR "digital" OR "educate" OR "evaluate" OR "feedback" OR "hotline" OR "internet" OR "invite" OR "letter"):ti,ab,kw
OR	4.13	("mail" OR "media" OR "phone" OR "prompt" OR "message" OR "mobile" OR "questionnaire" OR "recall" OR "recruit" OR "remind" OR "risk assess"):ti,ab,kw
OR	4.14	("self-refer" OR "send" OR "sent" OR "strategy" OR "survey" OR "telephone" OR "telemedicine" OR "telehealth" OR "training" OR "video"):ti,ab,kw

EMBASE

Group	Search ID	Search Logic
1	1.1	'lung cancer' OR 'lung tumor' OR 'lung neoplasm':ti,ab,kw
AND		
2	2.1	'mass screening':ti,ab,kw OR 'cancer screening':ti,ab,kw
	2.2	'early cancer diagnosis':ti,ab,kw OR 'early detection of cancer':ti,ab,kw
	2.3	'abnormal follow-up':ti,ab,kw OR 'diagnostic follow-up':ti,ab,kw OR 'abnormal evaluat*':ti,ab,kw OR 'diagnostic evaluat*':ti,ab,kw OR 'surveill*':ti,ab,kw OR 'diagnostic procedure':ti,ab,kw
AND		
3	3.1	'low dose computed tomography':ti,ab,kw OR ldct:ti,ab,kw OR 'low dose ct':ti,ab,kw
AND		
4	4.1	therapy:ti,ab,kw OR 'intervention study':ti,ab,kw OR intervention:ti,ab,kw
OR	4.2	'health behavior':ti,ab,kw OR 'health promotion':ti,ab,kw OR 'health practice':ti,ab,kw OR 'attitude to health':ti,ab,kw OR 'health attitude*':ti,ab,kw OR 'health knowledge':ti,ab,kw
OR	4.3	'persuasive communication':ti,ab,kw
OR	4.4	prevention:ti,ab,kw AND control:ti,ab,kw OR prevention:ti,ab,kw OR 'public health':ti,ab,kw OR 'implementation science':ti,ab,kw OR diffusion:ti,ab,kw OR 'program evaluation':ti,ab,kw OR dissemination:ti,ab,kw OR 'disseminat*':ti,ab,kw
OR	4.5	'health care delivery':ti,ab,kw OR 'healthcare delivery':ti,ab,kw OR 'delivery of healthcare':ti,ab,kw
OR	4.6	'health care quality':ti,ab,kw OR 'quality control':ti,ab,kw OR 'quality improvement study':ti,ab,kw OR 'quality improve*':ti,ab,kw OR 'quality assurance':ti,ab,kw
OR	4.7	'decision making':ti,ab,kw OR 'shared decision making':ti,ab,kw OR 'decision support system':ti,ab,kw OR 'clinical decision making':ti,ab,kw
OR	4.8	'smoking cessation':ti,ab,kw OR 'tobacco treatment':ti,ab,kw OR 'tobacco use treatment':ti,ab,kw OR 'tobacco use cessation':ti,ab,kw
OR	4.9	'accept*':ti,ab,kw OR 'adher*':ti,ab,kw OR 'apathy':ti,ab,kw OR 'attend*':ti,ab,kw OR 'attitude*':ti,ab,kw OR 'aware*':ti,ab,kw OR 'barrier*':ti,ab,kw OR 'behav*':ti,ab,kw OR 'compli*':ti,ab,kw OR 'comply*':ti,ab,kw OR 'consent*':ti,ab,kw OR 'cooperat*':ti,ab,kw OR 'dropout*':ti,ab,kw OR 'drop out*':ti,ab,kw OR 'educat*':ti,ab,kw OR 'improv*':ti,ab,kw OR 'incent*':ti,ab,kw OR 'increas*':ti,ab,kw
OR	4.10	'know*':ti,ab,kw OR 'motivat*':ti,ab,kw OR 'navigat*':ti,ab,kw OR 'nonattend*':ti,ab,kw OR 'non-attend*':ti,ab,kw OR 'nonrespon*':ti,ab,kw OR 'non-respon*':ti,ab,kw OR 'particip*':ti,ab,kw OR 'prefer*':ti,ab,kw OR 'prevalen*':ti,ab,kw OR 'promot*':ti,ab,kw OR 'refus*':ti,ab,kw OR 'respon*':ti,ab,kw OR 'satisf*':ti,ab,kw OR 'takeup*':ti,ab,kw OR 'uptake':ti,ab,kw OR 'utili*':ti,ab,kw

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OR	4.11	'adopt*':ti,ab,kw OR 'alert*':ti,ab,kw OR 'appointment*':ti,ab,kw OR 'assessment*':ti,ab,kw OR 'audit*':ti,ab,kw OR 'campaign*':ti,ab,kw OR 'community':ti,ab,kw OR 'counsel*':ti,ab,kw OR 'decision aid*':ti,ab,kw OR 'digital':ti,ab,kw OR 'educat*':ti,ab,kw OR 'evaluat*':ti,ab,kw OR 'feedback':ti,ab,kw OR 'hotline':ti,ab,kw OR 'internet':ti,ab,kw OR 'invit*':ti,ab,kw OR 'letter*':ti,ab,kw
OR	4.12	'mail*':ti,ab,kw OR 'media':ti,ab,kw OR 'phone*':ti,ab,kw OR 'prompt*':ti,ab,kw OR 'messag*':ti,ab,kw OR 'mobil*':ti,ab,kw OR 'questionnaire*':ti,ab,kw OR 'recall':ti,ab,kw OR 'recruit*':ti,ab,kw OR 'remind*':ti,ab,kw OR 'risk assess*':ti,ab,kw OR 'risk assessment':ti,ab,kw
OR	4.13	'self-refer*':ti,ab,kw OR 'send':ti,ab,kw OR 'sent':ti,ab,kw OR 'strateg*':ti,ab,kw OR 'survey':ti,ab,kw OR 'telephon*':ti,ab,kw OR 'telemed*':ti,ab,kw OR 'telehealth*':ti,ab,kw OR 'training':ti,ab,kw OR 'video*':ti,ab,kw OR 'risk assessment':ti,ab,kw

OVID

Group	Search ID	Search Logic
1	1.1	exp Lung Neoplasms/ or lung cancer.mp or lung tumor.mp
AND		*All Group 2 search terms combined using OR*
2	2.1	exp Mass Screening/
	2.2	exp "Early Detection of Cancer"/ or cancer screening.mp
	2.3	(abnormal follow-up or diagnostic follow-up or abnormal evaluat* or diagnostic evaluat* or surveill*).mp
AND		
3	3.1	(LDCT or low-dose CT or low-dose computed tomography).mp
AND		*All Group 4 search terms combined using OR*
4	4.1	exp Early Intervention, Educational/ or exp Early Medical Intervention/ or intervention.mp. or therapeutic process*.mp or exp Secondary Prevention/ or exp Risk Assessment/
OR	4.2	exp Health Promotion/ or exp Public Health/ or exp Health Behavior/ or Attitude to Health/ or exp Health Behavior or exp Health Knowledge, Attitudes, Practice/
OR	4.3	"diffusion of innovation"/ or health communication/ or information dissemination/ or persuasive communication/
OR	4.4	exp Program Evaluation/ or exp Implementation Science/ or exp Health Plan Implementation/ or "outcome and process assessment, health care"/
OR	4.5	exp "Delivery of Health Care"/
OR	4.6	exp Quality Improvement/ or exp Quality Assurance, Health Care/ or exp "quality of health care"/ or exp guideline adherence/ or exp quality assurance, health care/ or exp quality improvement/ or exp quality indicators, health care/ or exp "utilization review"/
OR	4.7	exp Decision Making/ or exp Decision Making, Shared/
OR	4.8	exp smoking cessation/ or exp smoking reduction/ or exp "tobacco use cessation"/ or exp Smoking Prevention/
OR	4.9	exp "treatment adherence and compliance"/ or exp "patient acceptance of health care"/ or exp patient compliance/ or exp no-show patients/ or exp patient dropouts/ or exp patient participation/ or patient satisfaction/ or patient preference/ or exp treatment refusal/ or exp Motivation/
OR	4.10	exp primary health care/ or exp patient-centered care/ or exp patient navigation/
OR	4.11	decision support techniques/ or clinical decision rules/ or exp medical informatics/ or exp medical informatics applications/ or exp decision making, computer-assisted/ or exp decision support techniques/ or exp decision support systems, clinical/ or exp health information systems/ or exp medical records systems, computerized/ or exp reminder systems/ or exp public health informatics/
OR	4.12	Exp Telemedicine/

PSYCINFO

Group	Search ID	Search Logic
1	1.1	noft("lung cancer" or "lung tumor" or "lung neoplasm")
AND		
2	2.1	noft("cancer screen*" or "mass screen*")
	2.2	noft("early detection of cancer")
	2.3	noft("abnormal follow-up" or "diagnostic follow-up" or "abnormal evaluat*" or "diagnostic evaluat*" or "surveill*")
AND		
3	3.1	noft("LDCT" or "low-dose CT" or "low-dose computed tomography" or "lung cancer screening")
AND		
4	4.1	noft("therapeutic processes" or "interven*")
OR	4.2	noft("health attitudes" or "health behavior" or "health knowledge" or "health promotion" or "health practice")
OR	4.3	noft("persuasive communicat*")
OR	4.4	noft("prevention*" or "public health" or "program evaluation" or "implementation*" or "diffusion*" or "dissemin*")
OR	4.5	noft("health care delivery" or "healthcare delivery" or "delivery of care")
OR	4.6	noft("quality assurance" or "quality improvement")
OR	4.7	noft("decision making" "or "decision-making" or "shared decision making" or "shared decision-making or "decision support")
OR	4.8	noft("cessation" or "tobacco treatment*" or "smoking cessation" or "tobacco use treatment" or "tobacco use cessation")
OR	4.9	noft("accept*" or "adher*" or "apathy" or "attend*" or "attitude*" or "aware*" or "barrier*" or "behav*" or "compli*" or "comply*" or "consent*" or "cooperat*" or "dropout*" or "dropout*" or "drop out*" or "educat*" or "improv*" or "incent*" or "increas*")
OR	4.10	noft("know*" or "motivat*" or "navigat*" or "nonattend*" or "non-attend*" or "nonrespon*" or "non-respon*" or "particip*" or "prefer*" or "prevalen*" or "promot*" or "refus*" or "respon*" or "satisf*" or "takeup*" or "uptake" or "utili*")
OR	4.11	noft("adopt*" or "alert*" or "appointment*" or "assessment*" or "audit*" or "campaign*" or "community" or "counsel*" or "decision aid*" or "digital" or "educat*" or "evaluat*" or "feedback" or "hotline" or "internet" or "invit*" or "letter*")
OR	4.12	noft("mail*" or "media" or "phone*" or "prompt*" or "messag*" or "mobil*" or "questionnaire*" or "recall" or "recruit*" or "remind*" or "risk assess*")
OR	4.13	noft("self-refer*" or "send" or "sent" or "strateg*" or "survey" or "telephon*" or "telemed*" or "telehealth*" or "training" or "video*")

SCOPUS

Group	Search ID	Search Logic
1	1.1	TITLE-ABS-KEY ("Lung cancer*" OR "lung neoplasm*" OR "lung tumor*")
AND		
2	2.1	TITLE-ABS-KEY ("cancer screen*" OR "mass screen*")
	2.2	TITLE-ABS-KEY ("early detection of cancer")
	2.3	TITLE-ABS-KEY ("abnormal follow-up" OR "diagnostic follow-up" OR "abnormal evaluat*" OR "diagnostic evaluat*" OR "surveill*")
AND		
3	3.1	TITLE-ABS-KEY ("LDCT" OR "low-dose CT" OR "low-dose computed tomography")
AND		
4	4.1	TITLE-ABS-KEY ("therapeutic processes" OR "interven*")
OR	4.2	TITLE-ABS-KEY ("health attitudes" OR "health behavior" OR "health knowledge" OR "health promotion" OR "health practice")
OR	4.3	TITLE-ABS-KEY ("persuasive communicat*")
OR	4.4	TITLE-ABS-KEY ("prevention*" OR "public health" OR "program evaluation" OR "implementation*" OR "diffusion*" OR "dissemin*")
OR	4.5	TITLE-ABS-KEY ("health care delivery" OR "healthcare delivery" OR "delivery of care")
OR	4.6	TITLE-ABS-KEY ("quality assurance" OR "quality improvement")

(continued)

OR	4.7	TITLE-ABS-KEY (“decision making” “or “ decision-making “ or “ shared AND decision AND making “ or “ shared AND decision-making OR “decision support”)
OR	4.8	TITLE-ABS-KEY (“cessation” OR “tobacco treatment*” OR “smoking cessation” OR “tobacco use treatment” OR “tobacco use cessation”)
OR	4.9	TITLE-ABS-KEY (“accept*” OR “adher*” OR “apathy” OR “attend*” OR “attitude*” OR “aware*” OR “barrier*” OR “behav*” OR “compli*” OR “comply*” OR “consent*” OR “cooperat*” OR “dropout*” OR “dropout*” OR “drop out*” OR “educat*” OR “improv*” OR “incent*” OR “increas*”)
OR	4.10	TITLE-ABS-KEY (“know*” OR “motivat*” OR “navigat*” OR “nonattend*” OR “non-attend*” OR “nonrespon*” OR “non-respon*” OR “particip*” OR “prefer*” OR “prevalen*” OR “promot*” OR “refus*” OR “respon*” OR “satisf*” OR “takeup*” OR “uptake” OR “utili*”)
OR	4.11	TITLE-ABS-KEY (“adopt*” OR “alert*” OR “appointment*” OR “assessment*” OR “audit*” OR “campaign*” OR “community” OR “counsel*” OR “decision aid*” OR “digital” OR “educat*” OR “evaluat*” OR “feedback” OR “hotline” OR “internet” OR “invit*” OR “letter*”)
OR	4.12	TITLE-ABS-KEY (“mail*” OR “media” OR “phone*” OR “prompt*” OR “messag*” OR “mobil*” OR “questionnaire*” OR “recall” OR “recruit*” OR “remind*” OR “risk assess*”)
OR	4.13	TITLE-ABS-KEY (“self-refer*” OR “send” OR “sent” OR “strateg*” OR “survey” OR “telephon*” OR “telemed*” OR “telehealth*” OR “training” OR “video*”)

Appendix are search terms used in each of the included databases: CINAHL, Cochrane Library, Embase, Ovid Medline, PsycINFO, and Scopus.

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Ethical Considerations

We conducted a systematic review without meta-analyses. As such, our study did not contain private information. Only publicly accessible documents were used, and searches were designed to capture published studies regardless of publication venue, sample size, or the like. The methodological rigor of the included studies was independently assessed and reported using established risk-of-bias tools, and the presentation of results followed standards of quality and rigor in reporting.

Consent to Participate

The study did not use private information.

Consent for Publication

N/A

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Data Availability

All data were obtained from publicly available sources that are referenced in the article’s bibliography. Each study is readily available to any interested party from online and/or library sources.

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