



Review Article

Education messages and strategies to inform the public, potential screening candidates and healthcare providers about lung cancer screening: A systematic review

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ABSTRACT

International lung cancer screening (LCS) trials, using low-dose computed tomography, have demonstrated clinical effectiveness in reducing mortality from lung cancer. This systematic review aims to synthesise the key messages and strategies that could be successful in increasing awareness and knowledge of LCS, and ultimately increase uptake of screening. Studies were identified via relevant database searches up to January 2022. Two authors evaluated eligible studies, extracted and crosschecked data, and assessed quality. Results were synthesised narratively. Of 3205 titles identified, 116 full text articles were reviewed and 22 studies met the inclusion criteria. Twenty studies were conducted in the United States. While the study findings were heterogenous, key messages mentioned across multiple studies were about: provision of information on LCS and the recommendations for LCS ($n = 8$); benefits and harms of LCS ($n = 6$); cost of LCS and insurance coverage for participants ($n = 6$) and eligibility criteria ($n = 5$). To increase knowledge and awareness, evidence from awareness campaigns suggests that presenting information about eligibility and the benefits and harms of screening, may increase screening intention and uptake. Evidence from behavioural studies suggests that campaigns supporting engagement with platforms such as educational videos and digital awareness campaigns might be most effective. Group based learning appears to be most suited to increasing health professionals' knowledge. This systematic review found a lack of consistent evidence to demonstrate which strategies are most effective for increasing participant healthcare professional and community awareness and education about LCS.

1. Introduction

Lung cancer is the number one cause of cancer death worldwide (Ferlay et al., 2019), with the majority of people diagnosed with late-stage, incurable disease. International lung cancer screening (LCS) trials, using low-dose computed tomography, have demonstrated clinical effectiveness in reducing mortality from lung cancer by 20–24% (Aberle

et al., 2011; De Koning et al., 2020). As a result of the evidence gained from the National Lung Screening Trial (NLST) in the United States (US), the US Preventive Screening Task Force recommended the implementation of targeted LCS in December 2013 (Moyer, 2014). This recommendation was updated in March 2021 to reduce the lower age limit to 50 years (from 55 years) and reduce the pack-year smoking history to 20 (from 30 years) (US Preventive Services Task Force, 2021;

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Jonas et al., 2021).

LCS implementation and uptake is in its infancy compared to, for example, breast cancer screening, and continues to evolve. In the US health system recent data from the Lung Cancer Screening Registry has shown uptake rates to increase slightly from 3.3% in 2016 to 5% in 2018 of eligible adults, but that uptake is variable across the US (Fedewa et al., 2021). Low and variable uptake is a major concern for the success of LCS implementation.

Pilot studies from the UK which frame screening as a “lung health check” and use mobile scanners to mitigate access issues, show promising outcomes, with higher uptake in socio-economically deprived communities resulting in 53% uptake in the trial setting (Quaife et al., 2020). The range of uptake proportions seen across studies may be accounted for by the different recruitment methods and denominators, but results from the Lung Screening Uptake Trial (LSUT) suggest that focused strategies with tailored resources for target groups may result in higher engagement in screening (Rankin et al., 2020), so further work is urgently needed.

Screening uptake is fundamental to program success, and therefore, it is vital to understand how to optimise uptake rates for targeted LCS programs and to help policymakers to select strategies that are best suited to the unique socio-cultural context in which they are implemented. An important and fundamental barrier may be a lack of awareness among clinicians and potential participants as screening it is not routinely offered (Qiu et al., 2016; Jenkins et al., 2018; Schiffelbein et al., 2020). Educating the public and health professionals about LCS is a key component to the success of LCS internationally (Tanoue et al., 2015).

This systematic review aimed to synthesise evidence from existing studies to understand key messages and strategies that might be successful in increasing awareness and knowledge of targeted LCS, and ultimately uptake of screening. This knowledge is crucial to inform strategies for successful uptake in countries which are considering implementing LCS programs.

2. Methods

2.1. Review question

“What education messages and strategies are used to inform the public, people at high risk and healthcare providers about lung cancer screening?”

2.2. Protocol and registration

This review was registered as a protocol with PROSPERO (CRD42021234778). The Preferred Reporting Items for Systematic Reviews checklist (Moher et al., 2009) has been used to guide reporting.

2.3. Search strategy

A comprehensive search strategy was developed in consultation with an academic librarian (Appendix A). Databases searched were Medline, EMBASE, PsycINFO and CINAHL, restricted to studies published between 1 January 2000 and 22 January 2022 [date of search]. After the removal of duplicates, two researchers independently screened titles and abstracts manually for inclusion/exclusion criteria (RD, AS) using Covidence systematic review software, which assists in managing systematic reviews (Innovation, n.d.). One author judged all articles with an additional author conducting a compliance check; the authors compared notes before finalising this step. An eligibility checklist was developed prior to search commencement. Those studies included at the title and abstract stage were full text reviewed. Included studies were selected independently by the reviewing researchers, and disagreements were resolved via discussion. Any uncertainty that arose was taken to the research team for further discussion. Once decisions were finalised, a

backward and forward citation search was conducted.

2.4. Inclusion and exclusion criteria

Studies met the inclusion criteria if they included the general population, those at higher risk of lung cancer (aged 55+, people who smoke or with smoking history) or health professionals; examined key messages and strategies influencing awareness of LCS; were quantitative or qualitative peer-reviewed publications including education programs and resources and/or awareness campaigns; and examined awareness of LCS.

Studies were excluded if they included participants diagnosed with lung cancer; examined other cancer screening programs or diagnostic test decision-making; only examined awareness of LCS without any awareness campaign or education resources; or were reviews, editorials, commentaries, research letters, conference abstracts (with no published paper available) or dissertations/theses.

2.5. Quality assessment and data extraction

Full text studies were independently critically appraised by two researchers (RD and AS) using the Joanna Briggs Institute (JBI) critical appraisal tools (The Joanna Briggs Institute, n.d.). Each study was appraised using the specific JBI tool that matched its methodology (qualitative, quasi-experimental, randomized controlled trials (RCTs), cross-sectional) using predetermined quality scores of low (0–59%), medium (60–79%) or high (80–100%) quality.

Final decisions for study inclusion were made in consultation with all authors and a data extraction template developed in Microsoft Excel. Data extraction was performed independently by two researchers (RD, AS) and any discrepancies resolved by discussion with the wider research team. For any included studies which also measured or explored an aspect of LCS decision-making, the data were extracted due to its close link with uptake of screening. Due to the heterogenous nature of the methodologies and outcome measures, a narrative synthesis of the results was performed.

3. Results

The searches retrieved 4584 titles, of which 1379 were duplicates, leaving 3205 titles and abstracts to be screened. A total of 3089 abstracts were excluded, leaving 116 full texts that were reviewed, of which 22 met the inclusion criteria (Fig. 1).

Of the 22 included articles, 20 (90.9%) reported on studies in the US (Schiffelbein et al., 2020; Cardarelli et al., 2017; Retrouvey et al., 2016; Sakoda et al., 2020; Sharma et al., 2018; Simmons et al., 2017; Springer et al., 2018; Strong and Renaud, 2020; Williams et al., 2021; Williams et al., 2020a; Williams et al., 2020b; Hudson et al., 2018; Kassem and Laird, 2019; Monu et al., 2021; Ortmeier et al., 2020; Paige et al., 2020; Raz et al., 2021), one from the UK (Ruparel et al., 2019) and one in The Netherlands/Belgium (Van Den Bergh et al., 2009). Fourteen of the 22 articles (63.6%) included participants who were potential screening candidates (Schiffelbein et al., 2020; Cardarelli et al., 2017; Sakoda et al., 2020; Sharma et al., 2018; Simmons et al., 2017; Strong and Renaud, 2020; Williams et al., 2020a; Williams et al., 2020b; Hudson et al., 2018; Kassem and Laird, 2019; Monu et al., 2021; Paige et al., 2020; Raz et al., 2021; Ruparel et al., 2019; Van Den Bergh et al., 2009), determined as people who met the USPSTF2013 LCS criteria. Of the remaining 8 studies, five were conducted with the general population (Retrouvey et al., 2016; Springer et al., 2018; Williams et al., 2021; Williams et al., 2020a; Jessup et al., 2018) and eight included health professionals (Simmons et al., 2017; Akhtar et al., 2021; Eberth et al., 2020; Hudson et al., 2018; Jessup et al., 2018; Kassem and Laird, 2019; Ortmeier et al., 2020; Ruparel et al., 2019). Four studies included both health professionals and participants who were potential screening candidates (Simmons

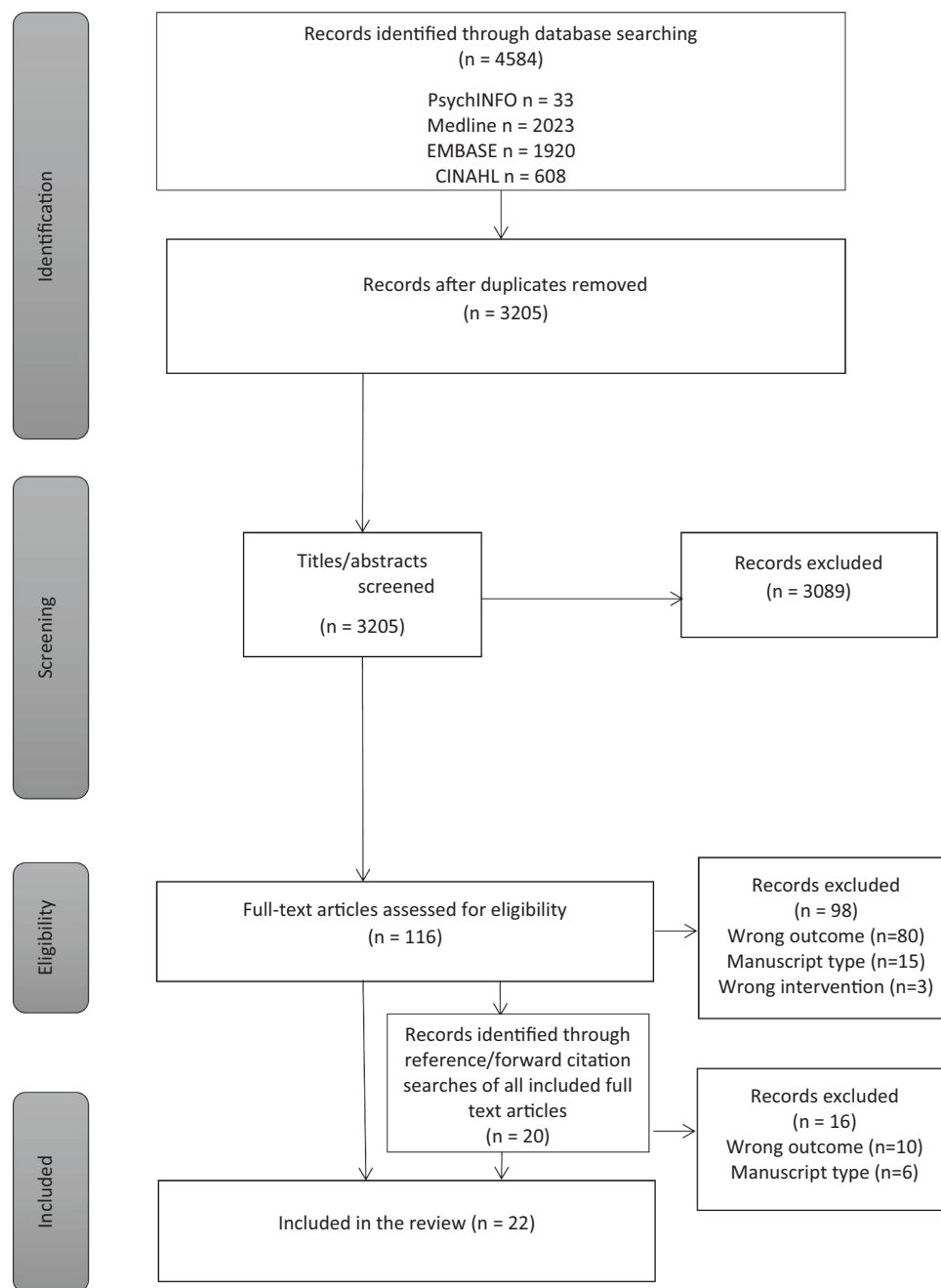


Fig. 1. PRISMA flowchart.

et al., 2017; Hudson et al., 2018; Kassem and Laird, 2019; Ruparel et al., 2019) and one included both health professionals and the general population (Jessup et al., 2018).

3.1. Quality of studies

We report on quality by study type (see Fig. 2) using the JBI Critical Appraisal Tools (Tufanaru et al., 2020), where a checklist of questions is applied for each study, by type. The two randomized studies (Sharma et al., 2018; Raz et al., 2021), were classified as medium quality (Appendix B), mostly due to biases in blinding. Of the ten quasi-experimental studies, classified as such where a study involved a non-randomized intervention or non-randomized mixed methods, one (10%) was high quality (Van Den Bergh et al., 2009), one low quality (10%) (Springer et al., 2018), and eight (80%) were classified medium (Sakoda et al., 2020; Strong and Renaud, 2020; Williams et al., 2021;

Williams et al., 2020a; Akhtar et al., 2021; Jessup et al., 2018; Monu et al., 2021; Ortmeier et al., 2020), mostly due to lack of a control group. Of the four cross-sectional studies, two (50%) were classified as low quality (Retrouvey et al., 2016; Kassem and Laird, 2019) and two (50%) as medium (Williams et al., 2020b; Paige et al., 2020), mostly due to biases in confounding factors and inclusion criteria. Of the six qualitative studies, five (83%) were classified as medium quality (Schiffelbein et al., 2020; Cardarelli et al., 2017; Simmons et al., 2017; Eberth et al., 2020; Hudson et al., 2018), mostly due to unclear philosophical perspectives and theoretical statements and one high quality study (Ruparel et al., 2019).

3.2. Intervention types

The 22 full-text articles reported on LCS awareness campaigns ($n = 11$) (Cardarelli et al., 2017; Retrouvey et al., 2016; Sakoda et al., 2020;

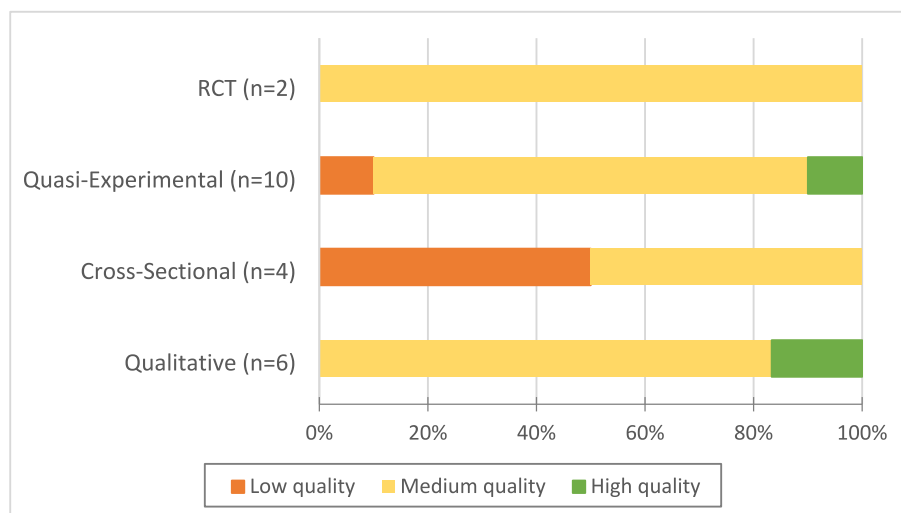


Fig. 2. Quality appraisal.

Springer et al., 2018; Williams et al., 2021; Williams et al., 2020a; Akhtar et al., 2021; Jessup et al., 2018; Kassem and Laird, 2019; Ortmeier et al., 2020; Van Den Bergh et al., 2009), behavioural interventions ($n = 4$) (Sharma et al., 2018; Strong and Renaud, 2020; Monu et al., 2021; Raz et al., 2021) and attitudes, perceptions and knowledge of screening ($n = 7$) (Schiffelbein et al., 2020; Simmons et al., 2017; Williams et al., 2020b; Eberth et al., 2020; Hudson et al., 2018; Paige et al., 2020; Ruparel et al., 2019) (Table 1). Six studies included decision-making in their interventions, measured decisional needs, or reported on decision-making that arose from the study findings (Sakoda et al., 2020; Simmons et al., 2017; Williams et al., 2020b; Raz et al., 2021; Ruparel et al., 2019; Van Den Bergh et al., 2009).

3.3. Awareness campaigns

The awareness campaigns involved nine quantitative studies (Retrouvey et al., 2016; Sakoda et al., 2020; Springer et al., 2018; Williams et al., 2021; Akhtar et al., 2021; Jessup et al., 2018; Kassem and Laird, 2019; Ortmeier et al., 2020; Van Den Bergh et al., 2009), one qualitative (Cardarelli et al., 2017) and one mixed methods (Williams et al., 2020a). Four of the 11 awareness campaigns were targeted at potential screening candidates (Cardarelli et al., 2017; Sakoda et al., 2020; Kassem and Laird, 2019; Van Den Bergh et al., 2009) and five at the general population (Retrouvey et al., 2016; Springer et al., 2018; Williams et al., 2021; Williams et al., 2020a; Jessup et al., 2018). Four campaigns also targeted health professionals (Akhtar et al., 2021; Jessup et al., 2018; Kassem and Laird, 2019; Ortmeier et al., 2020). Of these awareness campaigns, eight were experimental designs (Sakoda et al., 2020; Springer et al., 2018; Williams et al., 2021; Williams et al., 2020a; Akhtar et al., 2021; Jessup et al., 2018; Ortmeier et al., 2020; Van Den Bergh et al., 2009) and three descriptive (Cardarelli et al., 2017; Retrouvey et al., 2016; Kassem and Laird, 2019).

The awareness campaigns involved delivering educational sessions or providing resources for the general population or potential screening candidates about LCS that varied by one time point (Cardarelli et al., 2017; Retrouvey et al., 2016; Sakoda et al., 2020), a four-week campaign (Williams et al., 2021) to a 3-month campaign (Springer et al., 2018). Key outcomes of the awareness campaigns included participant attitudes and beliefs about lung cancer and LCS, messaging about screening, information seeking about LCS, knowledge and awareness of LCS, and ability to identify patients for LCS.

3.3.1. Potential screening candidate campaigns

The content of the awareness campaigns targeted at potential

screening candidates included information about LCS (Cardarelli et al., 2017): eligibility criteria, benefits and harms, and risk assessment (Table 2) (Sakoda et al., 2020). One awareness campaign was conducted in conjunction with the NELSON clinical trial (low-dose computed tomography (LDCT) versus control). The intervention for eligible participants was a 14-page information booklet that included content about the trial aims, background and design as well as LCS and follow-up (Van Den Bergh et al., 2009).

Another awareness campaign was aimed at implementing LDCT in a treatment and wellness center, targeting potential screening candidates and health professionals (Kassem and Laird, 2019). This campaign included strategies such as grand rounds and educational dinners describing screening program benefits, patient benefits, showed NLST data and details about the internal referral process, and educated call centre staff on eligibility and scheduling procedures. In addition, the campaign included LDCT promotion within the community through advertisements in local newspapers and social media during an awareness day for smoking cessation (National Smoke Out Day).

3.3.2. General population campaigns

Some awareness campaigns targeted at the general population included presenting the results from research about the benefits and harms of LCS, such as detecting cancer early or false positives.

Four campaigns that conducted pre-post measures, found that knowledge increased post campaign (Sakoda et al., 2020; Williams et al., 2021; Williams et al., 2020a; Akhtar et al., 2021), with 51% providing at least one additional correct response post campaign (on an 8-item survey) (Sakoda et al., 2020) as well as a statistically significant increase in perceived benefits of screening (Williams et al., 2021). Sakoda et al. (Sakoda et al., 2020) found that 65% of participants ($n = 680$) were willing to undergo LCS following the education class. One measure of total cancer stigma (measured using the Cancer Stigma Scale; 25 items across awkwardness, severity, avoidance, personal responsibility, policy opposition and financial discrimination (Marlow and Wardle, 2014)) was shown to significantly decrease following the campaign [$p < 0.024$], but the difference was small (0.08 standard deviations) (Williams et al., 2020a).

A digital awareness campaign targeting the general population and health professionals measured visits to institutional LCS web pages and the number of scheduled LDCT screening examinations (Jessup et al., 2018). The web page content for the general population included eligibility for LCS, insurance coverage and the benefits of early detection, using Facebook and Google messages. The health professional content included LCS mortality benefit and eligibility criteria, using

Table 1
Characteristics of included studies.

Author (year)	Country	Study aim	Population	# participants	Intervention	Key outcomes	Key strategies
Intervention studies (n = 15)							
Akhtar et al. (2022)	US	To describe the impact of LCS education on FQHC-based providers and MAs, and to assess the program's impact on LCS referral rates and utilization of LDCT.	Health professionals	Total n = 57: Healthcare providers, n = 29; medical assistants (MAs), n = 28	Awareness campaign – Education session Included benefits and harms of LCS (not specified)	Ability to determine eligible patients for LCS and subsequent patient referral for LDCT; knowledge, attitudes and beliefs regarding LCS.	Education was performed 'on site' at practices with vulnerable populations; focused education on MAs as well as providers; considerable time was spent answering providers questions about SDM. Providers must have the correct data, in particular related to cost and insurance coverage. Information available in doctor offices/waiting rooms, during annual exams, internet search engines (e.g., Google and Bing), flyers in grocery stores, television, newspaper, and radio advertisements, direct mail, and various health websites (e.g., WebMD and Mayo Clinic).
Cardarelli et al. (2017)	US	To derive perspectives of screening-eligible individuals from regional eastern Kentucky focus groups, on what might make an effective message about lung cancer screening, and what potential venues for delivering that information might be.	Potential screening candidates	n = 54 (6 focus groups)	Awareness campaign – Education session Included benefits (greater success of treatment, more treatment options at early stage) and harms of LCS (false alarms, overdiagnosis, radiation risks)	Eliciting perspectives about lung cancer, lung cancer screening, and salient and trusted messages about screening.	Highest CTRs resulted from content that referenced signs of lung cancer (17.09%, 335/1960) and the benefits of early detection (10.4%, 22/211). Within the provider-focused digital awareness campaign, LinkedIn surpassed industry standards for CTRs, whereas twitter did not.
Jessup et al. (2018)	US	To determine if a patient- and provider-focused LCS digital awareness campaign was associated with (1) utilization of LDCT and (2) engagement with online educational content on LCS and LDCT.	General population Health professionals	FB 47,450 clicks (2.59%) Google 1108 clicks (5.85%) LinkedIn 630 clicks (1.1%) Twitter 1139 clicks (0.19%)	Awareness campaign – Digital Awareness campaign – Digital	Visits to institutional LCS web pages; number of scheduled LDCT Visits to institutional LCS web pages.	
Kassem & Laird (2019)	US	To implement a LDCT program in a treatment and wellness center.	Potential screening candidates Health professionals	n = 823 (not stated)	Awareness campaign Awareness campaign – Education session	Recruitment and uptake of screening. Referral to screening.	
Monu et al. (2021)	US	To evaluate the effect of advertisement images on the self-reported likelihood of undergoing lung cancer screening.	Potential screening candidates	n = 191 (79% response rate)	Behavioural intervention – Advertisement images	Behaviour; likelihood to screen.	Highest likelihood of screening score seen in images with a high construal and promotion focus. Personalising messages not significant. Use of psychological theory beneficial.
Ortmeyer et al. (2020)	US	To assess the feasibility and effectiveness of implementing an interactive, group-based learning (GBL) curriculum to teach physicians about LCS compared to lecture-based learning (LBL).	Health professionals	n = 709 completed intervention (GBL group, n = 353; LBL group, n = 356); n = 129 completed survey (GBL, n = 69; LBL, n = 60).	Awareness campaign – Education session Included benefits and harms of LCS (not specified)	Post-program knowledge; format acceptance; ease of implementation; effectiveness; feasibility.	GBL may be superior through increased engagement and discussion of LCS evidence.
Raz et al. (2021)	US	To determine the effects of an educational video about LCS on utilization of chest CT and smoking habits.	Potential screening candidates	Total n = 1281; n = 1026 intervention group, n = 146 completed intervention, n = 136 completed	Behavioural intervention – Online educational video	Behaviour; received any chest CT within 6 months.	Very small proportion watched entire video.

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Table 1 (continued)

Author (year)	Country	Study aim	Population	# participants	Intervention	Key outcomes	Key strategies
Retrouvey et al. (2015)	US	To devise an awareness campaign to inform local population about a LCS tool, gauge community members' reactions to new guidelines, and measure community members' propensity to get screened.	General population	survey; $n = 255$ control group. $n = 69$	Awareness campaign – Education from residents to community Included benefits and harms of LCS (not specified)	Awareness; attitudes; barriers; knowledge.	Participants found guidelines confusing without help, especially official guideline statement and defining pack/years. Radiology residents can be utilised as a resource to educate patients.
Sakoda et al. (2019)	US	To conduct an evaluation on the effectiveness of a free group education class on LCS, in increasing patient knowledge and support of shared decision-making.	Potential screening candidates	$n = 680$ (response rate 79%)	Awareness campaign – Education session Included benefits and harms of LCS (not specified)	Knowledge; decision making capacity; interest in LCS; interest in smoking cessation.	Specialists were trained to facilitate the class. Patient education materials as decision aids.
Sharma et al. (2018)	US	To compare two different options to disseminate information about LCS via a Quitline.	Potential screening candidates	Agreed to participate $n = 1000$; present in follow-up $n = 438$; final sample $n = 431$; intervention, group B, $n = 213$; control, group A, $n = 218$.	Behavioural intervention – Information brochures and Quitline coach Included benefits (early detection) and harms of LCS (not specified)	Behaviour; participants seeking LCS information.	
Strong & Renaud (2020)	US	To explore using social media to educate patients about LCS. To assess motivation to discuss LCS with HCPs after viewing an educational program.	Potential screening candidates	$n = 31$	Behavioural intervention – Educational video	Knowledge; behaviour; motivation to discuss LCS with HCP.	Advertising metrics on Facebook used to target specific patient populations.
Springer et al. (2018)	US	To increase awareness of lung cancer screening in a targeted rural population.	General population		Awareness campaign – Community campaign	Awareness; discuss eligibility for LCS with healthcare provider; drive traffic to a LCS-related website for more information.	Google Adwords associated with lung cancer performed better than those associated with smoking, with a higher clickthrough (CTR) rate. Importance of market research for small media distribution.
Van den Bergh et al. (2009)	Netherlands, Belgium	To understand knowledge about lung cancer (screening), what are the attitudes, lung cancer risk perceptions, and the reasons to participate or decline participation in lung cancer screening among (non-) participants in the NELSON trial.	Potential screening candidates	$n = 889$ participants in NELSON, $n = 97$ non-participants in NELSON	Awareness campaign – Information brochure	Knowledge; attitudes; risk perception; informed decision; reasons for participation or decline.	
Williams, L et al. (2019)	US	To change participants' knowledge, attitudes, and beliefs about cancer risk factors and lung cancer.	General population	$n = 481$ baseline, $n = 451$ follow up	Awareness campaign – Education sessions	Knowledge of LCS; knowledge, attitude, and beliefs related to LC; early detection and prevention behaviors.	Trained CHWs are effective in increasing the knowledge of lung cancer screening and in changing general cancer knowledge, attitudes, and beliefs related to lung cancer among racial/ethnic minority and lower SES individuals. It may be unreasonable to expect patients to fully understand the recommendation during

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Table 1 (continued)

Author (year)	Country	Study aim	Population	# participants	Intervention	Key outcomes	Key strategies
Williams, L et al. (2021)	US	To assess post intervention changes in participants' knowledge, attitudes regarding lung cancer stigma, beliefs, self-efficacy and intent to obtain lung cancer screening.	General population	n = 77 baseline, n = 76 post intervention	Awareness campaign Included benefits and harms of LCS (not specified)	Knowledge of LCS.	a single patient encounter.
Observation studies (N = 7)							
Eberth et al. (2020)	US	To explore the perspectives of American College of Radiography (ACR) mammography screening program directors (MPDs) regarding efforts to raise LDCT screening awareness and appropriate referrals by identifying high risk individuals participating in routine mammography.	Health professionals	n = 1277 online survey (completed), n = 18 recorded interviews		Eliciting perspectives on: (1) general attitudes toward the integration of LDCT screening, (2) identifying mammography patients at high risk for lung cancer, (3) counselling about LDCT screening, and (4) strategies to identify high-risk women and increase awareness and knowledge of LDCT screening.	Increasing awareness and education key themes around risk stratification and communication. Most frequently reported strategy that could be implemented was passive advertising in the clinic, followed by the use of risk assessment tools.
Hudson et al. (2018)	US	To elicit feedback on existing promotion or education materials to foster LDCT screening behaviors among HR and PCP audiences as well as two informational videos.	Potential screening candidates	n = 38 (8 focus groups)		Perceptions of patient education materials.	Most participants preferred the risk assessment brochure compared to the one page brochure. Participants liked the checklist, as well as the additional information about risk factors, including second hand smoke, military exposure, asbestos, and arsenic. A few participants would have liked a checklist to determine their level of risk.
			Health professionals	n = 23 (9 focus groups of physicians, nurse practitioners, physician assistants)		Perceptions of patient education materials.	
Paige et al. (2020)	US	To explore how the availability of instrumental and emotional online support is associated with the incidence of patient-provider communication about lung cancer screening.	Potential screening candidates	n = 575		Awareness; perceived availability.	
Ruparel et al. (2019)	UK	To explore knowledge and perceptions around lung cancer and LCS with a focus on harms.	Potential screening candidates Health professionals	n = 35 (7 focus groups) n = 18		Knowledge; attitudes; beliefs; needs. Perceived knowledge; attitudes; beliefs; needs of 'at-risk' populations.	Theme: Appetite for balanced information. HCPs highlighted information overload, need to moderate the amount given.
Schiffelbein et al. (2020)	US	To elucidate the barriers to, facilitators of, and suggested interventions for increasing LCS among a rural screening-eligible population.	Potential screening candidates	n = 23 (completed focus group and survey)	Included benefits (early detection) and harms of LCS (false positives)	Attitudes; barriers; facilitators; interventions.	Suggested interventions: Addressing HCP understanding and recommendation of LCS; conducting community outreach to promote LCS awareness and access.

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Table 1 (continued)

Author (year)	Country	Study aim	Population	# participants	Intervention	Key outcomes	Key strategies
Simmons et al. (2017)	US	To examine knowledge and attitudes about LDCT screening for lung cancer among an ethnically and racially diverse sample.	Potential screening candidates	n = 38 (focus groups, in-person)		Attitudes; beliefs; awareness, future intentions	Share information through word-of-mouth, social media, tv, radio, newspaper, billboards, community bulletin boards (flyers), community venues. Community event proposed such as a fair. Suggest the need to educate PCPs and HR individuals regarding the recent coverage of LDCT screening via CMS and the ACA.
			Health professionals	n = 23 (focus groups, telephone)		Attitudes; knowledge.	After viewing two brief videos that explained the LDCT screening for lung cancer, participants were asked if they were considering getting a LDCT screening. The majority of participants indicated they would get screened if recommended by their doctor. A few participants clarified that they would only proceed if covered by their insurance. Webinar highly acceptable and PCPs reported learning a great deal which would encourage them to offer LCS in future
Williams, R et al. (2020)	US	To describe knowledge and awareness about LDCT, personal values about screening, uncertainty about the test, as well as decisional control and resources among high-risk African American adults. And, to examine the extent to	Potential screening candidates	n = 119		Knowledge about LCS; decisional values; decisional conflict; screening intentions.	educational materials should be made available to PCPs and patients for use in waiting rooms to increase awareness about LDCT screening and to stimulate physician-patient communication and shared decision-making. Efforts are needed to educate PCPs about lung cancer screening guidelines and insurance coverage. Referral tools such as pop-up reminders and electronic forms with a list of pre-identified sites and radiologists certified in LDCT screening would facilitate the referral process.
							Future research should consider the role family and friends could play in helping patients weigh the pros and cons of the options and help work through any uncertainty.

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Table 1 (continued)

Author (year)	Country	Study aim	Population	# participants	Intervention	Key outcomes	Key strategies
		which decisional needs are associated with participant intentions to discuss screening with others and, among those at higher risk, to undergo lung cancer screening.					

Twitter and LinkedIn. Visits to the institutional web pages increased during and after the campaign for both the general population (before: 51.0, during 823.9, after 438.8) and the health professional pages, and there were statistically significant differences between the mean number of weekly LDCT examinations scheduled before (349 scheduled), during (415 scheduled), and after (483 scheduled) implementation of the digital awareness campaign ($P < 0.001$).

3.3.3. Campaigns targeting health professionals

Three awareness campaigns that included health professionals (Akhtar et al., 2021; Kassem and Laird, 2019; Ortmeier et al., 2020) included details about the NLSST and its outcomes, using the evidence to demonstrate risks and benefits (Akhtar et al., 2021), emphasised the importance and value of LDCT screening (Kassem and Laird, 2019), and applying the fundamentals of screening to lung cancer (Ortmeier et al., 2020). One campaign additionally reported including the subsequent USPSTF recommendations and the importance of smoking cessation counselling in their learning objectives (Ortmeier et al., 2020). This campaign with 709 resident and faculty primary-care physicians, compared group-based learning (groups 8–15 presented with clinical vignette, total 3 h) with lecture-based learning (presentation and Q&A, 1 h) and reported outcomes from an evaluation completed by 18% of participants.

While both learning formats were found to be acceptable, the knowledge gain was greater in the group-based learning cohort; group-based learning was favoured overall as being best suited for promoting LCS implementation (Ortmeier et al., 2020). Another campaign also reported content in an educational session about LCS eligibility, smoking cessation, shared-decision making and billing (Akhtar et al., 2021). LCS and smoking cessation brochures were used as additional tools. Although only a small number of health professionals were enrolled in the educational session ($n = 29$), they were more confident identifying patients for LCS, resulting in an increase in LDCT scans ordered (prior = 9; post = 336 across two centres).

3.4. Behavioural interventions

Behavioural interventions ($n = 4$) involved two RCTs (Sharma et al., 2018; Raz et al., 2021) and two quantitative studies (Strong and Renaud, 2020; Monu et al., 2021), all targeted at potential screening candidates. Behavioural interventions included online advertising (Monu et al., 2021), online educational videos (Strong and Renaud, 2020; Raz et al., 2021), and brochures plus a Quitline coach (Sharma et al., 2018). The key outcomes for these interventions were motivation to discuss screening with a healthcare provider, recruitment and uptake.

All four studies conducted between group (Sharma et al., 2018; Monu et al., 2021; Raz et al., 2021) or pre-post analyses (Strong and Renaud, 2020) to evaluate different advertisements or educational videos/programs on LCS. The intervention contents included advertising images only (Monu et al., 2021), an educational video with information about lung cancer and screening (Strong and Renaud, 2020), including eligibility and decision-making assistance (Raz et al., 2021), and in-depth messages delivered by a Quitline coach (Sharma et al., 2018).

3.4.1. Screening uptake

Monu et al. presented LCS advertisements tailored to the viewer personality ($n = 191$), finding that there was no greater likelihood of screening uptake in those who saw a personality-matched advertisement compared with those who saw a non-matched advertisement (Monu et al., 2021).

Raz et al. (2021) conducted an RCT with potential screening candidates who attended smoking cessation services and compared a 30-min educational video with usual care for receipt of any chest CT within 6 months. The authors found that a small proportion of participants randomized to receive the intervention ($n = 146/1026$; 14%) watched the entire video. There was no significant difference in the numbers who went for chest CT or LDCT between the intervention and control groups unless participants had watched the entire video (chest CT: intervention 18.5% vs. control 8.6%, $p = 0.0037$; LDCT: intervention 8.9% vs. 4.3%, $p = 0.062$) (Raz et al., 2021). In an intervention using Quitline (professional telephone advisors providing encouragement, resources and support to help smokers quit) to disseminate information about LCS, there was no significant impact on LDCT uptake (Sharma et al., 2018). Sensitivity analysis however, revealed for both the control and intervention groups, those who recalled receiving the study brochure reported knowing more about LCS, thinking about their risk of LC and being more comfortable with an LCS exam (Sharma et al., 2018).

3.4.2. Motivation to speak to a healthcare professional about LCS

Sharma et al. found Quitline to increase the likelihood that a potential screening candidate reported speaking with a health professional about LCS and their insurance company about the cost of screening, but this was not significant (Sharma et al., 2018). Strong et al. showed a brief educational video hosted on YouTube led to a significant increase in knowledge about LCS (pre: 5.26 vs. post 8.19); and showed participants were not very motivated to discuss LCS with their providers (3.52 out of 5) (Strong and Renaud, 2020).

3.5. Attitudes, knowledge and awareness of LCS

The remaining seven articles aimed to explore attitudes to LCS, knowledge and awareness, perceptions of education materials, decisional needs, and strategies to increase awareness and knowledge of LCS. Six studies included potential screening candidates (qualitative (Simmons et al., 2017; Hudson et al., 2018; Ruparel et al., 2019), mixed methods (Schiffelbein et al., 2020), and cross-sectional studies (Williams et al., 2020b; Paige et al., 2020)) and four qualitative studies also included health professionals (Simmons et al., 2017; Eberth et al., 2020; Hudson et al., 2018; Ruparel et al., 2019).

3.5.1. Health professionals

Eberth et al. found in interviews and focus groups that health professionals view mammography as a teachable moment to increase knowledge and potential demand for LDCT screening (Eberth et al., 2020). Hudson et al. found that referral sheets for LDCT need to include information about initiating screening and how the referring provider will be kept informed about the screening process (Hudson et al., 2018).

Table 2
Summary of included studies (key strategies).

	INTERVENTION (n = 15)	Akhtar 2022	Cardarelli 2017	Jessup 2018	Kassem & Laird 2019	Monu 2021	Ortmeyer 2020	Raz 2021	Retrouvey 2015	Sakoda 2019	Sharma 2018
Information about LCS		x						x			
Promotion/information about LCS and recommendations			x		x		x	x	x		
Benefits and harms		x	x				x		x	x	x
Stigma											
Benefits of early detection				x	x	x					x
Mortality benefit				x							
Lung cancer screening				x				x			x
How to access LDCT resources											
Insurance coverage/cost of LCS		x		x							x
Cancer incidence											
Eligibility criteria		x		x				x		x	
Risk assessment										x	
NELSON trial aims											
Design of trial											
Follow-up											
NLST outcomes					x		x				
Importance of smoking cessation			x				x			x	
Risk factors including smoking		x		x			x				
Cue to action – Talk to a doctor											x
SDM		x						x			

UK health professionals acknowledged that they needed to moderate the information provided to avoid overloading recipients, albeit that potential screening candidates need information about the curative treatment following LCS and that information about harms was unlikely to deter them from screening (Ruparel et al., 2019).

3.5.2. Potential screening candidates

Hudson et al. reported that potential screening candidates ($n = 38$), when viewing two promotional videos about LCS, found it useful to view a lung cancer survivor undergoing the process of LDCT. However, some found it difficult to relate to the survivor in video one and wanted more information about risk factors and symptoms, as well as about the test and the results (Hudson et al., 2018). The second video was favoured, which presented information about LCS as a news story and included a testimonial from a World War II veteran, with potential screening candidates perceiving this as less stigmatising. These participants also viewed print materials, and favoured a risk assessment brochure to a one page brochure discussing risk factors and benefit of early detection, as it was more concise and allowed them to individualise their level of risk with checkboxes (high, intermediate, low) (Hudson et al., 2018).

Simmons et al. showed participants in focus groups with high-risk community members ($n = 38$) two informational videos, explaining LDCT screening for lung cancer (a national news story and a promotional video from a cancer centre) and found after watching the video, that the majority of participants indicated they would get screened if recommended by their doctor (Simmons et al., 2017). Ruparel et al. found potential screening candidates ($n = 35$) demonstrated fatalism, as well as a belief in screening and were more concerned about false negatives than false positives (Ruparel et al., 2019). There was an overarching feeling that they had a right to know and make an informed decision, despite varying information preferences (Ruparel et al., 2019).

In two cross-sectional studies by Williams et al. (2020b) ($n = 119$) and Paige et al. (2020) ($n = 575$) and one mixed methods study by Schiffelbein et al. (2020) ($n = 23$) with potential screening candidates, targeted patient and public education efforts were recommended along with practical information about where and how to access LDCT screening (Schiffelbein et al., 2020). In these studies, pre-existing

awareness and knowledge of LCS was low. Many participants (63%) felt that they didn't have the information they needed to make an informed decision, and decisional conflict was evident regarding screening in Williams et al. study (Williams et al., 2020b). Paige et al. found that the availability of online support was positively associated with clinical conversations about LCS (Paige et al., 2020).

3.6. Studies inclusive of decision-making

Six of the 22 studies included decision-making in their interventions, and measured decisional needs, or reported on decision-making that arose from the study findings. A sub-group of NELSON trial participants ($n = 2500$) were randomized into the Informed Decision-Making Trial by Van Den Bergh et al. (2009). They found when using knowledge items pertaining to LCS (characteristics of LCS, the trial and the test, lung cancer), 51.3% made an informed decision (adequate knowledge, positive attitude toward LCS and actual participation) to participate in the trial (Van Den Bergh et al., 2009).

Raz et al. included decision-making assistance in their online educational video (Raz et al., 2021), and Simmons et al. specifically asked focus groups who would influence their decision-making and what information was needed to make a decision about LCS (Simmons et al., 2017). Williams et al. (2020b) examined associations between decisional needs and intentions to discuss screening and measured decisional conflict, control and values, and found 37% of participants said they had all the information required to make a decision about screening.

In a qualitative study by Ruparel et al., participants recognised that they were entitled to an informed decision (Ruparel et al., 2019), and Sakoda et al., found 70% (of 680 participants) reported having their information needs met to make a screening decision following a free LCS group education class (Sakoda et al., 2020). This was mainly due to insufficient knowledge about LCS, which increased to 72.7% when using all knowledge items, including items about lung cancer, characteristics of LCS, and characteristics of the trial and the test. Discussions of the benefits and harms of LCS was recognised in a further five included studies (Retrouvey et al., 2016; Sakoda et al., 2020; Sharma et al., 2018;

Springer 2018	Strong & Renaud 2020	Van den Bergh 2009	Williams, L 2019	Williams, L 2020	OBSERVATION (n = 7)	Eberth 2020	Hudson 2018	Paige 2020	Ruparel 2019	Schiffelbein 2020	Simmons 2017	Williams, R 2020
	x								x			x
x				x		x				x	x	
				x							x	
		x		x			x					
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Eberth et al., 2020; Ortmeier et al., 2020).

Tables 3 and 4 summarise key components and recommendations from the included studies, demonstrating a wide range of strategies employed to increase awareness and education of LCS.

Table 3
Key messages and findings from included studies.

Delivery method	Content
<i>Potential participants</i>	
Educational sessions	Practical information about access to LCS Benefits of early detection Potential harms of LCS
Social media	Benefits of early detection Eligibility and risk factors Screening costs
Videos, printed materials	Eligibility and risk factors Information about, scan, results and follow up
Focus groups	Screening costs Appetite for information on decision-making Reassurance about interval scanning
<i>Communities</i>	
Educational sessions	Community outreach Linking message to family Survivor testimony
Social media, print media	Direct advertising Linking message to family
Videos, printed materials	Survivor testimony Relatable survivors News videos
Online	Website information Positively associated with LCS clinical advice
<i>Health professionals</i>	
Educational sessions	Community working training
Counselling	Using mammography as a 'teachable moment' to discuss LCS
Printed material	Radiology residents to educate patients
Social media	Eligibility criteria
<i>Other</i>	
Advertising	Psychological theories in advertising design

3.7. Theoretical frameworks

Of the 22 included articles, four (18%) reported use of a theoretical framework; two studies (Williams et al., 2021; Williams et al., 2020a) used the Health Belief Model (HBM) as their guiding conceptual model. One awareness campaign was designed around the HBM, a theoretical behaviour change model using the key constructs: perceived severity, perceived susceptibility, perceived threat, perceived benefits, perceived barriers, cues to action and self-efficacy to LCS and cancer prevention (Williams et al., 2021). One (Williams et al., 2020a) study used the HBM and RE-AIM framework to evaluate implementation processes. One study (Williams et al., 2020b) was guided by the Ottawa Decision Support Framework and one (Cardarelli et al., 2017) used the Communication-Persuasion Matrix framework to guide the development of focus group questions.

4. Discussion

This systematic review collates evidence about the education messages and strategies that have been conducted to increase awareness and education about LCS. It highlights the key awareness campaigns, behavioural interventions and studies that address attitudes, knowledge and awareness of LCS, predominantly based on studies conducted in the US. This is the first review that synthesises awareness and education strategies for LCS and can be used to inform the future development and implementation of LCS programs. We identified a lack of consistent evidence about effective awareness strategies, reflected in the heterogeneous studies included in this review. Key messages mentioned across multiple studies were about the provision of information on LCS and the recommendations for LCS, the benefits and harms of LCS, LCS costs and insurance coverage for participants and eligibility criteria. Despite this heterogeneity, what is evident from systematically reviewing the literature is that the process of screening lung cancer is highly complex, it requires engagement with diverse communities, participants and health professionals to understand their needs and to use tailored strategies to meet their needs. The review findings highlight that there is little consensus about what the core educational components are that should be included in any awareness or education strategy. The findings show a nascent evidence base about how best to support healthcare providers after engaging in educational campaigns to enhance their knowledge or shift attitudes. The review findings suggest that measures to track the impact of education and awareness strategies on screening uptake need

Table 4**Key recommendations.***Need to include*

Education messages:

- Need to increase knowledge of LDCT screening for patients and clinicians (Hudson et al., 2018)
- Information about the signs of lung cancer and benefits of early detection
- Eligibility, costs, harms and benefits
- Materials need to be effective at helping individual comprehend complex risks and benefits to address concerns and preferences
- About low subsequent risk of developing cancer in context of indeterminate pulmonary nodules (Ruparel et al., 2019)

Screening programs need to provide:

- Multilevel coordinator and institutional support
- Online social support – Instrumental (information to support behaviour and address concerns) and emotional (resources to manage affective elements of concern)

Priority groups:

- Tailor to groups e.g., rural: Knowledge, HCP recommendation, motivation to know screening results, transportation

Considerations

For community:

- Advertise directly to the community
- Consider role of friends and family in decision making (Williams et al., 2020b)
- Well-designed group education effective and efficient means to educate and equip patients with sufficient knowledge to facilitate IDM regarding LCS (Sakoda et al., 2020)
- Consider targeted patient and public education to encourage those at highest risk to speak with PCPS and LCS (Schiffelbein et al., 2020)
- Personalising messages was not significant in increasing likelihood of screening (Monu et al., 2021)
- A 30-min video was too long for people to complete watching
- Advertisements grounded in psychological theory can influence health related behaviour (Monu et al., 2021)

For health professionals:

- Need for physician champions and incentives for their recruitment (Kassem and Laird, 2019)
- Need to moderate the amount of information given (Ruparel et al., 2019)
- Information materials not replace support of a HCP (Ruparel et al., 2019)
- Use existing network infrastructures to reach stakeholders (Williams et al., 2020a)

Delivery method

- Quitline (Sharma et al., 2018)
- Health websites (e.g. WebMD, Mayo Clinic) (Cardarelli et al., 2017)
- Digital awareness campaigns (Jessup et al., 2018)
- Information in doctors' offices/waiting rooms during annual exams (Cardarelli et al., 2017)
- Use various media: Internet search engines, (Cardarelli et al., 2017) direct mail, (Cardarelli et al., 2017) TV, newspaper, radio adverts, (Schiffelbein et al., 2020; Cardarelli et al., 2017; Springer et al., 2018) petrol stations, convenience stores, (Cardarelli et al., 2017; Springer et al., 2018) social media (Strong and Renaud, 2020)
- Mix of both group and lecture based formats for physician education (Ortmeyer et al., 2020)
- Radiology residents can be utilised as a resource to educate patients (Retrouvey et al., 2016)

to be developed. Beyond a call for greater research investment in LCS (Australia, 2019; Weber et al., 2019) and harnessing lessons learned from other cancer screening programs, there is an imperative to engage participants, community and health professionals in the design and delivery education and awareness strategies in all jurisdictions where LCS programs are offered.

The review identified a lack of robust studies from which to draw conclusions about what types of educational campaigns work best for potential screening candidates, signalling a need to systematically conduct research on methods to improve participation uptake in LCS programs. The quality appraisal of the studies included in this review showed that the majority were of medium or high quality. The two RCTs

conducted were both assessed as medium quality. and measured different interventions: one an educational video and the other giving information via a brochure and a Quitline coach. Neither RCT found significant differences between the intervention and the control group, suggesting the need for the intervention to be tailored. One RCT was limited in its conclusions due to the small number of randomized patients that engaged with the intervention ($n = 146/1026$) (Raz et al., 2021) and the authors suggested that face-to-face interventions may be more effective to engage individuals than a video. Although both RCTs were underpowered to detect differences between the two groups, it does appear that engagement in and knowledge of screening is improved for those participants who viewed a video or brochure. These approaches may be acceptable to participants, but the feasibility of strategies need to be further investigated. Future high-quality RCTs would benefit from pilot testing of their respective interventions to measure feasibility and acceptability and require a large enough sample for any significant differences in awareness and knowledge to be detected.

Studies that conducted awareness campaigns generally found that there was an increase in knowledge, perceived benefits and self-efficacy, and a reduction in perceived barriers to LCS, severity of lung cancer and cancer stigma. Behavioural interventions mainly yielded non-significant outcomes of screening uptake, although digital awareness campaigns were shown to be successful at increasing knowledge and screening uptake (Jessup et al., 2018). However, caution is warranted regarding these findings, as none of the interventions were rigorously tested. Research published subsequent to the review shows that targeted strategies to encourage screening must consider not only behavioural motivation to screen, but also those strategies that address the opportunity to engage (e.g., convenient location of screening) and capability (e.g., increased self-efficacy through awareness campaigns) (Dunlop et al., 2022). Given the widespread use of social media and proliferation of online health content, digital awareness campaigns may be a feasible and wide-reaching option to raise awareness and education about LCS. This lack of evidence creates an opportunity for further investigation, particularly incorporating digital media, with perhaps the need to engage with digital communication and marketing specialists to enhance campaign potential.

Eight studies focused on increasing awareness and education of health professionals about LCS, which is paramount to program uptake (Qiu et al., 2016). Studies that focused on health professionals found that interactive group based learning, based around a clinical vignette, was more successful for increasing knowledge (Ortmeyer et al., 2020). Health professionals clearly need education about the whole process of screening, from generating awareness, engaging in shared decision making, the first screening appointment and encouraging return for follow up scans or incidental findings (Hudson et al., 2018). The role of digital awareness campaigns led to increased visits to online educational content for health professionals, leading to an increase in screening uptake by potential screening candidates (Jessup et al., 2018). The importance of clinical champions to educate their colleagues was identified in one study, indicating an opportunity to further investigate the role of champions, their potential reach and potential impact (Kassem and Laird, 2019).

The importance of broadly educating the general public is emphasised across five studies focused on increasing awareness and education in the population, not just those identified as potential high-risk screening candidates. It was clear across the narrative synthesis that education about LCS for the general community should emphasis screening as a process, rather than focusing solely on the LDCT test, and that adherence to follow up is needed to maximise mortality benefits (Han et al., 2017; Sakoda et al., 2021). This involves the need for

awareness and education in the general population to maximise LCS success and benefits, as acknowledged in a recent editorial (Melzer and Triplette, 2022).

Explaining the benefits and harms of screening in education strategies to facilitate shared decision-making and informed choice is crucial. Shared decision-making is mandated for government insurance in the US to provide reimbursement for screening (Moyer, 2014). Some studies included in this review did present the benefits and harms (e.g. over-diagnosis, radiation exposure) of LCS in campaigns, interventions and resources. True shared decision-making is difficult to achieve with elucidation of all the consequences of each proposed option, largely due to the uncertainty that harms pose to individuals (Han, 2013). A recent scoping review of decision support tools found, on average, more harms than benefits were described across all included studies, with radiation exposure, false positives and harms from follow up procedures the most frequent (Jallow et al., 2022). Importantly, only two of the 22 decision support tools were designed for those with low health literacy (Jallow et al., 2022). Decision aids need to be prepared prior to the implementation of a LCS program to ensure equitable decision-making is achieved from the start of a program, with a balance of benefits and harms. Three studies in this review involved end users in development of the campaigns to varying degrees (Cardarelli et al., 2017; Raz et al., 2021; Ruparel et al., 2019). Future research should involve the development of interventions that are co-designed with end-users and which are then tested across different populations eligible for LCS with more qualitative work and cognitive testing, prior to implementation trials to measure effectiveness and implementation strategies to increase knowledge, awareness, and uptake of screening. Co-design enables the perspectives of the target community to be considered from the beginning, usually through workshops; resources for a co-design process are available (A. for C, 2019). The review findings highlight a need to research implementation strategies that are equitable in ensuring the benefits of LCS are realised across all high-risk groups (Patricia Rivera et al., 2020), with only a few studies included in this review focusing on the groups known to be at highest risk of lung cancer.

4.1. Strengths and limitations

The strengths of this review include a comprehensive search strategy across multiple international databases, as well as independent reviews by two researchers to minimise potential biases. As the studies were heterogenous, it was not possible to conduct a meta-analysis and therefore the results have been synthesised narratively. Measuring the quality of the educational information in the strategies used was out of the scope of this review. However, there is a wide range in the quality of information about LCS in educational materials (Jallow et al., 2022), websites (Dodd et al., 2022) and decision aids.

5. Conclusion

This systematic review shows that there is a lack of consistent evidence to demonstrate which strategies are most effective for increasing community and health professional's awareness and education about LCS. Some key messages were repeated across studies, and these were

about LCS information and recommendations, benefits and harm, costs to participants and who is eligible for LCS. To increase knowledge and awareness, evidence from awareness campaigns suggests that presenting information about eligibility, and the benefits and harms of LCS may increase screening intention and uptake. Evidence from behavioural studies suggests that campaigns supporting engagement such as educational videos and digital awareness campaigns might be most effective. Group based learning appears to be best suited for increasing health professionals' knowledge and educating them about the benefits and harms of LCS, identifying potential screening candidates, and in conducting SDM would provide them with skills to support offering LCS. Future awareness and education campaigns should address use of quality evaluation measures and assess the underlying quality of message content. Drawing on these international examples is highly informative for other countries to develop locally appropriate messaging and strategies for testing.

Author contributions

RD and NR conceived the study. RD and AS screened title and abstracts. RD and AS completed the full text review and data extraction. RD completed the data synthesis with support from AS and NR. RD and AS conducted the quality assessment. RD wrote the manuscript with input from AS, NR, DM, CD, RdL, HS, ES.

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Role of the funders

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the manuscript. The corresponding authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Disclosures

HM is an investigator on the ILST and ALST. ES is an investigator on the ILST.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

HM is an investigator on the ILST and ALST. ES is an investigator on the ILST.

Data availability

No data was used for the research described in the article.

Appendix A. Database search terms

	MEDLINE	EMBASE	PSYCINFO
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CINAHL	
28	TI (program* N3 (implement* or disseminat* or evaluat* or organi?Ation* or administration*)) OR AB (program* N3 (implement* or disseminat* or evaluat* or organi?Ation* or administration*))
29	TI ("feasibility stud*" or "pilot project*" or "practice guideline*" or education) OR AB ("feasibility stud*" or "pilot project*" or "practice guideline*" or education)
30	TI ((health or patient) N3 (educat* or teach* or learn* or literate or literacy or awareness or Engage* or motivat*)) OR AB ((health or patient) N3 (educat* or teach* or learn* or literate or literacy or awareness or engage* or motivat*))
31	TI (health N3 (promot* or program* or campaign* or adverti* or communicat)) OR AB (Health N3 (promot* or program* or campaign* or adverti* or communicat))
32	(MM "decision making, shared") OR (MM "decision making, patient+") OR (MH "decision making+") OR (MH "decision support techniques+") OR (MH "decision making, clinical+")
33	(MH "decision support systems, clinical")
34	"Choice behaviour"
35	TI ("shared decision*" or "sharing decision*" or "informed decision*" or "informed choice*" or "decision aid*") OR AB ("shared decision*" or "sharing decision*" or "informed decision*" or "informed choice*" or "decision aid*")
36	TI ("decision making" or "decision support*" or "choice behavio?r*") OR AB ("decision making" or "decision support*" or "choice behavio?r*")
37	"Patient participation"
38	TI (patient* N3 (involv* or participat*)) OR AB (patient* N3 (involv* or participat*))
39	(MH "patient selection")
40	(recruit* or select* or invit* or enrol*) OR (recruit* or select* or invit* or enrol*)
41	S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37 OR S38 OR S39 OR S40
42	S18 AND S41

Appendix B. Critical appraisal

Study	OVERALL Risk of Bias
RCT (n=2)	
Raz et al., 2021	Medium
Sharma et al., 2018	Medium
Quasi-Experimental (n=9)	
Jessup et al., 2018	Medium
Monu et al., 2021	Medium
Ortmeyer et al., 2020	Medium
Sakoda et al., 2019	Medium
Springer et al., 2018	High
Van den Bergh et al., 2009	Low
Williams, L et al., 2019	Medium
Strong & Renaud, 2020	Medium
Cross-Sectional (n=4)	
Kassem & Laird, 2019	High
Paige et al., 2020	Medium
Retrouvey et al., 2015	High
Williams, R et al., 2020	Medium
Qualitative (n=6)	
Cardarelli et al., 2017	Medium
Eberth et al., 2020	Medium
Hudson et al., 2018	Medium
Ruparel et al., 2019	Low
Schiffelbein et al., 2020	Medium
Simmons et al., 2017	Medium

RCT (n=2)

Study	1. Was true randomization used for assignment of participants to treatment groups?	2. Was allocation to treatment groups concealed?	3. Were treatment groups similar at the baseline?	4. Were participants blind to treatment assignment?	5. Were those delivering treatment blind to treatment assignment?	6. Were outcomes assessors blind to treatment assignment?	7. Were treatment groups treated identically other than the intervention of interest?	8. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	9. Were participants analyzed in the groups to which they were randomized?	10. Were outcomes measured in the same way for treatment groups?	11. Were outcomes measured in a reliable way?	12. Was appropriate statistical analysis used?	13. Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	OVERALL
Raz et al., 2021	Green	Orange	Green	Yellow	Yellow	Orange	Green	Yellow	Green	Green	Green	Green	Green	Yellow
Sharma et al., 2018	Green	Orange	Green	Green	Orange	Orange	Green	Green	Green	Green	Green	Green	Green	Yellow

QUASI-EXPERIMENTAL (n=9)

Study	1. Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?	2. Were the participants included in any comparisons similar?	3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	4. Was there a control group?	5. Were there multiple measurements of the outcome both pre and post the intervention/exposure?	6. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	7. Were the outcomes of participants included in any comparisons measured in the same way?	8. Were outcomes measured in a reliable way?	9. Was appropriate statistical analysis used?	OVERALL
Jessup et al., 2018	Green	Yellow	Yellow	Orange	Green	Yellow	Yellow	Green	Green	Yellow
Monu et al., 2021	Green	Green	Orange	Orange	Green	Yellow	Green	Green	Green	Yellow
Ortmeyer et al., 2020	Green	Green	Yellow	Orange	Green	Yellow	Green	Green	Green	Yellow
Sakoda et al., 2019	Green	Green	Orange	Orange	Green	Yellow	Green	Green	Green	Yellow
Springer et al., 2018	Green	Yellow	Yellow	Orange	Green	Yellow	Yellow	Green	Orange	Orange
Van den Bergh et al., 2009	Green	Green	Orange	Green	Green	Yellow	Green	Green	Green	Green
Williams, L et al., 2019	Green	Green	Orange	Orange	Green	Yellow	Green	Green	Green	Yellow
Strong & Renaud, 2020	Green	Green	Orange	Orange	Green	Yellow	Green	Green	Green	Yellow

. (continued).

CROSS-SECTIONAL (n=4)

Study	1. Were the criteria for inclusion in the sample clearly defined?	2. Were the study subjects and the setting described in detail?	3. Was the exposure measured in a valid and reliable way?	4. Were objective, standard criteria used for measurement of the condition?	5. Were confounding factors identified?	6. Were strategies to deal with confounding factors stated?	7. Were the outcomes measured in a valid and reliable way?	8. Was appropriate statistical analysis used?	OVERALL
Kassem & Laird, 2019	Green	Orange	Green	Green	Orange	Orange	Green	Yellow	Orange
Paige et al., 2020	Orange	Green	Green	Green	Orange	Orange	Green	Green	Yellow
Retrouvey et al., 2015	Orange	Orange	Orange	Orange	Orange	Orange	Green	Yellow	Orange
Williams, R et al., 2020	Green	Green	Orange	Green	Orange	Orange	Green	Green	Yellow

QUALITATIVE (n=6)

Study	1. Is there congruity between the stated philosophical perspective and the research methodology?	2. Is there congruity between the research methodology and the research question or objectives?	3. Is there congruity between the research methodology and the methods used to collect data?	4. Is there congruity between the research methodology and the representation and analysis of data?	5. Is there congruity between the research methodology and the interpretation of results?	6. Is there a statement locating the researcher culturally or theoretically?	7. Is the influence of the researcher on the research, and vice-versa, addressed?	8. Are participants, and their voices, adequately represented?	9. Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?	10. Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?	OVERALL
Cardarelli et al., 2017	Orange	Green	Green	Green	Green	Orange	Orange	Green	Green	Green	Yellow
Eberth et al., 2020	Green	Green	Green	Green	Green	Orange	Orange	Green	Orange	Green	Yellow
Hudson et al., 2018	Orange	Green	Green	Green	Green	Orange	Orange	Green	Green	Green	Yellow
Ruparel et al., 2019	Orange	Green	Green	Green	Green	Orange	Orange	Green	Green	Green	Yellow
Schiffelbein et al., 2020	Orange	Green	Green	Green	Green	Orange	Orange	Green	Green	Green	Yellow
Simmons et al., 2017	Orange	Green	Green	Green	Green	Orange	Orange	Green	Green	Green	Yellow

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References

A. for C, 2019. Innovation, A Guide to Build Co-Design Capability.

Aberle, D., Adams, A., Berg, C., Black, W., Clapp, J., Fagerstrom, R., Gareen, I.F., Gatsonis, C., Marcus, P.M., Sicks, J.D., National Lung Screening Trial Research Team, 2011. Reduced lung-cancer mortality with low-dose computed tomographic screening. *N. Engl. J. Med.* 365, 395–409.

Akhtar, A., E.S. MSW, Castro, S., Sur, M., Lozano, V., D’Souza, G., Yeung, S., Macalintal, J., Patel, M., Zou, X., Wu, P., Silver, E., Sandoval, J., Gray, S.W., Reckamp, K.L., Kim, J.Y., Sun, V., Raz, D.J., Erhunmwunse, L., 2021. A lung cancer screening education program impacts both referral rates and provider and medical assistant knowledge at two federally qualified health centers. *Clin. Lung Cancer* 1–8. <https://doi.org/10.1016/j.clcc.2021.12.002>.

Australia, L.F., 2019. Making Lung Cancer a Fair Fight: A Blueprint for Reform, Milton, QLD. <https://lungfoundation.com.au/wp-content/uploads/2018/10/Information-Paper-Making-Lung-Cancer-A-Fair-Fight-A-Blueprint-for-Reform-Oct2018.pdf>.

Cardarelli, R., Roper, K.L., Cardarelli, K., Felmer, F.J., Prater, S., Ledford, K.M., Justice, B., Reese, D.R., Wagner, P., Cantrell, C., 2017. Identifying community perspectives for a lung cancer screening awareness campaign in Appalachia Kentucky: the Terminate Lung Cancer (TLC) study. *J. Cancer Educ.* 32, 125–134. <https://doi.org/10.1007/s13187-015-0914-0>.

De Koning, H.J., Van Der Aalst, C.M., De Jong, P.A., Scholten, E.T., Nackaerts, K., Heuvelmans, M.A., Lammers, J.W.J., Weenink, C., Yousaf-Khan, U., Horeweg, N., Van’T Westeinde, S., Prokop, M., Mali, W.P., Mohamed Hoesein, F.A.A., Van Ooijen, P.M.A., Aerts, J.G.J.V., Den Bakker, M.A., Thunnissen, E., Verschakelen, J., Vliegenthart, R., Walter, J.E., Ten Haaf, K., Groen, H.J.M., Oudkerk, M., 2020. Reduced lung-cancer mortality with volume CT screening in a randomized trial. *N. Engl. J. Med.* 382, 503–513. <https://doi.org/10.1056/NEJMoa1911793>.

Dodd, R., Zhang, C., Sharman, A., Carlton, J., Tang, R., Rankin, N., 2022. Assessing information available for health professionals and potential participants on lung cancer screening program websites: cross-sectional study. *JMIR Cancer*. 8, e34264 <https://doi.org/10.2196/34264>.

Dunlop, K.L.A., Marshall, H.M., Stone, E., Sharman, A.R., Dodd, R.H., Rhee, J.J., McCullough, S., Rankin, N.M., 2022. Motivation is not enough: a qualitative study of lung cancer screening uptake in Australia to inform future implementation. *PLoS One* 17, e0275361. <https://doi.org/10.1371/journal.pone.0275361>.

Eberth, J.M., Ersek, J.L., Terry, L.M., Bills, S.E., Chintanipattu, N., Carlos, R., Hughes, D. R., Studts, J.L., 2020. Leveraging the mammography setting to raise awareness and facilitate referral to lung cancer screening: a qualitative analysis. *J. Am. Coll. Radiol.* 17, 960–969. <https://doi.org/10.1016/j.jacr.2020.02.001>.

Fedewa, S.A., Kazerooni, E.A., Studts, J.L., Smith, R.A., Bandi, P., Sauer, A.G., Cotter, M., Sineshaw, H.M., Jemal, A., Silvestri, G.A., 2021. State variation in low-dose computed tomography scanning for lung cancer screening in the United States. *J. Natl. Cancer Inst.* 113, 1044–1052. <https://doi.org/10.1093/jnci/djaa170>.

Ferlay, J., Colombet, M., Soerjomataram, I., Mathers, C., Parkin, D.M., Piñeros, M., Znaor, A., Bray, F., 2019. Estimating the global cancer incidence and mortality in 2018: GLOBOCAN sources and methods. *Int. J. Cancer* 144.

Han, P., 2013. Conceptual, methodological, and ethical problems in communicating uncertainty in clinical evidence. *Med. Care Res. Rev.* 70, 14S–36S.

Han, S., Erdogan, S., Toumazis, I., Leung, A., Plevritis, S., 2017. Evaluating the impact of varied compliance to lung cancer screening recommendations using a microsimulation model. *Cancer Causes Control* 28, 947–958.

- Hudson, J.N., Quinn, G.P., Wilson, L.E., Simmons, V.N., 2018. Evaluation of promotional materials to promote low-dose computed tomography (LDCT) screening to high-risk consumers and health care providers. *J. Cancer Educ.* 33, 1043–1051. <https://doi.org/10.1007/s13187-017-1204-9>.
- V.H. Innovation, Covidence Systematic Review Software, Melbourne, Aust. (n.d.). www.covidence.org.
- Jallow, M., Bonfield, S., Kurtidu, C., Baldwin, D., Black, G., Brain, K., Donnelly, M., Janes, S., McCutchan, G., Robb, K., Ruparel, M., Van Os, S., Quaife, S., 2022. Decision support tools for low dose computed tomography (LDCT) lung cancer screening: a scoping review of information content, format, and presentation methods. *Chest* 162 (4), 930–941. <https://doi.org/10.1016/j.chest.2021.12.638>.
- Jenkins, W., Matthews, A., Bailey, A., Zahnd, W., Watson, K., Mueller-Luckey, G., Molina, Y., Crumly, D., Patera, J., 2018. Rural areas are disproportionately impacted by smoking and lung cancer. *Prev. Med. Reports* 10, 200–203.
- Jessup, D.L., Glover, M., Daye, D., Banzi, L., Jones, P., Choy, G., Shepard, J.A.O., Flores, E.J., 2018. Implementation of digital awareness strategies to engage patients and providers in a lung cancer screening program: retrospective study. *J. Med. Internet Res.* 20, 1–9. <https://doi.org/10.2196/jmir.8932>.
- Jonas, D.E., Reuland, D.S., Reddy, S.M., Nagle, M., Clark, S.D., Weber, R.P., Enyioha, C., Malo, T.L., Brenner, A.T., Armstrong, C., Coker-Schwimmer, M., Middleton, J.C., Voisin, C., Harris, R.P., 2021. Screening for lung cancer with low-dose computed tomography: updated evidence report and systematic review for the US Preventive Services Task Force. *JAMA - J. Am. Med. Assoc.* 325, 971–987. <https://doi.org/10.1001/jama.2021.0377>.
- Kassem, D., Laird, C., 2019. Developing a successful LDCT program in a comprehensive community cancer center. *Oncol. Issues* 34, 60–67. <https://doi.org/10.1080/10463356.2018.1553421>.
- Marlow, L., Wardle, J., 2014. Development of a scale to assess cancer stigma in the non-patient population. *BMC Cancer* 14, 285. <https://doi.org/10.1186/1471-2407-14-285>.
- Melzer, A., Triplette, M., 2022. Screening high risk populations for lung cancer: early evidence of a stage shift suggests real world benefits. *BMJ* 376, o666 <https://doi.org/10.1136/bmj.o666>.
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med.* 6, e1000097 <https://doi.org/10.1371/journal.pmed.1000097>.
- Monu, J.I., Achar, C., Wood, D.E., Flum, D.R., Agrawal, N., Farjah, F., 2021. Psychological traits and the persuasiveness of lung cancer screening health messages. *Ann. Thorac. Surg.* <https://doi.org/10.1016/j.athoracsur.2021.04.047>.
- Moyer, V., 2014. Screening for lung cancer: U.S. Preventive Services Task Force recommendation statement. *Ann. Intern. Med.* 160, 330–338.
- Ortmeyer, K., Ma, G.X., Kaiser, L.R., Erkmén, C., 2020. Effective educational approaches to training physicians about lung cancer screening. *J. Cancer Educ.* <https://doi.org/10.1007/s13187-020-01784-4>.
- Paige, S.R., Salloum, R.G., Krieger, J.L., Williams, M., Xue, W., Brumback, B., 2020. Promoting clinical conversations about lung cancer screening: exploring the role of perceived online social support. *J. Health Commun.* 25, 650–659. <https://doi.org/10.1080/10810730.2020.1836087>.
- Patricia Rivera, M., Aldrich, M.C., Henderson, L.M., Cardarelli, R., Carter-Harris, L., Crothers, K., Fathi, J.T., Ford, M.E., Katki, H.A., Sakoda, L.C., Smith, R., Tanner, N. T., Triplette, M., Wiener, R.S., Winn, R.A., Wisnivesky, J.P., Harmon, J., Lawrence, K., 2020. Addressing disparities in lung cancer screening eligibility and healthcare access: an official American thoracic society statement. *Am. J. Respir. Crit. Care Med.* 202, E95–E112. <https://doi.org/10.1164/rccm.202008-3053ST>.
- Qiu, R., Copeland, A., Sercy, E., Porter, N., McDonnell, K., Eberth, J., 2016. Planning and implementation of low-dose computed tomography lung cancer screening programs in the United States. *Clin. J. Oncol. Nurs.* 20, 52–58.
- Quaife, S.L., Ruparel, M., Dickson, J.L., Beeken, R.J., McEwen, A., Baldwin, D.R., Bhowmik, A., Navani, N., Sennett, K., Duffy, S.W., Wardle, J., Waller, J., Janes, S.M., 2020. Lung screen uptake trial (LSUT): randomized controlled clinical trial testing targeted invitation materials. *Am. J. Respir. Crit. Care Med.* 201, 965–975. <https://doi.org/10.1164/rccm.201905-0946OC>.
- Rankin, N.M., McWilliams, A., Marshall, H.M., 2020. Lung cancer screening implementation: complexities and priorities. *Respirology* 25, 5–23. <https://doi.org/10.1111/resp.13963>.
- Raz, D.J., Ismail, M.H., Haupt, E.C., Sun, V., Park, S., Alem, A.C., Gould, M.K., 2021. Improving utilization of lung cancer screening through incorporating a video-based educational tool into smoking cessation counseling. *Clin. Lung Cancer* 22, 83–91. <https://doi.org/10.1016/j.clcc.2020.12.003>.
- Retrouvey, M., Patel, Z., Shaves, S., 2016. US Preventive Services Task Force CT lung cancer screening recommendations: community awareness and perceptions. *J. Am. Coll. Radiol.* 13, R35–R37. <https://doi.org/10.1016/j.jacr.2015.12.011>.
- Ruparel, M., Quaife, S., Baldwin, D., Waller, J., Janes, S., 2019. Defining the information needs of lung cancer screening participants: a qualitative study. *BMJ Open Respir. Res.* 6, 1–10. <https://doi.org/10.1136/bmjresp-2019-000448>.
- Sakoda, L.C., Meyer, M.A., Chawla, N., Sanchez, M.A., Blatchins, M.A., Nayak, S., San, K., Zin, G.K., Minowada, G., 2020. Effectiveness of a patient education class to enhance knowledge about lung cancer screening: a quality improvement evaluation. *J. Cancer Educ.* 35, 897–904. <https://doi.org/10.1007/s13187-019-01540-3>.
- Sakoda, L.C., Henderson, L.M., Rivera, M.P., 2021. Adherence to lung cancer screening: what exactly are we talking about? *Ann. Am. Thorac. Soc.* 18, 1951–1952. <https://doi.org/10.1513/annalsats.202106-724vp>.
- Schiffelbein, J.E., Carluzzo, K.L., Hasson, R.M., Alford-Teaster, J.A., Imset, I., Onega, T., 2020. Barriers, facilitators, and suggested interventions for lung cancer screening among a rural screening-eligible population. *J. Prim. Care Community Heal.* 11, 1–9. <https://doi.org/10.1177/2150132720930544>.
- Sharma, A., Bansal-Travers, M., Celestino, P., Fine, J., Reid, M.E., Hyland, A., O'Connor, R., 2018. Using a smoking cessation quitline to promote lung cancer screening. *Am. J. Health Behav.* 42, 85–100. <https://doi.org/10.5993/AJHB.42.6.9>.
- Simmons, V.N., Gray, J.E., Schabath, M.B., Wilson, L.E., Quinn, G.P., 2017. High-risk community and primary care providers knowledge about and barriers to low-dose computed tomography lung cancer screening. *Lung Cancer* 106, 42–49. <https://doi.org/10.1016/j.lungcan.2017.01.012>.
- Springer, S.M., McFall, A., Hager, P., Percy-Laury, A., Vinson, C.A., 2018. Lung cancer screening: an emerging cancer control issue presents opportunities for an awareness campaign in rural Michigan. *Cancer Causes Control* 29, 1257–1263. <https://doi.org/10.1007/s10552-018-1080-6>.
- Strong, A., Renaud, M., 2020. Using social media as a platform for increasing knowledge of lung cancer screening in high-risk patients. *J. Adv. Pract. Oncol.* 11, 453–459. <https://doi.org/10.6004/jadpro.2020.11.5.2>.
- Tanoue, L.T., Tanner, N.T., Gould, M.K., Silvestri, G.A., 2015. Lung cancer screening. *Am. J. Respir. Crit. Care Med.* 191, 19–33. <https://doi.org/10.1164/rccm.201410-1777CI>.
- The Joanna Briggs Institute. Critical Appraisal Tools., (n.d.). <https://joannabriggs.org/critical-appraisal-tools>.
- Tufanaru, C., Munn, Z., Aromataris, E., Campbell, J., Hopp, L., 2020. Chapter 3: Systematic reviews of effectiveness. In: *JBI Manual*.
- US Preventive Services Task Force, 2021. Screening for lung cancer US Preventive Services Task Force recommendation statement. *JAMA* 325, 962–970. <https://doi.org/10.1001/jama.2021.1117>.
- Van Den Bergh, K.A.M., Essink-Bot, M.L., Van Klaveren, R.J., De Koning, H.J., 2009. Informed participation in a randomised controlled trial of computed tomography screening for lung cancer. *Eur. Respir. J.* 34, 711–720. <https://doi.org/10.1183/09031936.00098908>.
- Weber, M.F., Marshall, H.M., Rankin, N., Duffy, S., Fong, K.M., Dunlop, K., Humphreys, L., Smit, A.K., Cust, A.E., Taylor, N., Mitchell, G., Kang, Y.J., Tucker, K., Jenkins, M., Macrae, F., Lockart, I., Danta, M., Armstrong, B.K., Howe, M., 2019. Cancer screening in Australia: future directions in melanoma, Lynch syndrome, and liver, lung and prostate cancers. *Public Heal. Res. Pract.* 29, 1–9. <https://doi.org/10.17061/phrp2921910>.
- Williams, L.B., Shelton, B.J., Gomez, M.L., Al-Mrayat, Y.D., Studts, J.L., 2020a. Using implementation science to disseminate a lung cancer screening education intervention through community health workers. *J. Community Health* 46, 165–173. <https://doi.org/10.1007/s10900-020-00864-2>.
- Williams, R.M., Beck, K.H., Butler, J., Lee, S., Wang, M.Q., Taylor, K.L., Knott, C.L., 2020b. Lung cancer screening decisional needs among African American smokers of lower socioeconomic status. *Ethn. Health* 1–19. <https://doi.org/10.1080/13557858.2020.1771681>.
- Williams, L.B., Looney, S.W., Joshua, T., McCall, A., Tingen, M.S., 2021. Promoting community awareness of lung cancer screening among disparate populations: results of the cancer-community awareness access research and education project. *Cancer Nurs.* 44, 89–97. <https://doi.org/10.1097/NCC.0000000000000748>.