

Promoting lung cancer awareness, help-seeking and early detection: a systematic review of interventions

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Summary

Lung cancer (LC) is the leading cause of cancer death. Barriers to the early presentation for LC include lack of symptom awareness, symptom misappraisal, poor relationship with doctors and lack of access to healthcare services. Addressing such barriers can help detect LC early. This systematic review describes the effect of recent interventions to improve LC awareness, help-seeking and early detection. This review was guided by the Cochrane Handbook for Systematic Reviews of Interventions. Electronic databases MEDLINE, CINAHL, ERIC, APA PsycARTICLES, APA PsycInfo and Psychology and Behavioral Sciences Collection were searched. Sixteen studies were included. Knowledge of LC was successfully promoted in most studies using educational sessions and campaigns. LC screening uptake varied with most studies successfully reducing decision conflicts using decision aids. Large campaigns, including UK-based campaign 'Be Clear on Cancer', were instrumental in enhancing LC awareness, promoting help-seeking and yielding an increase in chest X-rays and a decrease in the number of individuals diagnosed with advanced LC. Multimodal public health interventions, such as educational campaigns are best suited to raise awareness, reduce barriers to help-seeking and help detect LC early. Future interventions ought to incorporate targeted information using educational resources, face-to-face counselling and video- and web-based decision aids.

Key words: cancer, prevention, intervention, health education, community based intervention

INTRODUCTION

Lung cancer (LC) is the leading cause of cancer incidence and mortality in men and women globally, with 2.1 million new cases (11.6% of the total cancer cases) and 1.8 million deaths (18.4% of the total cancer deaths) in the year 2018 alone (Bray *et al.*, 2018). More than half of LC cases (53%) are diagnosed among men

and women aged 55–74 years (median age = 70 years) (Torre *et al.*, 2016). In contrast to the increase in survival rates for most cancers, LC is typically diagnosed at advanced stages with a five-year survival rate of 5% (Siegel *et al.*, 2018).

Screening individuals at risk for LC with low dose computed tomography (LDCT) has been shown to

reduce LC mortality by up to 20% (National Lung Screening Trial Research Team, 2011; Marcus *et al.*, 2016). The European Union stressed the importance of starting LC screening using LDCT throughout Europe (Oudkerk *et al.*, 2017). However, to date, very few countries possess screening programs for LC (Siegel *et al.*, 2018), and the uptake of LC screening in countries like the United States of America (USA) remains low, with only 4% of 6.8 million eligible individuals reporting having undergone LDCT (Jemal and Fedewa, 2017). This highlights the importance of raising awareness of LC, supporting at-risk individuals in making a decision regarding LC screening and promoting early presentation for symptoms indicative of LC.

A persistent cough, a change in a pre-existing cough, and shortness of breath are common symptoms of early-stage LC (Chowienzyk *et al.*, 2020). Haemoptysis remains the strongest symptom predictor of LC, yet it occurs in only a fifth of patients (Walter *et al.*, 2015). Patients with LC can also be asymptomatic until systemic symptoms, such as unexplained weight loss and fatigue occur, signalling advanced disease (American Cancer Society, 2019). Therefore, the symptom signature of LC is considered to be broad (Koo *et al.*, 2018) in comparison to cancers that have a narrow symptom signature with single identifiable symptoms, such as breast (O'Mahony *et al.*, 2013) and testicular (Saab *et al.*, 2017a) cancers. This may lead to delay in early presentation and LC diagnosis (Holmberg *et al.*, 2010).

Early help-seeking for symptoms indicative of LC is key for timely and early diagnosis and improved survivorship. However, patients diagnosed with LC experience, on average, a 6-month delay between symptom onset and initiation of treatment (Ellis and Vandermeer, 2011). This is known to have detrimental effects on early diagnosis, quality of life, cost of healthcare, and patients' eligibility for curative treatment (Walter *et al.*, 2015; World Health Organisation, 2020). Several barriers to help-seeking and early detection of LC exist, such as lack of symptom awareness, poor relationship with physicians and lack of healthcare access (Carter-Harris, 2015; Koo *et al.*, 2018; Cassim *et al.*, 2019; Cunningham *et al.*, 2019). Symptom misappraisal is another key contributor to help-seeking delay, especially in the presence of risk factors like smoking (Smith *et al.*, 2016) and comorbidities, such as chronic obstructive pulmonary disease (COPD) (Cunningham *et al.*, 2019). For instance, a survey of 2042 participants found that being a smoker was associated with a reduced likelihood of help-seeking for symptoms indicative of LC, potentially due to pre-existing respiratory symptoms associated with chronic smoking (Smith *et al.*, 2016).

Similarly, in their qualitative study, Cunningham *et al.* (2019) found that individuals with COPD attributed changes in their respiratory symptoms to their COPD and failed to mention LC, despite having a significantly greater risk for LC. LC stigma also impacts negatively on help-seeking for LC 'alarm' symptoms. Indeed, a survey of 93 symptomatic individuals found that higher levels of perceived LC stigma were associated with a median waiting time of 41 days prior to seeking medical help for symptoms of concern (Carter-Harris, 2015). Therefore, raising awareness and promoting early presentation for symptoms indicative of LC can help detect LC early and improve survival.

The international literature has highlighted the importance of interventions that target awareness, symptom evaluation and early help-seeking for LC (Dlamini *et al.*, 2019). For example, a national campaign in the UK entitled 'Be Clear on Cancer' resulted in a significant increase in LC awareness, respiratory consultations, number of physician-prescribed chest X-rays and CT scans, and number of LC cases diagnosed at early stages (Ironmonger *et al.*, 2015). Interventions often vary in terms of modalities, intended mechanisms, theoretical basis and target area/groups. This systematic review aims to describe the effect of recent interventions to improve (i) knowledge and/or awareness of LC; (ii) help-seeking intentions and/or behaviours for LC and (iii) early detection of LC.

METHODS

This systematic review was guided by the Cochrane Handbook for Systematic Reviews of Interventions (Higgins *et al.*, 2019) and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses checklist (Moher *et al.*, 2009).

Eligibility criteria

The review eligibility criteria were predetermined using the PICO (Population, Intervention, Comparison, Outcomes) framework (Moher *et al.*, 2009). Population: conducted among individuals of any age including at-risk populations; Intervention: included any intervention, programme, or campaign; Comparison: incorporated within- or between-group comparison; and Outcomes: reported on at least one of the review outcomes (i.e. knowledge/awareness of LC, help-seeking intentions/behaviours for LC and/or early detection of LC). Studies were excluded if they included patients with LC, used LC screening as the intervention, did not

incorporate a comparator, and used any nonexperimental design.

Search strategy

A search was conducted using the electronic databases MEDLINE, CINAHL, ERIC, APA PsycARTICLES, APA PsycInfo and Psychology and Behavioral Sciences Collection. Keywords were truncated and combined using Boolean operators 'OR' and 'AND' and the proximity indicator 'N.' The following keywords were searched on title or abstract: (lung* OR pulmo*) N3 (cancer* OR neoplas* OR malignan* OR tumo*) AND (know* OR aware* OR detect* OR help-seek*) AND (interven* OR program* OR campaign* OR trial* OR experiment* OR educat*).

The search was conducted on 15 January 2020 and, for pragmatic reasons, was limited to studies published in English between January 2015 and January 2020. Of note, there is no gold standard for limiting the search by year of publication, though studies published within a 10-year timeframe are broadly considered to be recent (Wilhelm and Kaunelis, 2005). However, knowledge decay is common in public health interventions and is one of the reasons researchers frequently develop and refine health promotion interventions, whilst older interventions and campaigns become increasingly obsolete over time (Nimmons *et al.*, 2017; Saab *et al.*, 2018). Therefore, it had been agreed a priori to limit the current search to evidence published within a five-year timeframe in order to source and synthesize the most up-to-date evidence relating to the latest interventions and educational LC campaigns.

Study selection

Records were transferred to Covidence, an online software used to produce systematic reviews of interventions (The Cochrane Collaboration, 2020). Titles and abstracts were screened, and irrelevant records were excluded. The full text of potentially eligible records was then screened and reasons for exclusion were recorded. Title, abstract and full-text screenings were conducted in pairs. For a screening decision to be made, each record was screened twice by two independent reviewers. Screening conflicts were resolved by a third reviewer.

Data extraction and synthesis

Data were extracted using a standardized data extraction table (Supplementary Table 1S) as follows: author(s); year; country; aim(s); design; theoretical underpinning; sample; setting; relevant outcomes; intervention; procedures; instruments; follow-up times and

findings. Data extraction was conducted by one reviewer. Each extracted study was then cross-checked by the rest of the review team.

A meta-analysis with summary measures of intervention effect requires that the included studies be sufficiently homogenous (Higgins *et al.*, 2019). Therefore, given the heterogeneity of the studies in terms of design, outcomes and outcome measures, a meta-analysis was not plausible. Instead, a narrative synthesis of study findings was conducted, and findings were synthesized and discussed according to the review aims under the headings (i) knowledge and awareness, (ii) help-seeking and (iii) early detection.

Quality and level of evidence

The Mixed Methods Appraisal Tool (MMAT) helps appraise the methodological quality of five study categories: qualitative studies, randomized controlled trials (RCTs), nonrandomized studies, quantitative descriptive studies and mixed methods studies (Hong *et al.*, 2018). In line with the current review aim and eligibility criteria, the methodological quality of three study categories was appraised, namely RCTs (seven quality appraisal items), nonrandomized studies (seven quality appraisal items) and mixed methods studies (17 quality appraisal items). Each of the quality appraisal items was judged on a 'Yes', 'No' and 'Can't tell' basis. The clarity of research questions and the use of appropriate data collection methods to address those were assessed for all study categories. For RCTs and nonrandomized studies, sample representativeness and similarities between participant groups at baseline were assessed. Other items related to blinding the outcome assessor, reporting of complete outcome data, accounting for confounders, and ensuring that interventions have been administered as intended. For mixed methods studies, additional items assessed the integration of quantitative and qualitative methods and explored whether divergences and inconsistencies between quantitative and qualitative results have been adequately addressed.

The Scottish Intercollegiate Guidelines Network's (Scottish Intercollegiate Guidelines Network, 2019) guidelines were used to assess the level of evidence per study. This assesses the study design and how well a study was carried out and helps judge whether research conclusions are accurate. Level of evidence scores range from 1⁺⁺, 1⁺, 1⁻, 2⁺⁺, 2⁺, 2⁻, 3, to 4. A score of 1⁺⁺ corresponds to high quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias, whereas a score of 4 is assigned to expert opinions (Scottish Intercollegiate Guidelines Network, 2019).

Level of evidence and quality assessments were conducted by one reviewer and verified independently by the review team. Discrepancies in quality appraisal ratings and level of evidence assessment scores were then discussed among the review team until consensus was reached. When consensus was not reached between two reviewers, a third reviewer was asked to resolve conflicts. Studies were included in the present review regardless of their methodological quality and level of evidence to minimize the risk of study selection and reporting bias (Higgins *et al.*, 2019).

RESULTS

Database searching yielded 4362 records. Following deletion of duplicates, 3270 records were screened on title and abstract and 3222 irrelevant records were excluded. Full texts of the remaining 48 records were screened. Of those, 16 studies were included in this review (Figure 1).

Study characteristics

Most studies were conducted in the USA ($n=8$) and the UK ($n=6$), with the majority being uncontrolled before–after studies ($n=8$) and RCTs ($n=4$). Half of the studies ($n=8$) used multiple researcher-designed instruments to collect data and collected data from rural/underprivileged areas. Five studies were underpinned by theory including the Health Belief Model (Fung *et al.*, 2018; Williams *et al.*, 2021); elements of

Self-Regulation Theory, Theory of Planned Behaviour, and Implementation Intentions (Emery *et al.*, 2019); Ottawa Decision Support Framework (Lau *et al.*, 2015) and Theory of Planned Behaviour (Mueller *et al.*, 2019). Six studies used large or national multimodal campaigns as their intervention with three studies reporting on the same campaign namely the ‘Be Clear on Cancer’ UK-based campaign (Ironmonger *et al.*, 2015; Moffat *et al.*, 2015; Power and Wardle, 2015) (Table 1).

Quality and level of evidence

All 16 studies had clear research questions and used appropriate data collection methods. RCTs ($n=4$) performed appropriate randomization, had comparable groups at baseline, presented complete data outcomes, and had participants adhere to the assigned intervention; however, only one RCT reported on blinding the outcome assessor (Emery *et al.*, 2019) (Supplementary Table 2S). As for non-RCTs ($n=11$), only three studies reported that participants were representative of the target population (Power and Wardle, 2015; Sakoda *et al.*, 2020; Williams *et al.*, 2021), and one study accounted for confounders (Williams *et al.*, 2021). Otherwise, all non-RCTs met the remaining MMAT criteria (Supplementary Table 3S). The only mixed methods study (Cardarelli *et al.*, 2017) met most of the MMAT criteria; however, it was unclear as to how data were synthesized and whether there were divergences and

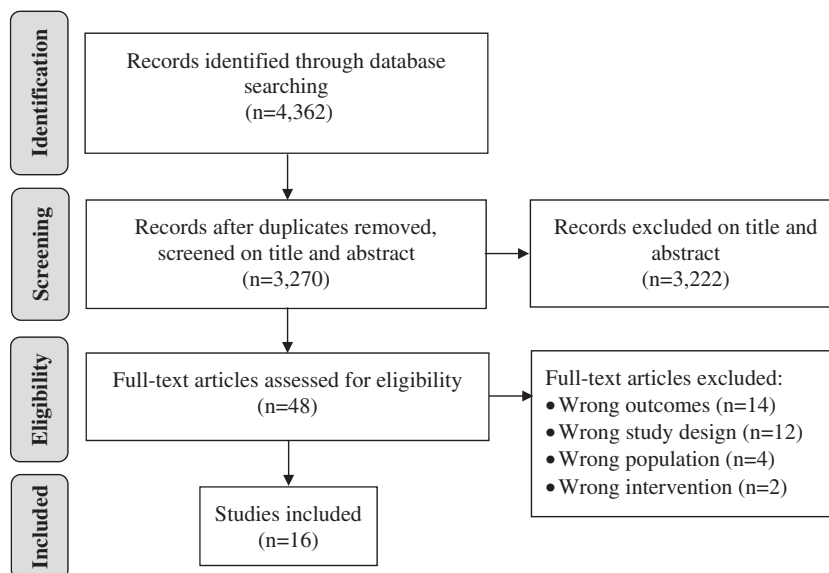


Fig. 1: Study identification, screening and selection process.

Table 1: Study characteristics ($n = 16$)

Country	USA ($n = 8$) UK ($n = 6$) Australia ($n = 1$) Colombia ($n = 1$)
Design	Uncontrolled before–after ($n = 8$) Randomized controlled trial ($n = 4$) Controlled before–after ($n = 1$) Mixed methods ($n = 1$) Retrospective ($n = 1$) Time-trend ($n = 1$)
Theory ^a	Health Belief Model ($n = 2$) Elements of Self-Regulation Theory, Theory of Planned Behaviour, and Implementation Intentions ($n = 1$) Ottawa Decision Support Framework ($n = 1$) Theory of Planned Behaviour ($n = 1$)
Sample (min–max)	30–2090 participants
Settings	Community including rural/underprivileged areas ($n = 8$) Acute care ($n = 3$) General practice ($n = 1$) Lung cancer screening programme ($n = 1$) Online ($n = 1$) Primary care records ($n = 1$) Public health centre ($n = 1$)
Outcomes ^b	Knowledge/awareness of LC ($n = 12$) Help-seeking intentions/behaviours for LC ($n = 10$) Early detection of LC ($n = 7$)
Intervention	Large/national campaigns ($n = 6$) Face-to-face counselling, video slideshow, and web-based decision aid ($n = 1$) Information film and booklet ($n = 1$) Lung cancer screening education class ($n = 1$) Research education seminars ($n = 1$) School educational sessions ($n = 1$) Self-help manual ($n = 1$) Tailored information and Theory of Planned Behaviour components ($n = 1$) Video-based decision aid ($n = 1$) Web-based decision aid ($n = 1$) Weekly sessions and lung cancer eligibility checklist ($n = 1$)
Instruments ^c	Researcher-designed ($n = 8$) Cancer Awareness Measure ($n = 4$) Decision Conflict Scale ($n = 3$) Electronic medical records ($n = 3$) Others ($n = 18$)
Follow-up (min–max)	Immediately post-test–5 years post-test

^a $n = 5$ studies underpinned by theory.

^b $n =$ number of times an outcome was measured.

^c $n =$ number of times an instrument was used.

inconsistencies between quantitative and qualitative results (Supplementary Table 4S).

Half of the studies ($n = 8$) scored 2⁺ on the SIGN level of evidence criteria, indicating well-conducted non-RCTs with a low risk of confounding or bias and a

moderate probability that the relationship is causal. Only one RCT (Emery *et al.*, 2019), and one non-RCT (Williams *et al.*, 2021) had a low risk of bias.

Findings from individual studies are reported in Table 2.

Table 2: Findings from individual studies ($n=16$)

Reference country	Design theory	Sample	Outcome	Intervention	Instrument	Follow-up	Findings ^a
Cardarelli <i>et al.</i> (2017) USA	Sequential mixed-methods	$n = 145$ high-risk individuals (IG = 2 regions, CG = 1 region)	LDCT uptake	'Terminate Lung Cancer' campaign	Telephone survey and LDCTs	12 months	O2. 73(50.3%) came across the campaign: 5 (3.4%) considered LDCT and 2(1.4%) sought information about LDCT. O3. 5(3.4%) got LDCT. Significant uptake of LDCT in IG ($p = \text{NR}$). O1. No significant change in knowledge between IG and CG at 1 and 12 mon post-test (MD = -0.2, $p = 0.3954$ and MD = -0.1, $p = 0.6083$, respectively)
Emery <i>et al.</i> (2019) Australia	RCT SRT, TPB, Implementation Intentions	$n = 551$ high-risk individuals (IG = 274, CG = 277)	LC symptom knowledge, appraisal, help-seeking, consult rates, health service use	IG: Spirometry, self-help manual, discussions, tailored monthly prompts; CG: Spirometry, discussion on lung health	Questionnaire and GP record review	1 month 12 months	O2. 40% increase in consults (95% CI IG 0.57 (0.47–0.70), CG 0.41 (0.32–0.52), RR = 1.40 (1.08–1.82), $p = 0.0123$). not statistically significant difference in time to first ($p = 0.207$) or all consults ($p = 0.147$). O1. Awareness of LC early detection at post-test increased by 6.4% for IG ($p = 0.18$) and decreased by 2.1% in CG ($p = 0.49$, with no statistically significant differences between groups ($p = 0.13$)). O1. Knowledge increased by 33% post-test ($M = 3.97$, $SD = 2.87$, 95% CI 2.90–5.04, $p < 0.001$).
Fung <i>et al.</i> (2018) USA	RCT HBM	$n = 395$ Chinese Americans (IG = 202, CG = 193)	Knowledge of cancer prevention	IG: Education on cancer prevention; CG: Education on bio-specimen collection	Questionnaire	Immediate	O1. Awareness of LC early detection at post-test increased by 6.4% for IG ($p = 0.18$) and decreased by 2.1% in CG ($p = 0.49$, with no statistically significant differences between groups ($p = 0.13$)). O1. Knowledge increased by 33% post-test ($M = 3.97$, $SD = 2.87$, 95% CI 2.90–5.04, $p < 0.001$).
Houston <i>et al.</i> (2018) USA	Uncontrolled before–after	$n = 30$ high-risk individuals	LCS knowledge	Video-based patient DA on LCS	Online survey	Immediate	O1. Knowledge increased by 33% post-test ($M = 3.97$, $SD = 2.87$, 95% CI 2.90–5.04, $p < 0.001$).

(continued)

Table 2: (Continued)

Reference	country	Design theory	Sample	Outcome	Intervention	Instrument	Follow-up	Findings ^a
Ironmonger (2015)	UK	Controlled before– after	<i>n</i> = 1153 high-risk individuals (pre-test); <i>n</i> = 1121 (post- test)	Awareness, con- sults, urgent LC referral, CXRs, CTs, LC diag- nosis, stage, treatment	IG: 'Be Clear on Cancer' national campaign; CG: No campaign	Survey	Immediate 6 months 8 months	O1. Increased awareness of cough ($p < 0.001$), breath- lessness ($p = 0.024$), hae- moptysis ($p < 0.001$), chest pain ($p = 0.015$), weight loss ($p < 0.001$). O2. Help-seeking increased by 63% during and 46% 8 weeks post-test ($p < 0.001$). CG vs IG $p < 0.001$. GP referrals in- creased by 31.8% ($p < 0.001$). O3. CXRs and CTs increased by 18.6% and 15.7%, re- spectively ($p < 0.001$). Diagnosis increased by 9.1% ($p < 0.001$) in IG and 1.5% in CG ($p = 0.373$). 30% increase in stage I/LC and 3.5% de- crease in stage IV (both $p < 0.001$).
Jessup <i>et al.</i> (2018)	USA	Retrospective study	<i>n</i> = 927 Twitter; <i>N</i> = 595 LinkedIn; <i>N</i> = 13 341 Facebook; <i>N</i> = 1522 Google	LDCT uptake	20-Week pay-per- click campaign tar- geting patients, caregivers, and healthcare providers	Social media data, medical records for data on LDCT	20 weeks	O3. Mean scheduled LDCT per week increased by 3% during and 5.8% 1-week post-campaign ($p = 0.001$).
Kennedy <i>et al.</i> (2018)	UK	Time-trend study	<i>n</i> = NR cases of LC	CXRs, stage at diagnosis	Regional/local campaign	Referral for CXR and LC stage	5 years	O3. 80.8% increase in CXRs. 8.8% increase in patients diagnosed with stage I/II LC and 9.3% reduction in stage III/IV LC ($\chi^2(1) = 32.2, p < 0.0001$).

(continued)

Table 2: (Continued)

Reference country	Design theory	Sample	Outcome	Intervention	Instrument	Follow-up	Findings ^a
Lau <i>et al.</i> (2015) USA	Uncontrolled before– after ODSF	n = 60 high-risk individuals	Knowledge of LCS benefits and harms, de- cisional conflict	Web-based DA	Online survey	4 months	O1. Knowledge of risk fac- tors, benign lumps, and screening benefits, harms, eligibility increased (pre- test M = 7.52/14, SD = 1.89; post-test M = 10.93/14, SD = 2.19, p < 0.001). O2. Decisional conflict de- creased (pre-test M = 46.33, SD = 29.69; post-test M = 15.08, SD = 25.78, p < 0.001). O1. Increased knowledge of LCS eligibility for age (p < 0.0001), smoking his- tory (p < 0.0001), benefits (p = 0.03), harms (p = < 0.0001). O3. 423 had shared decision- making visit: 23(5.4%) did not go have LDCT. O1. Awareness of LC warn- ing signs and risk factors increased across all time- points (p < 0.001).
Mazzone <i>et al.</i> (2017) USA	Uncontrolled before– after	n = 125 high-risk individuals pre- test; n = 122 post-test n = 113 1 month post-test	LCS knowledge	Face-to-face counsel- ing, video, web- based DA	Survey	Immediate 1 month	O1. Mentions of cough/ hoarseness increased by 9% (p = 0.001). Proportion identifying ‘cough for 3 weeks or more that doesn’t go away’ as LC symptom increased by 15% (p < 0.001). O2. 63% increase in GP at- tendance for symptoms weeks post-test.
Meneses-Echávez <i>et al.</i> (2018) Colombia	Uncontrolled before– after	n = 243 female adolescents	LC awareness	Two 90-min school educational sessions	Survey	1 month 3 months 6 months	O1. Awareness of LC warn- ing signs and risk factors increased across all time- points (p < 0.001).
Moffat <i>et al.</i> (2015) UK	Uncontrolled before– after	n = 1412 at-risk individuals pre- test; n = 1246 post-test	Awareness of LC signs and symp- toms, GP attendance	‘Be Clear on Cancer’ national campaign	Survey, medical re- cord review	Immediate NR weeks	O1. Mentions of cough/ hoarseness increased by 9% (p = 0.001). Proportion identifying ‘cough for 3 weeks or more that doesn’t go away’ as LC symptom increased by 15% (p < 0.001). O2. 63% increase in GP at- tendance for symptoms weeks post-test.

(continued)

Table 2: (Continued)

Reference country	Design theory	Sample	Outcome	Intervention	Instrument	Follow-up	Findings ^a
Mueller <i>et al.</i> (2019) UK	Feasibility study using RCT with block randomization TPB	<i>n</i> = 130 individuals with potential LC symptoms	LC help-seeking	IG: Tailored information and TPB; CG-TPB; Untailored information and TPB; CG-TAIL; Tailored information without TPB; CG: Usual care	Questionnaire	NR	O2. 98.5% (<i>n</i> = 128) considered help-seeking appropriate. 65.4% (<i>n</i> = 85) said they would make a GP appointment. Highest intention reported in IG ($\chi^2(3) = 8.14, p = 0.04$).
Power and Wardle (2015) UK	Uncontrolled before–after	<i>n</i> = 2090 from households in 2010; <i>n</i> = 2001 in 2012	LC knowledge, awareness, help-seeking	‘Be Clear on Cancer’ national campaign	Computer-assisted survey	2 years	O1. Recall of LC symptoms increased by 8% ($p < 0.001$). Recognition of cough or hoarseness as signs of LC increased by 11% ($p < 0.001$). O2. No statistically significant change in barriers targeted by the campaign ($p > 0.05$). Barriers not targeted by the campaign were less endorsed post-campaign ($p < 0.05$).
Ruparel <i>et al.</i> (2019) UK	Nested RCT	<i>n</i> = 229 high-risk individuals (IG = 120, CG = 109)	LC knowledge, decisional conflict, LDCT completion	IG: Information film, booklet, discussion; CG: Booklet only	Questionnaire	Immediate	O1. Mean objective knowledge increased by 2.16 (SD = 1.8) for IG and 1.84 (SD = 1.9) for CG ($p < 0.001$). Mean subjective knowledge increased by 0.92 (SD = 1) for IG and 0.55 (SD = 1.0) for CG ($p < 0.001$). O2. Decisional conflict higher in IG ($M = 8.5/9$, SD = 1.3) than CG ($M = 8.2/9$, SD = 1.5, $p = 0.007$).

(continued)

Table 2: (Continued)

Reference	country	Design theory	Sample	Outcome	Intervention	Instrument	Follow-up	Findings ^a
Sakoda <i>et al.</i> (2020)	USA	Uncontrolled before–after	<i>n</i> = 680 LCS class attendees	LCS knowledge, decision-making capacity, interest	Educational class on LCS	Survey	Immediate	O3. No statistical significance in LDCCT uptake between groups (<i>p</i> = 0.66). O1. Knowledge increased by 51% post-test (<i>M</i> = 0.09, <i>SD</i> = 2.29, <i>p</i> < 0.0001). O2. Willingness to get screened decreased by 15% post-test.
Williams <i>et al.</i> (2021)	USA	Uncontrolled before–after HBM	<i>n</i> = 481 African American majority	knowledge of LC risk factors, symptoms, LCS, screening uptake	c-Care intervention with weekly sessions on harms of smoking and LCS	Survey	Immediate 3 months	O1. Post-test increase in knowledge (<i>p</i> < 0.001) and 54.5% increase in correct answers regarding LCS. O2. Perceived susceptibility, threat, intent, and cue to action showed no significant changes between pre- and post-test. O3. 38% of those who met screening eligibility (<i>n</i> = 14) complete LCS.

CG, control group; CI, confidence interval; CT, computed tomography; CXR, chest X-ray; DA, decision aid; GP, general practitioner; IG, intervention group; LC, lung cancer; LCS, lung cancer screening; LDCCT, low dose computed tomography; M, mean; MD, mean difference; NR, not reported; O, objective; ODSF, Ottawa decision support framework; RCT, randomized controlled trial; RR, relative rate; SD, standard deviation; SRT, self-regulation theory; TPP, theory of planned behaviour; UK, United Kingdom; USA, United States of America; χ^2 , chi-square test.

^aFindings according to review objectives: O1: knowledge and/or awareness of LC; O2: help-seeking intentions and/or behaviours for LC; O3: early detection of LC, including clinical outcomes.

Knowledge and awareness

Subjective and objective knowledge of LC were promoted in 12 studies using approaches, such as decision aids (Lau *et al.*, 2015; Mazzone *et al.*, 2017; Houston *et al.*, 2018); film and booklet (Ruparel *et al.*, 2019) and educational sessions (Williams *et al.*, 2021; Sakoda *et al.*, 2020). Lau *et al.* (2015) evaluated the effectiveness of a web-based decision aid (www.shouldscreen.com) among 60 at-risk individuals and found that knowledge of risk factors, benefits and harms of screening, screening eligibility and percentage of benign lumps increased significantly 4 months post-test [pre-test: mean = 7.52/14, standard deviation (SD) = 1.89; post-test: mean = 10.93/14, SD = 2.19; $p < 0.001$]. A second study used the same decision aid and also reported statistically significant increases in knowledge of screening-eligible ages ($p < 0.0001$), smoking history eligibility criteria ($p < 0.0001$), benefits ($p = 0.03$) and harms ($p < 0.0001$) of LC screening 1 month post-test (Mazzone *et al.*, 2017).

An information film and booklet (intervention group [IG]) compared with booklet only (control group [CG]) yielded a statistically significant increase in knowledge in both groups, with a greater improvement among IG ($p < 0.001$) (Ruparel *et al.*, 2019). Educational interventions in the form of LC screening classes (Sakoda *et al.*, 2020) and a 4-week educational intervention (Williams *et al.*, 2021) were also instrumental in increasing objective knowledge of LC screening immediately post-test and 3 months post-test (both $p < 0.001$).

As for knowledge of LC signs, symptoms, and risk factors, a 90-min educational session significantly increased awareness of warning signs for LC and LC risk factors 1 month, 3 months and 6 months post-test ($p < 0.001$) (Meneses-Echávez *et al.*, 2018). Three before–after studies evaluated the impact of the UK campaign ‘Be Clear on Cancer’ on knowledge of LC signs and symptoms (Ironmonger *et al.*, 2015; Moffat *et al.*, 2015; Power and Wardle, 2015). The campaign was successful in increasing awareness of cough ($p < 0.001$), breathlessness ($p = 0.024$), haemoptysis ($p < 0.001$), chest pain ($p = 0.015$) and unexplained weight loss ($p < 0.001$) as symptoms of LC (Ironmonger *et al.*, 2015). Recall and recognition of a persistent cough or hoarseness as signs of LC also increased significantly from 67% pre-campaign to 78% post-campaign ($p < 0.001$) (Power and Wardle, 2015). The increase in unprompted awareness of cough/hoarseness was significantly lower among men as compared with women (45% vs 55%; $p = 0.001$) (Moffat *et al.*, 2015), and there was no statistically significant change in pre- and

post-campaign results for individuals aged 75 years or more ($p = 0.721$) as compared with 11% increase for the 55–74 years age group ($p = 0.001$). As for prompted awareness, the proportion of participants identifying a ‘cough for 3 weeks or more that doesn’t go away’ as definite warning sign of LC increased from 18% pre-campaign to 33% post-campaign ($p < 0.001$), with no statistically significant difference between men and women pre-campaign ($p = 0.389$) and post-campaign ($p = 0.587$) (Moffat *et al.*, 2015).

In contrast, a spirometry, self-help manual, action and coping plans and tailored monthly prompts (SMS, emails, post-cards, phone calls, and fridge magnets) (IG) yielded no statistically significant changes in knowledge in comparison to spirometry and brief general discussion about lung health (CG) 1 and 12 months post-test (mean difference = -0.2, $p = 0.3954$ vs. mean Difference = -0.1, $p = 0.6083$, respectively) (Emery *et al.*, 2019). Similarly, a four-day research education seminar on cancer prevention (IG) and biospecimen collection (CG) did not yield a statistically significant increase in awareness of LC early detection immediately post-education ($p = 0.18$ and $p = 0.49$, respectively; group comparison $p = 0.13$) (Fung *et al.*, 2018).

Help-seeking

Ten studies addressed help-seeking for LC including seeking help from a General Practitioner (GP) and deciding to undertake LC screening. Spirometry, self-help manual, action and coping plans, and tailored monthly prompts which initially failed to raise LC awareness, were successful in increasing respiratory consultations by 40% among the IG [95% Confidence Interval (CI) IG 0.57 (0.47–0.70), CG 0.41 (0.32–0.52), Relative Rate 1.40 (1.08–1.82); $p = 0.0123$] (Emery *et al.*, 2019).

Mueller *et al.* (2019) conducted a feasibility RCT with block randomization to four groups: tailored information and Theory of Planned Behaviour components (IG); untailored information with Theory of Planned Behaviour components; tailored information without Theory of Planned Behaviour components; and usual care (CG). It was found that the four groups differed significantly in scores on the help-seeking intention variable, ($\chi^2(3) = 8.14$, $p = 0.04$), with the highest intention reported in the IG (Mueller *et al.*, 2019). In contrast, an uncontrolled before–after study using the Health Belief Model reported no statistically significant changes in intent and cue to action immediately and 3 months following a 4-week educational intervention (Williams *et al.*, 2021).

The campaign 'Be Clear on Cancer' was instrumental in increasing help-seeking for LC symptoms and reducing barriers to help-seeking (Ironmonger *et al.*, 2015; Moffat *et al.*, 2015; Power and Wardle, 2015). Help-seeking for cough increased by 63% during the campaign and by 46% 8 weeks later among at-risk groups ($p < 0.001$) (Ironmonger *et al.*, 2015). The campaign was also associated with a 63% increase in GP attendances for symptoms linked to the campaign, with no difference between genders ($p = 0.107$) (Moffat *et al.*, 2015). The largest increase was seen in the 50–59-year age group in comparison to older age groups (88%, $p < 0.001$). As for perceived barriers to help-seeking, there was no statistically significant change in barriers targeted by the campaign, such as being 'worried about wasting the doctor's time' (26% in 2010 and 24% in 2012, $p = 0.158$) or believing that the 'doctor would be difficult to talk to' (14% in 2010 and 13% in 2012, $p = 0.617$). However, barriers not targeted by the campaign, such as being 'too scared' ($p = 0.016$), being 'worried about what the doctor might find' ($p = 0.002$), 'difficulty arranging transport' ($p = 0.002$), 'difficulty making an appointment' ($p = 0.025$) and being 'too busy' ($p = 0.009$) were less endorsed post-campaign (Power and Wardle, 2015).

In terms of screening decisions, Cardarelli *et al.* (2017) conducted a multimodal campaign titled 'Terminate Lung Cancer' and found that, out of 145 high-risk individuals, 73 (50.3%) came across the campaign. Of those, 5 (3.4%) thought about getting an LDCT and 2 (1.4%) sought information about LDCT. Three studies used the Decision Conflict Scale (Lau *et al.*, 2015; Ruparel *et al.*, 2019; Sakoda *et al.*, 2020). A web-based decision aid yielded a decrease in Decision Conflict Scale scores indicating lower decisional conflict (pre-test mean = 46.33, SD = 29.69; post-test mean = 15.08, SD = 25.78; $p < 0.001$) (Lau *et al.*, 2015). In contrast, participants who watched an information film and read a booklet (IG) had higher decisional conflict (mean = 8.5/9, SD = 1.3) in comparison to those who read a booklet only (CG) (mean = 8.2/9, SD = 1.5; $p = 0.007$) (Ruparel *et al.*, 2019). Moreover, an LC screening class led to a decrease in the proportion of at-risk participants who wanted to be screened from 80% pre-test to 65% immediately post-test (Sakoda *et al.*, 2020).

Early detection

The effect of interventions on early detection of LC (i.e. screening uptake and clinical outcomes) was addressed in seven studies. LDCT uptake varied widely between

38% after a 4-week educational intervention (Williams *et al.*, 2021) and 94.6% following face-to-face counseling and shared web-based decision-making (Mazzone *et al.*, 2017). The multimodal 'Terminate Lung Cancer' campaign yielded a significant uptake of LDCT in the two intervention regions as compared with the control region (p -value not reported) (Cardarelli *et al.*, 2017). Another social media-based campaign was linked to a 3% increase in LDCT per week immediately post-campaign and a further 5.8% increase a week later ($p = 0.001$) (Jessup *et al.*, 2018). In contrast, LDCT completion rates showed no statistical significance between those who watched an information film and read a booklet (IG) and those who read a booklet only (CG) ($p = 0.66$) (Ruparel *et al.*, 2019).

Clinical outcomes reported following large campaigns included the number of chest X-rays and CT scans ordered, new LC cases, stage at diagnosis and LC treatments (Ironmonger *et al.*, 2015; Kennedy *et al.*, 2018). The 'Be Clear on Cancer' campaign was associated with an increase in GP-referred chest X-rays and CT scans by 18.6% and 15.7%, respectively ($p < 0.001$) (Ironmonger *et al.*, 2015). Moreover, LC diagnosis increased by 9.1% ($p < 0.001$) for IG and 1.5% for the CG ($p = 0.373$) and the proportion of nonsmall cell LC diagnosed at stage I increased from 14.1% to 17.3% ($p < 0.001$) and decreased from 52.5% to 49% ($p < 0.001$) for stage IV. As for treatments, there was a 2.3%-point increase ($p < 0.001$) in resections for patients seen (IG), with no evidence that these proportions changed in CG pre-campaign ($p = 0.404$) and post-campaign ($p = 0.425$) (Ironmonger *et al.*, 2015). A local UK campaign which overlapped with 'Be Clear on Cancer' also resulted in an 80.8% increase in community-ordered chest X-rays between the 3 years pre-campaign and 3 years post-campaign and yielded an 8.8% increase in patients diagnosed with stage I/II LC as opposed to a 9.3% reduction in cases of stage III/IV LC ($\chi^2(1) = 32.2$, $p < 0.0001$) (Kennedy *et al.*, 2018).

DISCUSSION

A wide range of educational interventions were implemented across the reviewed studies, with several studies testing large national and multimodal campaigns. Most interventions explored knowledge and awareness of LC and its screening, while others examined help-seeking behaviours and early detection of LC, including screening uptake and clinical outcomes, such as stage of LC at diagnosis and treatments received.

Overall, participants were poorly informed about LC at baseline. However, web-based decision aids (Lau

et al., 2015; Mazzone *et al.*, 2017; Housten *et al.*, 2018), information resources (Ruparel *et al.*, 2019) and educational sessions (Sakoda *et al.*, 2020; Williams *et al.*, 2021) yielded a significant increase in knowledge and awareness of LC risk factors, warning signs, benefits and harms of screening, and screening eligibility. Notably, tailored monthly prompts (i.e. SMS, emails, post-cards, phone calls, fridge magnets) did not significantly increase LC awareness, detection, or screening uptake (Emery *et al.*, 2019).

In terms of participants' sociodemographic profiles, men demonstrated lower awareness than women (Moffat *et al.*, 2015). Gender disparity in knowledge is well documented in other malignancies including colorectal (Clarke *et al.*, 2016) and skin (Christoph *et al.*, 2016) cancers. Age also played a role in increased LC awareness, with a significant improvement in unprompted awareness in the 55–74 years age group (Moffat *et al.*, 2015). This finding is encouraging since LC is mainly diagnosed in older generations. In the USA, for example, LC is most common among those aged 65 years or older, with a median age of 71 years at diagnosis (National Cancer Institute, 2020). In an Irish study, Ryan *et al.* (2015) emphasized the importance of age as a significant risk factor in cancer diagnosis and highlighted that, even though age is a nonmodifiable risk factor, researchers must target information to increase LC awareness and promote consultation among at-risk age groups (McCutchan *et al.*, 2019).

In keeping with high-risk groups, half of the studies were conducted in rural/underprivileged areas. A pooled analysis of case–control studies found that socioeconomic deprivation and lack of healthcare access among at-risk populations were associated with advanced LC at diagnosis (Hovanec *et al.*, 2018). Therefore, McCutchan *et al.* (2019) identified the need for multi-faceted community-based interventions to encourage high-risk individuals, living in deprived areas, to seek LC information outside of the GP setting. This may promote better relationships between high-risk groups and trained intervention facilitators, subsequently improving engagement in LC screening and help-seeking (McCutchan *et al.*, 2019).

Interventions aiming to increase help-seeking intentions ought to consider incorporating tailored information based on, for example, the components of the Theory of Planned Behaviour (Mueller *et al.*, 2019). Such theory-based interventions should address individuals' attitudes, social norms, and perceived behaviour control as well as integrating measures to ensure effective decision-making skills (Ruparel *et al.*, 2019). Moreover, at-risk individuals should be encouraged to

consider the benefits and harms of health screening in order to make informed decisions and improve health outcomes (Bell *et al.*, 2017). Current evidence suggests that the use of decision aids can increase knowledge of the benefits and harms of LC screening, whilst providing a better understanding of the nature of screening (Reuland *et al.*, 2018). Therefore, methods to help dissipate LC screening decisional conflicts, such as video- and web-based decision aids should be considered (Lau *et al.*, 2015; Mazzone *et al.*, 2017; Housten *et al.*, 2018). Notably, the use of such aids proved successful in reducing decision conflict and cancer-related distress among individuals at risk for breast (Metcalfe *et al.*, 2017), prostate (Reidy *et al.*, 2018) and colorectal (Perestelo-Perez *et al.*, 2019) cancers, inclusive of those with low literacy and health literacy levels.

Three studies reported on a successful national campaign in the UK titled 'Be Clear on Cancer' which resulted in a significant increase in awareness of LC symptoms (Ironmonger *et al.*, 2015; Moffat *et al.*, 2015; Power and Wardle, 2015). This campaign also helped reduce barriers to help-seeking, increase GP consultations for at-risk individuals, increase in individuals requesting chest X-rays, and increase in GP-referred chest X-rays and CT scans. Moreover, there was an encouraging increase in early-stage LC diagnosis as a result of this campaign (Ironmonger *et al.*, 2015). Alternative strategies, such as the use of social media campaigns could be modified to drive engagement with health services in people with minor/early symptoms (Jessup *et al.*, 2018). Freeman *et al.* (2015) reported on lessons learned from the use of social media in public health campaigns and identified positive changes in motivation and action. The use of social media makes it easier to connect with specific population cohorts, increase information visibility, and potentially deliver successful health promotion campaigns. It is worth noting, however, the age profile of at-risk individuals and the learning strategies that appeal to high-risk age groups (Chelf *et al.*, 2002; Saab *et al.*, 2017b).

There are several complex barriers that can affect an individual's understanding of a disease and impede decision-making and help-seeking. It is evident from this review that multimodal public health campaigns would best suit high-risk populations. Approaching health from a population perspective, future interventions and campaigns should consider including a structured theoretical framework, such as the Theory of Planned Behaviour (Ajzen and Manstead, 2007). Moreover, future interventions ought to incorporate targeted information through the use of educational resources, face-to-face counselling, and video- and web-based decision

aids, while being cognizant of the preferred learning strategies and the key characteristics of health-promoting messages that would appeal to at-risk groups.

Limitations

Rigour was sought in the conduct and reporting of this systematic review. However, several threats to generalizability are worthy of note. While some of the review team members were multilingual, none of the languages used in non-English language papers was spoken by the research team and no resources were available to professionally translate non-English papers to English, which resulted in excluding those. Moreover, while the five-year search limit helped source the latest evidence, older interventions were omitted. Generalizability of findings is also hindered by the small number of studies included and the fact that almost half of the reviewed studies ($n = 7$) did not meet two key quality assessment criteria namely ‘participants representative of target population’ and ‘confounder accounted for in the design and analysis’ and only two studies had a low risk of bias (Emery *et al.*, 2019; Williams *et al.*, 2021). Study selection bias could have occurred, since only outcomes that were in line with the review aims were reported and no records were sought from the grey literature.

Despite this being a systematic review of interventions, a meta-analysis was not plausible primarily due to heterogeneity in study designs, outcomes and outcome measures. The reliability and generalizability of the review results are limited further by the presence of three sources of bias: (i) study designs: the included studies used six different study designs; (ii) study instruments: half of the studies ($n = 8$) used researcher-designed instruments and failed to report on the validity and reliability of those instruments and (iii) follow-up periods: diverse follow-up periods of data collection were evident, with some studies not having baseline data and others measuring outcomes either immediately post-test or at multiple points post-test. The implication is that findings relating to subjective data measured objectively would change over time and repeat measures at different points in time give different results. Hence, a consistent prepost repeat measures approach is key to minimizing this bias in future research.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *Health Promotion International* online.

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