Review article

Promoting men's knowledge of cancer risk reduction: A systematic review of interventions

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ABSTRACT

Objective: To critically appraise and discuss evidence from interventions designed to increase men's knowledge about cancer risk reduction.
Methods: A systematic review was conducted. Six electronic databases were searched for interventions published between January 1st 2006 and May 30th 2016 in English. Studies were included if they used an experimental design, included adult males ($\geq$18 years), and had a primary focus on the acquisition and utilisation of information on cancer risk reduction. The methodological quality of the included studies was appraised.
Results: A total of 25 studies met the inclusion criteria, 23 of which involved prostate cancer risk reduction. Twenty-one studies reported knowledge gain among the men. Three studies found that knowledge gain was associated with health literacy.
Conclusions: Interventions aiming to improve men's knowledge about cancer risk reduction require a multimodal approach. Findings highlight the need to design and measure the impact of interventions for men on wider cancer risk reduction topics, while accounting for different socio-demographic and ethnic groups, literacy and health literacy levels.
Practice implications: More research is warranted into the development and evaluation of theoretically-driven multimodal community-based approaches to information dissemination for men taking into account their daily information spheres such as workplaces and community environs.
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1. Introduction

Cancer incidence and mortality among men is higher than women for non-gender specific cancers [1–6]. In 2012, the estimated incidence rates were almost one quarter higher among men than women [7]. Cancer accounts for 33% of deaths among men compared to approximately 20% among women [7,8]. Reasons for these trends are not fully understood [3]. Inequities in population health status are related to inequalities in absolute income and social status, often referred to as the social gradient in health. Notably, the social gradient in health is linked to worsened health outcomes, especially among men in lower socio-economic groups [9]. Social determinants of cancer risk among men include socio-economic status, educational attainment, living, and working conditions. [3,4,7,10].

Two in 5 cancer deaths in men, compared to just over 1 in 4 cancer deaths in women, can be attributed to potentially modifiable risk factors such as lifestyle factors and less frequent health services use [11]. More than one third of the cancer burden could be reduced by modifying key lifestyle risk factors such as tobacco use, obesity, unhealthy diet, inadequate physical inactivity, alcohol consumption, and exposure to infections [11,12], in addition to adhering to the "European Code Against Cancer" recommendations [13]. Men's higher cancer incidence and mortality are also influenced by poor cancer awareness, lower screening uptake, delays in seeking health information, and lower healthcare utilisation [1,10,14–18].

Improving knowledge about cancer risk reduction is a key aim of public health campaigns, including those from the World Health Organisation, Cancer Research UK, and the Irish Cancer Society [19–21]. However, men are less likely to engage with information than women [22,23]. Our aim was to systematically review the effectiveness of interventions designed to increase knowledge about cancer risk reduction among men. To our knowledge, this is the first systematic review on this theme.

2. Methods

2.1. Data sources and searches

The Cochrane Handbook for Systematic Reviews was used as the methodological framework to guide the systematic review [24]. MEDLINE, CINAHL, PsycINFO, PsycARTICLES, Psychology and Behavioural Sciences Collection, and ERIC databases were systematically searched for interventions about cancer risk reduction information targeted towards men using the Boolean terms "OR" and "AND," Medical Subject Headings (MeSH), and truncation "*"(Table 1).

2.2. Study selection and inclusion criteria

Studies were included if they had a primary focus on (i) adult men (aged $\geq$18 years), (ii) involved interventions supporting the acquisition of knowledge from cancer risk reduction information **as** primary and/or secondary outcomes, and (iii) were published in English between 1st January 2006 and 30th May 2016. Studies involving exclusively women or where findings from men and women were indistinguishable were excluded, as were studies

Table 1
Search Terms.

Men	AND	inform*	AND	cancer*	AND	need*	AND	Prevent*
OR		OR		OR		OR		OR
Males		advice		neoplas*		necessit*		"reduc* risk"
OR		OR		OR		OR		OR
MAN		advis*		oncolog*		require*		minimis*
OR		OR		OR		OR		OR
Males		educat*		tumour*		seek*		minimiz*
				OR		OR		OR
				tumor*		look*		"health promot*"
						OR		OR
						search*		Screen*
						OR		
						acquir*		
						OR		
						learn*		
						OR		
						"engag* with"		
						OR		
						use		
						OR		
						using		
						OR		
						utilis*		
						OR		
						utiliz*)		

Table 2
Data extraction and quality tables from individual studies.

Author(s) & year	Country & Setting	Aim(s)	Study Design & Theoretical Underpinning	Study Population[a]	Data Collection Method & Instrument	Intervention	Findings[b]	Intervention supported knowledge gain (Yes/No/Partly)	Quality Rating[c]
Allen et al. (2010)	USA Worksites	"To evaluate a decision aid (DA) designed to promote informed decision-making (IDM) for prostate cancer (PCa) screening." (p.2172)	Quantitative Randomized controlled trial (RCT) Ottawa Decision Support Framework	At baseline: n = 812 (NR for men) (Control = 414, Intervention = 398) At follow-up: n = 625 (NR for men) (Control = 334, Intervention = 291) M = NR Age range = 45- ≥ 55	Self-administered pencil-and-paper surveys Decisional status; PCa knowledge; Decision self-efficacy; Control Preference Scale; Decisional conflict	Personal risk for PCa; Pros and cons of screening; Screening preferences; Scenarios of men going through a decision-making process Intention to treat addressed	1. In comparison to the control group, men who used the DA had improved knowledge scores (79% vs. 43%, p < 0.01).	Yes	M
Arora et al. (2013)	USA Primary care clinics	"To develop and pilot test PreView, a novel interactive Video Doctor plus Provider Alert, that can be implemented during a primary care visit to encourage all cancer screening and cancer screening discussions that are recommended for a particular individual." (p.2)	Quantitative Pilot study Pre- and post-test Transtheoretical Model of Behaviour Change	n = 80 (n = 33 men) M = 60.6 (SD 7.4) Age range = 50–86	Socio-demographic data; Intention to ask their physician about screening; Interest in getting screened; Received the right amount of information; Increased their knowledge; Helped them decide to be screened; They were ready to have the test/discussion	Multimedia tool interactive interface – Video Doctor before appointment for cancer screening and discussion re eligibility assessment. Assists the physician in providing information and screening tests	1.85% reported that the information increased their knowledge.	Yes	W
Çapık & Gözüm (2012)	Turkey Public institutions	"To investigate the effect of web-assisted education and reminders, based on the health belief model, for the purpose of increasing individuals' awareness about PCa, as well as the health belief, level of knowledge and early diagnosis behaviours regarding PCa." (p.71)	Quantitative single-group longitudinal design Health Belief Model	At baseline: n = 75 At follow-up: n = 73 M = 49.1 (SD 3.7) Age range = 41–65	Demographic data collected at pre-test: PCa screening knowledge test; Health Belief Model Scale; Screening participation form Data collected at pre-test (T1), 3 months (T2), six months (T3)	Print materials; Interactive educational sessions; Website- PCa, risk factors, early diagnosis, screening and availability, signs and symptoms of PCa. Reminders: Flyers, monthly e-mails, cell phone messages	1. Knowledge score increased from T1 to T3, but not significantly (p = 0.325).	No	W
Carter et al. (2010)	USA Two Black Belt counties	"To promote screening behaviour in African American men. The objectives were: to identify enablers and barriers to screening; to develop and	Mixed-methods: (Quasi-experimental three-phase design [focus groups, educational intervention, follow-up]) Pre- and post-test Community-Based	Focus groups: n = 74 (n = 39 men) Intervention: n = 405 (n = 239 men) Post-test: n = 204 men M = NR Age range ≥ 40	- Focus groups -Demographics survey Intervention based on focus groups findings. Screening confirmation postcard 3 month follow-up phone survey assessed	13 modules General knowledge of the prostate, PCa, screening, PCa treatment, patient empowerment, and insurance PCa Education Manual, a CD, and male	1. A significant change in knowledge post-test in 11 knowledge questions (p < 0.005).	Yes	W

Table 2 (*Continued*)

Author(s) & year	Country & Setting	Aim(s)	Study Design & Theoretical Underpinning	Study Population[a]	Data Collection Method & Instrument	Intervention	Findings[b]	Intervention supported knowledge gain (Yes/No/ Partly)	Quality Rating[c]
		test the effectiveness of an education intervention; and to determine the impact of the intervention on PCa screening rates through follow-up survey." (p.91)	Participatory Research Model		PCa knowledge increased PCa dialogue, screening behaviour, spousal support, and importance of women having knowledge of PCa	reproductive system models			
Cogbill et al. (2014)	USA - Database of African American previous study parti-cipants - Community organiza-tion and events	"To understand African American male attitudes on Colorectal Cancer (CRC) screening, receipt of CRC screening information and the best strategy to provide African American men online CRC screening education." (p.1)	Mixed-methods: (Focus groups and pilot project/ feasibility trial) Pre- and post-test	Focus groups: n = 18 M = NR Age range = 50–66 Intervention: n = 60 M = NR Age range = 50-72	Focus groups CRC and screening knowledge and concerns; Health information mode preferences; Demographic survey knowledge, and beliefs about CRC and benefits and barriers to screening Random assignment Email messages or one phone messages. Phone survey Reminder messages via telephone or email Website visits and acceptability	CRC website, educational materials consisted of screenshots of magazines- African American specific email and phone messages —facts about CRC Prompts to visit the website over a three week period	1. 70% of website users identified the correct screening age vs 56.4% at baseline (p = NR); 2.9%, 11.4% and 38.5% could correctly identify the appropriate frequency for COL, SIG and FOBT respectively.	Yes	W
Driscoll et al. (2008)	USA Community organisations	"To evaluate the process and outcomes of two community-based interventions to promote PSA Informed Decision Making (IDM)." (p.88)	Mixed-methods (Intervention and focus groups) Pre- and post-test	Intervention: At baseline: n = 361 At post-test: n = 339 At 6-months: n = 274 At 12-months: n = 254 Focus groups: At 6 months: n = 23 At 12 months: n = 24 M = NR Age range = NR	Survey Pre-intervention Post-intervention 6 and 12 month follow-up Semi structured in-depth interviews — Sampling- One upper-socioeconomic status (SES) and one lower-SES	-PSA only: Information about PCa and PSA tests; -Men's health Screening-heart attack, stroke, and colon cancer. Community educational sessions; 1. Oral presentation PCa or men's health poster 2. Video; men discussed PSA screening decisions.	1. Knowledge of PCa and PSA remained higher than baseline among low-er and higher SES group at 12 month fol-low up for both inter-ventions (p = NR).	Yes	M
Frencher et al. (2016)	USA Barbershops	"To investigate the effectiveness of using decision support instrument (DSI) to assist African American men in making PCa screening	Quantitative Pre- and post-test Community-Based Participatory Research Model	Intervention A: n = 60 Intervention B: n = 60 Mean = NR Age range ≥ 40	Pre- and post-test survey related to DSI intervention which addressed knowledge, intention and preferences.	*Intervention A*:b FIMDM DVD 'The PSA Decision: What YOU Need to Know' (23 min) Patient narratives Expert lectures PCa and screening information	*Interven-tion A*: 1. 23% pre-test identified PSA test compared to 55% at post-test. Interven-tion B: 1. Total PCa knowledge	Yes	W

Table 2 (*Continued*)

Author(s) & year	Country & Setting	Aim(s)	Study Design & Theoretical Underpinning	Study Population[a]	Data Collection Method & Instrument	Intervention	Findings[b]	Intervention supported knowledge gain (Yes/No/ Partly)	Quality Rating[c]
		decisions." (p.506)				*Intervention B*: VCU DVD Intervention: 'It's a Big Decision' cast and information tailored to African Americans	statistically higher than Intervention A $p < 0.005$) ($p < 0.001$).		
Ilic (2013)	Australia Workplace	"To explore the knowledge, awareness, and perceptions of male workers about PCa screening. The study also aimed to explore the perceived barriers and enablers to behaviour change in promoting greater uptake of health services relating to PCa as a result of workplace-based education campaigns." (p.287)	Qualitative Descriptive	n = 12 M = 42.75 (SD 9.4) Age range = 35–56	Semi-structured interviews using a topic guide	Help a Mate (HAM) campaign comprising pamphlet, calendar, and website with information about PCa and its screening	1. Increased PCa awareness-media campaigns and talking to PCa survivors.	Partly	M
Landrey et al. (2013)	USA General internal medicine clinics	To evaluate "the effect of a mailed low-literacy informational flyer about the PSA test on measures of shared decision making."(p.67)	Quantitative Pragmatic RCT	n = 303 Control n = 147 M = 62.4 (SD = NR) Age range = NR Intervention n = 136 M = 62.2 (SD = NR) Age range = NR	- Medical chart review -Follow-up telephone survey within 2 weeks of the clinic visit -Pragmatic RCT comparing the patient flyer sent 1 week before a scheduled annual health maintenance visit vs. usual care	A patient flyer with 6facts about PSA testing written at 4th grade level. It encouraged men to talk to their HCPs about the PSA test	1. PSA knowledge scores were the same in both arms of the trial 2. Unable to analyse differences in baseline education or literacy levels.	No	W
Luque et al. (2011)	USA Barbershops	To describe the outcomes of a community based, barber health adviser pilot intervention to promote knowledge, and awareness of PCa and IDM PCa screening among predominantly African American customers.	Quantitative Post-test Community-based participatory research	n = 40 M = 53 (SD = NR) Age range = 40–73	Post-intervention survey	Brochure; poster DVD, plastic prostate model; barber talking points card- early detection and screening; IDM based on current PCa screening guidelines. Content validity – four medical experts.	1. 78% – educational materials increased their knowledge of PCa (Z = –3.98, $p < 0.01$).	Yes	W

Table 2 (*Continued*)

Author(s) & year	Country & Setting	Aim(s)	Study Design & Theoretical Underpinning	Study Population[a]	Data Collection Method & Instrument	Intervention	Findings[b]	Intervention supported knowledge gain (Yes/No/Partly)	Quality Rating[c]
Luque et al. (2015)	USA Community	To demonstrate feasibility of the process of engaging barbers in a trial to improve PCa education in the community.	Quantitative Feasibility study Pre- and post-test	n = 11 (n = 10 men) M = 47 (SD = NR) Age range = 36–64	Receipt of education in barbershops. Intervention group (n = 6 shops) and control group (n = 6)	Feasibility of engaging barbers in a community trial to improve PCa education. Train barbers in intervention sites, to deliver the intervention over 6 months, conduct pre- and post-testing	Intervention group 1. Statistically significant difference between the average pre- and post-test knowledge score (72% and 89%, respectively).	Yes	W
McCormack et al. (2009)	USA Community	"To examine the impact of presenting theory based information about PSA alone (PSA-Only Intervention) or framed in the context of messages about other men's health intervention for which evidence is more certain (Men's Health Intervention) on men's knowledge about and decisions about PCa screening". (P. 239)	Quantitative Quasi-experimental longitudinal design	n = 584 M = NR Age range = 40–80	Baseline data Men's Health Group vs. PSA only group. Men's health group received information on PCa, CRC and cardiovascular screening. PSA only – more detailed information on PCa 45 min Intervention. Follow up interviews 6 and 12 months later by mail. Framed messages – PSA test uncertainty	Physician oral presentation by a/question-and-answer session 20-min video Web site Print materials, a trifold brochure, poster, and a pocket card DA	1. Men's Health intervention had lower knowledge pre-intervention than the PSA-Only (p < 0.001) and control groups (p = 0.001); Men's Health and PSA Only interventions groups had significantly greater knowledge increases than the control group (Men's Health, p < 0.001; PSA-Only, p < 0.05); Men's Health groups had greater knowledge gains than the PSA only group. 2. Greater health literacy, higher education, being married, previous PSA test, excellent self-reported health significantly associated with increased knowledge gain post	Yes	W

Table 2 (*Continued*)

Author(s) & year	Country & Setting	Aim(s)	Study Design & Theoretical Underpinning	Study Population[a]	Data Collection Method & Instrument	Intervention	Findings[b]	Intervention supported knowledge gain (Yes/No/Partly)	Quality Rating[c]
							intervention.		
McCree-Hale et al. (2012)	Jamaica Hospital outpatient clinics	"To evaluate the impact of a theory-based health education intervention on PCa awareness and intention to screen among men in Western Jamaica". (p.580)	Quantitative Pre- and post-test Transtheoretical Model and Health Belief Model	n = 207 (n = 118 completed both, pre- and post-test) M = 58.7 (SD = NR) Age range = 40–89	Interviewer administered 25-item questionnaire	Multimedia/ computer based health education group interventions attended by men (average of 4 in a group) lasting about 45 min	1. There was a significant improvement in PCa awareness (Knowledge of PCa screening tests, risk factors and symptoms) and intention to screen.	Yes	W
Partin et al. (2006)	USA Medical facilities for veterans	To examine (i) use of PCa screening DAs distributed as part of a RCT; (ii) whether reported use varied by type of aid (video or pamphlet); and (iii) what affect reported use had on PCa screening knowledge	Quantitative RCT	n = 893 M = 68 (SD 9.38) Age range ≥ 50	Phone survey one week post-clinic appointment DA use; PCa screening knowledge; Patient characteristics Information on chronic disease diagnoses and medications collected from outpatient databases	Effectiveness study to assess outcomes following: pamphlet, video or usual care	1. Video and pamphlet groups had significantly higher knowledge scores (7.44 (p = 0.001) and 7.26 (p = 0.03) respectively) compared to control group (6.90).	Yes	M
Rajbabu et al. (2007)	UK - GP surgeries —Community sources (social groups, pubs, railway stations) - County Councils	"To compare knowledge and beliefs about PCa of African/ Carribean (Black) and White men in the UK". "To ascertain if simple information provision improved knowledge of PCa symptoms and risk factors, and whether different racial groups would take such information equally". (p. 257)	Quantitative Experimental RCT	n = 871 (information = 429, no information = 442) M = 51 (SD = NR) Age range = 29–87	Validated questionnaire demographics, awareness, and perceptions	*Control group*: no information prior to filling questionnaire *Information group*: Information leaflet- PCa symptoms and risk factors which was posted to sample prior to questionnaire	1. Information group was able to identify more symptoms of cancer and more risk factors than the control group (p < 0.001) for both black and white men.	Yes	M
Ross et al. (2010)	USA Community Centre and Churches	"To evaluate the applicability of an evidence based video intervention to promote IDM for PCa among AA men with different levels of health literacy". (p.228)	Quantitative Pre- and post-test	n = 49 M = 59 (SD = NR) Age range = 35–91	Single Session pre- and post-test interview/ survey: Demographics; PCa screening history Test of Functional Health Literacy in Adults (TOFHLA); PCa knowledge –PROCASE Knowledge Index; Perceptions of the video	Video	1. PCa knowledge scores increased post-intervention. 2. Health Literacy associated with education (p = 0.002).	Yes	W

Table 2 (*Continued*)

Author(s) & year	Country & Setting	Aim(s)	Study Design & Theoretical Underpinning	Study Population[a]	Data Collection Method & Instrument	Intervention	Findings[b]	Intervention supported knowledge gain (Yes/No/Partly)	Quality Rating[c]
					information Balance of information				
Sandiford & D'Errico (2016)	USA Churches in suburban communities	To develop and implement "an educational intervention that uses a risk assessment decision tool to increase PCa knowledge and facilitate SDM for screening for AA men". (p. 87)	Quantitative Pre- and post-test Iowa Model Health Belief Model; Community Empowerment Model	n = 50 M = 57 (SD = NR) Age range = 30–75	Pre- and post-test knowledge questionnaire and risk assessment decision tool	4 stage intervention: 2-page PCa Screening DA. 30 min PCa facts PowerPoint presentation 4-min video of PCa survivors sharing their experience of coping with a PCa diagnosis	1. Increased PCa knowledge; increased awareness of personal risks, having information necessary to initiate a discussion with a HCP and intention to participate in SDM within six months.	Yes	W
Stamatiou et al. (2008)	Greece Hospitals	"To evaluate the impact of similar printed educational material on PCa screening by PSA and DRE". (p. 365)	Quantitative Randomised trial	At baseline: n = 1500 At 24-month: n = 1135 (informed = 548, non-informed = 587) M = NR Age range = 50–86	Self-reported improvement in knowledge. Correct responses to a brief questionnaire assessing knowledge, PSA and DRE screening	Control: Verbal information in the clinic Intervention: The above plus written leaflet on PCa screening	1. Self-reported increased knowledge, number of correct responses to questionnaire (42.8% informed group v 15% non-informed group), and PSA screening rate higher in intervention group; no difference in DRE (very low rates in both groups). No effect sizes provided.	Yes	W
Taylor et al. (2013)	USA Primary care outpatient clinics	To compare print-based DAs, web-based interactive DAs, and usual care in terms of PCa knowledge, decisional conflict, decisional satisfaction, and screening behaviour.	Quantitative Randomised trial	n = 1879 Print DA: n = 628 M = 56.7 (SD 6.8) Usual care: n = 626 M = 56.9 (SD 6.8) Web DA: n = 625 M = 57(SD 6.8) Age range = 45–70	3 time points: baseline, 1 month (T2) and 13 months (T3) post-intervention. PCa knowledge and screening, decisional conflict, decisional satisfaction, and screening outcomes	Print DA: prostate, screening tests, treatment options, risks, adverse effects, risk factors, discuss screening with HCP, values clarification tool and resources. Online DA: Text DA, voiceover, pop-up definitions, video testimonials, interactive values clarification	1. At 1 month web vs UCB, 2.26 (95% CI, 1.88–2.64; P < 0.001), and print vs UC B, 2.40 (95%CI, 2.02–2.78; P < 0.001). and at 13 months) web vs UCB, 1.46 (95% CI, 1.07–1.84; P < 0.001), and print vs UC B, 1.54 (95% CI, 1.17–1.91; P < 0.001). post-intervention.	Yes	M

Table 2 (Continued)

Author(s) & year	Country & Setting	Aim(s)	Study Design & Theoretical Underpinning	Study Population[a]	Data Collection Method & Instrument	Intervention	Findings[b]	Intervention supported knowledge gain (Yes/No/ Partly)	Quality Rating[c]
Thomas et al. (2014)	Australia Community	To assess whether participation in a community jury leads to different screening choices and information levels in comparison to factsheets only	Quantitative Randomised trial	n = 26 *Control:* n = 14 M = 62 (SD 4.9) *Community jury:* n = 12 M = 61 (SD 4.8) Age range = 50–70	3 time points: pre-, post-, and 3 months post-screening intention Self-reported knowledge of benefits and potential harm of screening Knowledge quiz	tool, and figures/graphics Control: Factsheets Intervention: Control factsheet, other factsheets and the community jury intervention	1. Increase in self-reported knowledge (effect size = 1.2) and in objective knowledge of accuracy of screening at post-test (no effect size given), maintained at 3-month follow-up.	Yes	W
Tomko et al. (2015)	USA Community	To assess the degree to which a web-based DA impacted important decision-making outcomes. The study is focused on the association of different facets of website use with the outcomes of PCa knowledge, decisional conflict, satisfaction, and screening behaviour.	Quantitative Pre- and post-test Ottawa Decision Support Framework	*Web-based DA at;* −*baseline:* n = 631 -*one month:* n = 257 -*13 months:* n = 238 *Total users:* n = 253 M = 57.5 (SD 7) Age range = NR	Demographic data, PCa knowledge, satisfaction with decision scale, decisional conflict scale, PCa screening, time on website, number of website sections, testimonial values and value clarification tool	Web-based DA included six video testimonials and values classification tool	1. All measures of website use were positively associated with greater knowledge.	Yes	M
vanVugt et al. (2010)	Netherlands Community	"To assess the effect of providing a leaflet including individualized risk estimation on IDM of men, i.e. knowledge about PCa and PSA screening, attitude towards undergoing a PSA test, and intention to have a PSA test". (p.669)	Quantitative Prospective intervention Theory of Planned Behaviour	*Men who completed Questionnaires 1 and 2:* n = 601 M = 59.5 (SD 2.9) Age range = 55–65	Questionnaire on PCa knowledge, attitude and intention to have a PSA test. Men without a history of PCa screening were sent the leaflet and Questionnaire 2 within 2 weeks after returning Questionnaire 1 Validated health and anxiety measures	Men without a history of PCa screening were sent the leaflet and Questionnaire 2 within 2 weeks after returning Questionnaire 1. Leaflet: Risk indicator-pros and cons of PCa screening, calculate individual risk of having a biopsy-detectable PCa	1. At the second assessment (questionnaire 2) significantly more men had relevant knowledge (284/601, 50% vs 420/601, 77%, p < 0.001).	Yes	M
Volk et al. (2008)	US Primary care centres	"To evaluate an entertainment-based patient DA for PCa screening among patients with low or high health literacy". (p.482)	Quantitative Randomised trial Edutainment Decision Aid Model	*Low-literacy site*: Entertainment Education (EE) intervention (n = 40) Audio-booklet control n = 49, M = 55.6 (SD 7.3) *High-literacy site*: EE intervention (n = 123) Audio-booklet control (n = 140) M = 56.1 (SD 6.1) Age range = 50–70	Post-intervention and 2-week follow-up conducted. Acceptability of DA Engagement with Entertainment DA Knowledge of PCa Decisional Conflict scale Patient	DA followed the Edutainment DA Model (EDAM) -combine a storyline with factual medical information - Patients were randomised to receive an EDAM for PCa screening or an audio-booklet	1. Knowledge improved for low and high health literacy patients 2. Patients at the low-literacy site were more engaged with EE than patients at	Yes	M

Table 2 (Continued)

Author(s) & year	Country & Setting	Aim(s)	Study Design & Theoretical Underpinning	Study Population[a]	Data Collection Method & Instrument	Intervention	Findings[b]	Intervention supported knowledge gain (Yes/No/Partly)	Quality Rating[c]
				non-African American Age range = 40–70 African American	Involvement in Health Care decision making		the high-literacy site.		
Watts et al. (2014)	Australia Community	"To examine the efficacy of an online screening DA for men with a family history of PCa". (p.1)	Quantitative Randomised trial Ottawa Decision Support Framework	*Baseline: Control:* n = 69 M = 56.5 (SD 9.9) *Intervention:* n = 69 M = 55.4 (SD 9) Age range = 40–79 *Post-reading: Control:* n = 55 *Intervention:* n = 47 *12-months post-test: Control:* n = 48 *Intervention* n = 42	Knowledge questionnaire, perceived risk; Inclination regarding PSA testing; Stages of decision making; Screening behaviour and Decision Regret Scale at 12 months	Tailored DA (intervention) Non-tailored information about PCa screening (control)	1. The DA had no effect on knowledge.	No	M
Williams-Piehota et al. (2008)	USA Community-based organisations	"To assess the usefulness of a health information styles segmentation strategy in understanding audience subgroups". (p.440)	Quantitative IDM intervention Pre- and post-test	n = 319 (Independent active = 131, doctor-dependent active = 151, passive = 37) M = 64.1 (SD 10.8) Age range = NR	Three health information style groups: independent active, doctor-dependent active, and passive. PCa knowledge; socio-demographics, attitudes, health behaviours and health status. Baseline questionnaire-in person 6 month follow up- via post	45-min physician oral presentation question and answer session 20-min video and print materials-brochure, poster and, shirt-pocket DA.	1. All groups had significantly increased PCa knowledge after the intervention. Passives exhibited the greatest increase in knowledge at a 6-month follow-up.	Yes	W

*Information refers to cancer prevention and risk reduction information.
1. Did intervention support knowledge gain? If yes, what was the effect size?
2. Impact of health literacy on knowledge gain.
Abbreviations: COL = Colonoscopy; CI = Confidence Interval; CRC =Colorectal Cancer; DA = Decision Aid; DRE = Digital Rectal Examination; DSI = Decision Support Instrument; EE = Entertainment Education; FIMDM: Informed Medical Decision Making Foundation; FOBT = Faecal Occult Blood Test; HAM = Help a Mate; HCP = Health Care Professional; IDM = Informed Decision-Making; NR = Not reported; PCa = Prostate Cancer; PSA = Prostate Specific Antigen; SD = Standard Deviation; SDM = Shared Decision Making; SES = Socio-Economic Status; SIG = Sigmoidoscopy; UC = Usual Care; VCU = Virginia Commonwealth University.
[a] Sample size (n); [mean age in years (y) ± standard deviation, age range in years(y)]; gender: males unless otherwise reported.
[b] Findings organised according to the following research questions.
[c] Quality Tools The Effective Public Health Practice Project (EPHPP) Quality Assessment Tool for Quantitative Studies [26]: M = Moderate, W = Weak; Critical Appraisal Skills Programme (CASP) Qualitative Checklist [27]: M = Moderate.

involving cancer survivors. Opinion papers, policy reports conference abstracts, dissertations and theses were also excluded.

2.3. Study selection and data extraction

Covidence support software was used for screening of papers and data extraction [25]. Paired authors independently screened records on title and abstract and evaluated the full-texts of potentially eligible papers. Disagreements were resolved by consensus or a third reviewer. The reference lists of eligible studies were also reviewed. All the authors extracted data from eligible studies using a predefined extraction table (Table 2). Data extraction included: author(s); year; country and setting; study aim(s); study design and theoretical underpinning; data collection method and instruments; and findings relating to the review aims.

2.4. Assessment of methodological quality

The Effective Public Health Practice Project (EPHPP) Quality Assessment Tool for Quantitative Studies [26] and Critical Appraisal Skills Programme (CASP) Qualitative Checklist [27] were used to assess methodological quality. Eligible studies were included regardless of methodological quality in order to reduce the risk of bias [28].

2.5. Data synthesis

Data synthesis was conducted (MR) and cross-checked (FJD). Findings were analysed and synthesised thematically according to the review aim. The primary outcome of interest was the extent to which the intervention supported knowledge gain about cancer

risk reduction information among men. We defined knowledge gain as increased knowledge about cancer risk reduction information at any time following the intervention. Cancer risk reduction information was defined as the provision of information about how to avoid or reduce carcinogenic exposures, adopt behaviours to reduce the cancer risk, or to participate in organised intervention programmes [13].

As a secondary outcome, we focused on the consideration given to health literacy in intervention development and the effect of health literacy on knowledge gain. Health literacy is an evolving concept in health promotion [29]. We used Sørensen's conceptual model of health literacy i.e. health literacy is "linked to literacy and entails people's knowledge, motivation and competencies to access, understand, appraise, and apply health information in order to make judgements and take decisions in everyday life concerning healthcare, disease prevention and health promotion to maintain or improve quality of life during the life course" (p3) [30].

The Test of Functional Health Literacy in Adults (TOFHLA) [31] concepts of categorising health literacy levels were used. People with inadequate health literacy are defined as those unable to read or interpret health related material, people with marginal health literacy have difficulty reading or interpreting such material, and people with adequate health literacy can read and interpret the majority of health related texts [31].

3. Results

3.1. Study selection

Overall, 4117 titles were identified. Following duplicate deletion, 3374 records were screened on title and abstract and 3054

were excluded. The full-texts of 320 papers were evaluated and 25 intervention studies were included (Fig. 1) [32].

3.2. Study characteristics

Seventeen studies originated in the United States, three studies in Australia, and the other studies were undertaken in Turkey, the United Kingdom, Greece, and the Netherlands. Twenty-three studies addressed prostate cancer risk reduction information, one intervention addressed colorectal cancer information, and one study addressed multiple cancers including prostate and colorectal cancers. Participants were recruited from communities, churches, barbershops, workplaces, universities, hospitals, and primary care centres.

The most common intervention formats were educational sessions, print materials, DVDs, and multimedia computer-based information such as on-screen graphics and video clips. Seven US studies predominantly targeted African American men only, and the other studies focused on racially diverse participants from the US, Europe, Australia, and Jamaica.

Participant ages ranged between 29 [33] and 91 years [34] and sample sizes ranged from 10 [35] to 1879 [36]. Studies were predominantly randomised controlled trials (RCT; n = 9) and pre-post-test designs (n = 12). Other study designs included longitudinal (n = 2), qualitative (n = 1), and post-test measurement only (n = 1). Twelve studies were underpinned by one or more theoretical models including the: Ottowa Decision Making Framework (n = 3); Health Belief Model (n = 3); Theory of Planned Behaviour (n = 1); Transtheoretical Model of Behaviour Change (n = 2); Edutainment Decision Making Model (n = 1); Community Based Participation Model (n = 3); and Community Empowerment Model (n = 1).
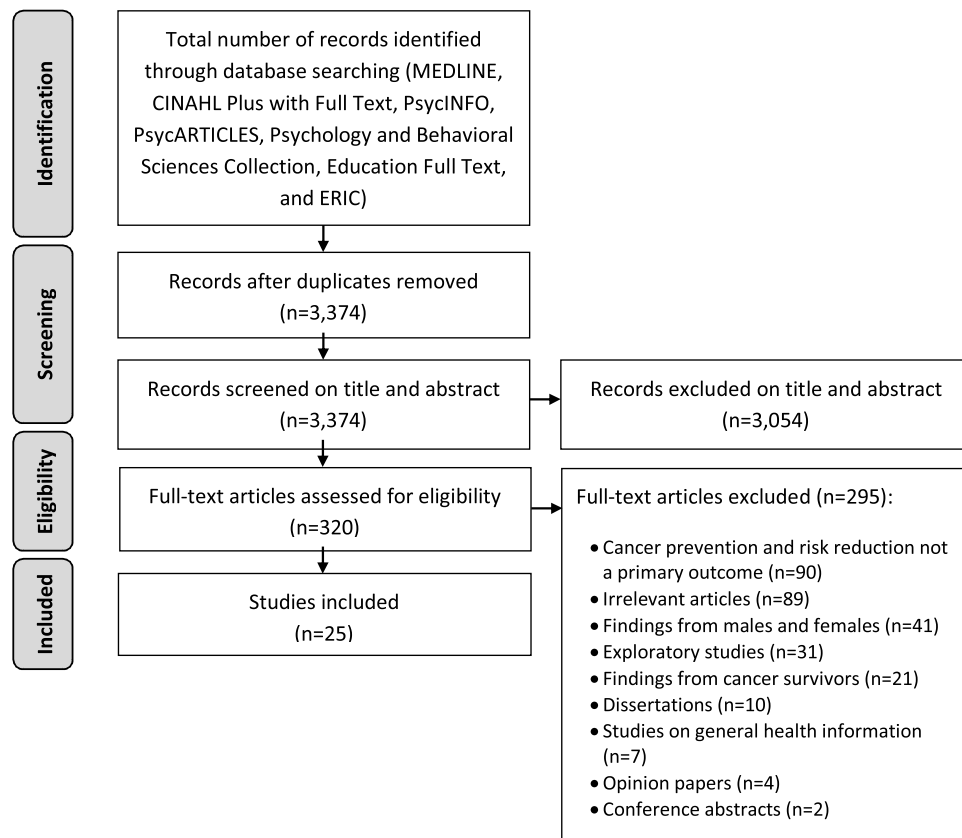

Fig. 1. Study identification, screening, and selection flowchart [32].

3.3. Critical appraisal

The quality rating of intervention studies ranged from weak (n = 15) to moderate (n = 9). The global rating assigned to individual studies depended on the clarity and detail of reporting regarding selection bias, study design, confounders, blinding, data collection, withdrawal and dropouts, intervention integrity, and analyses. Studies with a global rating of "weak" were assigned two or more weak ratings, while studies with a global rating of "moderate" were assigned one weak rating [26]. The qualitative study was rated as being of moderate quality because the relationship between the researcher and the study participants was unclear [27].

3.4. Synthesis of results

The results from individual studies are presented in Table 2. Study findings were synthesised based on two areas: knowledge gain post-intervention and the influence of health literacy on knowledge gain.

3.4.1. Knowledge gain post-intervention

Twenty-one studies using multimodal approaches such as printed materials (e.g. brochures, leaflets, and calendars), education sessions, interactive video, online, and audio intervention components reported knowledge gain. One study partly supported and three did not significantly support knowledge gain. Knowledge gain following the intervention was measured at different times, from immediately to two weeks post-intervention (n = 14) to between three to twenty-four months post-intervention (n = 10). Various methods were also used to assess knowledge gain, including adaptations of validated scales such as the PROCASE Knowledge Index [37], study specific surveys based on previous evidence or national guidelines, in-depth focus groups or individual interviews.

Men in the 'Take the Wheel' interactive video/audio workplace-based intervention had significantly improved prostate cancer knowledge scores post-intervention compared to non-users (79% vs. 43%; p < 0.01) [38]. Ilic et al. reported that the workplace-based 'Help a Mate' intervention increased participants' awareness of prostate cancer [39].

Taylor et al. used a study-specific knowledge scale to measure prostate cancer knowledge among men who received identical web and print-based decisional aids (intervention group) and those who received usual care (control group). In comparison to the control group, the intervention group had >2-fold increase in knowledge one month post-intervention (p < 0.001) and a 1.5-fold increase 13 months post-intervention [36]. In an intervention aimed at older men, the intervention groups had higher prostate cancer screening knowledge scores after using either of two mailed decisional aids, i.e. a video (7.44, 95%CI 7.22 to 7.65; p = 0.03) or pamphlet (7.22, 95%CI 7.06 to7.49; p = 0.001), compared to the usual decision-making support given during routine appointments (6.90, 95%CI 6.68 to 7.13) [40]. Similarly, most older users (85%) of the 'PreView Interactive Doctor/Provider Alert' agreed that they had increased prostate cancer screening knowledge following the intervention [41].

PowerPoint presentations used to deliver culturally relevant prostate cancer information to men with low literacy (95%) in group settings resulted in improvements in 13 prostate cancer knowledge items (p ≥ 0.0135) post-intervention [42]. African American men who attended a 30-min PowerPoint presentation demonstrated an 8% increase in correct responses on the post-intervention questionnaire (69% vs 77%) [43]. Another intervention aimed at African American men reported that knowledge about prostate cancer increased significantly in 11 knowledge questions (p < 0.005) following an intervention with 13 modules, which focused primarily on prostate cancer, screening, and treatment [44].

Two interventions providing identical information on prostate cancer screening in different formats (i.e. the computerised 'Edutainment' decisional aid or an audio-booklet decisional aid), reported knowledge gains two weeks post-intervention for all men regardless of the decisional aid format [45]. McCormack et al. compared two community-level multimedia educational interventions, the Prostate Specific Antigen (PSA)-Only intervention which provided information about prostate cancer and PSA testing and the Men's Health intervention which provided information about screening for and prevention of heart attacks, strokes, and colon cancer. Both intervention groups were compared to each other and to men who received no information (control group) [46]. Both intervention groups demonstrated greater knowledge gains than the control group at 1- and 12-month follow-up (PSA-Only; p < 0.05, Men's Health; p < 0.001). The Men's Health group had the greatest overall knowledge gains at 12-month follow-up [46]. In another study using the same PSA- Only and Men's Health interventions, knowledge increased markedly in both intervention groups [47]. A decrease in knowledge was reported at the 12-month follow-up; however, knowledge gain remained higher than baseline in the intervention groups [47].

In barbershop video-based interventions aimed at African American men aged ≥40, the culturally tailored group decisional aid resulted in greater prostate cancer knowledge than the generic decisional aid (2 vs 1.5 points) [48]. Luque et al. used culturally and linguistically appropriate print materials and a DVD, supplemented by a prostate model, and delivered by African American barber health advisors. A significant increase in knowledge was reported post-intervention (p < 0.01) [49]. Additionally, Luque et al. found significantly higher post-training prostate cancer knowledge scores among barber health advisers compared to pre-training (89% vs 72%; p < 0.05) [35].

An illustrated prostate cancer education leaflet and physician-discussion intervention improved prostate cancer knowledge among 48.2% of men compared to 15% of the control group (physician discussion only) after 24 months [50]. Similarly, Thomas et al. found that men in a community jury who received a PSA fact sheet with expert and peer discussion, were more informed about prostate cancer screening than those who received the PSA fact sheet only (mean difference = 1.7; effect size = 1.2 SD; p < 0.001) [51]. Furthermore, the intervention group (information leaflet) was able to identify more prostate cancer symptoms than the non-intervention group in a community-based study (mean symptom score 3.1 vs 2.3; p = 0.001). However, knowledge gain varied by ethnic group [33].

In a study exploring the use of an interactive web-based decisional aid for prostate cancer screening, linear regression indicated that greater use of the website was associated with significantly higher knowledge scores (≥30 vs.<30 min) on the website [B = 0.91 (95% CI = 0.40,1.42), p < 0.001] [52]. An intervention using the 'Prostate Risk Indicator' leaflet-based decisional aid among educated older men found that significantly more men were classified as having sufficient prostate cancer knowledge two weeks post-intervention (50% vs 77%; p < 0.001) [53]. In an online colorectal cancer decisional aid, 70% of users identified the correct screening age compared to 56.4% at baseline. There were also improvements in knowledge about the frequency of colonoscopy (2.9%), sigmoidoscopy (11.4%), and the faecal occult blood test (38.5%) [54].

Some interventions did not significantly support knowledge gain. These included a pamphlet about PSA testing designed for those with low literacy [55], an online decisional aid for men with a familial history of prostate cancer [56], and a multi-media intervention including an educational session, print media,

website, monthly email, and text messaging about prostate cancer screening participation [57].

3.4.2. Influence of health literacy on knowledge gain

Health literacy is linked to the person's capacity to find, process, and apply health information in order to make judgements and take decisions concerning health related issues to maintain or improve quality of life across the lifespan [29,30]. Three studies found that health literacy levels were associated with knowledge gain [34,45,46]. In a video-based intervention, Ross et al. reported that the highest knowledge gains were achieved among men with inadequate health literacy (+2.05) as compared to those with marginal health literacy (+1.50) and adequate functional health literacy (+1.27) measured using the TOFHLA [34]. McCormack et al. found that higher health literacy levels were a key factor associated with greater knowledge in the Men's Health Group and PSA-Only Group [46]. Volk et al. reported that an 'Edutainment' decisional aid model resulted in improved knowledge gain for men with inadequate or marginal and adequate health literacy post-intervention. However, those with inadequate or marginal health literacy were more engaged with the entertainment-based aid than men with adequate health literacy [45]. In contrast, Landrey et al. were unable to analyse differences in education or literacy levels on the benefit of PSA screening information [55].

4. Discussion and conclusion

4.1. Discussion

4.1.1. Principal findings

This novel systematic review found that the majority of interventions promoted knowledge gain regarding cancer risk reduction among men of different ethnicities, ages, health literacy, and literacy levels. A common feature of the interventions identified is that they aimed to improve men's uptake of cancer risk prevention information, decision-making regarding information uptake, and ultimately decision-making and screening uptake.

Physicians were identified as key information sources and men were more likely to act on prostate cancer screening information provided by physicians [46]. Culturally appropriate approaches [42] and the use of prominent civic figures [49] were also successful in increasing knowledge. Furthermore, barbershop interventions facilitated knowledge gain [35,48].

Information format was perceived as important. For instance, information segmentation [58]; easy to read language, large font size, bullet points, summaries [42,55]; visual aids and models [49]; and entertainment-based interventions [45] were successful in engaging men with cancer risk reduction information. Furthermore, finding ways to make health information more relevant is key to reaching men [59].

The internet could be used for health education if users are directed to reliable sources [60]. The internet provides anonymised information and facilitates privacy and control over the information sought, which is important to many men [61,62]. However, interventions involving text, email, or phone reminders did not promote significant knowledge gains [55–57]. Environmental and resource barriers including internet access and text system technical and administrative challenges had an impact on the effectiveness of these interventions in improving cancer risk reduction knowledge levels [54].

Inadequate or marginal health literacy affects almost half of European adults [63]. However, it was considered in only four intervention studies [34,45,46,55]. Other ways to improve information delivery were evidenced in the wider literature [64]. Methods which are also useful for those with low health literacy included: easy-to-read leaflets, large font size, bullet points, and summaries [42,55,65,66] and simple language, visual aids, line diagrams, and anatomical models [42,49,65,67]. Furthermore, men prefer direct, short, and sharp information, utilising plain language with no medical terminology, limited statistics, group sessions, visually-based educational materials [68,69] and culturally appropriate photographs and materials [42,65,66].

4.1.2. Limitations

Only studies from 2006 onwards were included, which may have resulted in omission of important studies. Due to heterogeneity in study design, it was not possible to conduct a meta-analysis. Moreover, although our search categories were broad to capture all studies investigating cancer risk reduction interventions among men (Table 1), those identified were predominantly in relation to cancer screening, and more specifically prostate cancer screening among African American men. While risk of prostate cancer among African Americans is almost double that of Caucasians [70], the decision to undergo prostate cancer screening is important for men of all ethnicities, given the prevalence of prostate cancer worldwide [7] and the longer-term impact of prostate cancer and treatment for men [71–73]. Interventions aimed at increasing knowledge of other cancer screening tests among other cancers, including colorectal cancer, were under-represented. Furthermore, while cancer screening can reduce the number of people who develop or die from the disease, intervention studies investigating the effectiveness of information on other risk reduction behaviours like weight reduction, nutrition, exercise, and smoking cessation among men [11–13] were not identified. Moreover, interventions tailored to men with low literacy and health literacy were lacking. These represent major gaps in the literature, which need to be addressed in future research.

4.2. Conclusions

Interventions aiming to improve men's knowledge about cancer risk reduction require a multimodal approach. Findings highlight the need to provide men with trustworthy and accessible information; for physicians to partake in targeted health promotion activities; and for researchers to design and measure the impact of interventions aimed at men from different socio-demographic and ethnic backgrounds and literacy and health literacy levels.

This systematic review demonstrated that the majority of interventions promoted knowledge gain about cancer risk reduction among men of different ethnicities and age groups. Researchers are encouraged to consider men's informational needs, preferred learning strategies, and health literacy when designing interventions and to address the influence of health literacy levels on men's engagement with information. Understanding how and where to engage men with this information is important, because of the ongoing disparity between cancer incidence and mortality between men and women.

4.3. Implications for practice

There is a dearth of interventions designed to improve men's knowledge of cancer risk reduction strategies more generally. Interventions that successfully increased knowledge could be used more widely. Physicians remain an important information source, however, increasing strain on primary care means that this is increasingly unavailable to men [74,75]. A greater focus on matching information sources with men in terms of literacy, age, and preferred format as well as removing technological barriers is needed by those involved in the provision of cancer information.

More research is warranted into the development and evaluation of theoretically driven multimodal community-based approaches to information delivery to men. This could be achieved using men's preferred/usual environment (e.g. workplaces) and community environments such as the Men's Shed Association.

Acknowledgements

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