Understanding patient factors to increase uptake of cancer screening: a review

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Early detection of cancer through organized screening is a central component of population-level strategies to reduce cancer mortality. For screening programs to be effective, it is important that those invited to screening participate. However, uptake rates are suboptimal in many populations and vary between screening programs, indicating a complex combination of patient factors that require elucidation to develop evidence-based strategies to increase participation. In this review, the authors summarize individual-level (sociodemographic and psychosocial) factors associated with cancer screening uptake and evidence for the effectiveness of behavioral interventions to increase uptake. The authors reflect on current trends and future directions for behavioral cancer screening research to overcome challenges and address unmet needs in reducing cancer mortality.

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The worldwide cancer burden is growing rapidly against the background of an aging population. In 2020, there were an estimated 19.3 million new cancer cases and 10 million cancer deaths globally, and it is estimated that annual cancer cases will increase to 28.4 million by 2040 if current trends continue [1]. Diagnosis of cancer at an early stage is crucial to reducing cancer mortality rates. Many countries have set targets to drive for earlier and faster cancer diagnosis. For example, in England the National Health Service set the goal that the proportion of people with cancer diagnosed at an early stage will increase from approximately 50–75% by 2028 [2].

Early detection of cancer and precancer through screening of asymptomatic people forms a key part of any national cancer strategy. There is high-quality evidence from randomized controlled trials that organized screening is effective at reducing cancer mortality [3–6]. Consequently, there are established national screening programs for breast, cervical and colorectal cancer in many countries. Screening for lung cancer is currently under expansion internationally, and screening for prostate cancer is available but not recommended as an organized program. Organized cancer screening has been implemented in most European countries, North America, Australia and parts of Asia but is less common in low- and middle-income countries, including those in Central and South America, Africa and the Eastern Mediterranean region.

In this review, the authors examine patient factors in cancer screening uptake, summarizing evidence known to the authors combined with evidence identified through ad hoc ‘scoping’ searches to fill gaps and update our knowledge. The authors highlight key defining developments, relying generally on the interpretation of the authors of the original research. The authors include some evidence of prostate cancer screening uptake because it may be relevant to other cancer screening programs, such as with regard to understanding engagement of men in colorectal and lung cancer screening.

The authors focus primarily on evidence from the UK and US, supplemented by evidence originating from other countries with organized cancer screening. The UK and US have generated much of the relevant research into patient factors in cancer screening, indicating potential shortcomings of the generalizability of current knowledge to screening uptake globally and the need for more research in different cultures and health systems. Although country-specific nuances of screening programs and their organization can make it difficult to transfer lessons learned in one country to another, inclusion of evidence from both the UK and US offers insight into patient

Table 1. US Preventive Services Task Force and UK National Screening Committee cancer screening recommendations.

	USPSTF	UK NSC	Ref.
Breast cancer screening	Women aged 50–74 years get a mammogram every 2 years. Women aged 40–49 years may start screening subject to individual values and preferences.	Women aged 50–70 years get a mammogram every 3 years. Women aged 71 years and over can self-refer to continue screening.	[7,8]
Cervical cancer screening	Recommended in women aged 21–29 years every 3 years with cervical cytology alone and in women aged 30–65 years every 3 years with cervical cytology alone, every 5 years with high-risk HPV testing alone or every 5 years with HPV testing in combination with cytology (co-testing).	Women aged 25–64 years get HPV primary screening; every 3 years for ages 25–49, then every 5 years until the age of 64.	[9,10]
Colorectal cancer screening	Women and men aged 45–75 should be regularly screened. Several screening strategies, including stool tests, flexible sigmoidoscopy, colonoscopy and CT colonography (virtual colonoscopy), are recommended. Adults aged 76–85 years should be selectively offered screening.	Women and men aged 60–74 years (50–74 years in Scotland) get a FIT every 2 years (FOBT in Northern Ireland).	[11,12]
Lung cancer screening	Women and men aged 50–80 years with a 20 pack-year smoking history and who currently smoke or have quit within the past 15 years get a low-dose CT scan annually.	Not recommended (under review).	[13,14]
Prostate cancer screening	Not recommended, but men aged 55–69 years can get a PSA test after individualized discussion of the benefits and risks.	Not recommended; however, men over 50 can get a PSA test but should consider the benefits and risks.	[15,16]

CT: Computed tomography; FIT: Fecal immunochemical test; FOBT: Fecal occult blood test; PSA: Prostate-specific antigen; UK NSC: UK National Screening Committee; USPSTF: US Preventive Services Task Force.

factors in cancer screening within two contrasting healthcare systems. Cancer screening in the UK is free at the point of delivery, supported by the UK National Screening Committee, and includes systematic call and recall of eligible patients based on their registration with a general practitioner. By contrast, there is no centrally organized cancer screening in the US, but patients can self-refer and discuss screening with their doctor via health insurance or government-run health programs. Current US Preventive Services Task Force and UK National Screening Committee cancer screening recommendations are shown in [Table 1](#).

Uptake is typically defined as the percentage of those invited who receive an adequate screen (a definitive test result) within a specified period after their test. Uptake has been described as the most important factor in determining the success of a cancer screening program [17]. There are several reasons why participation in cancer screening should be high. First, high uptake ensures that an adequate number of cancers are detected early, with a significant enough reduction in cancer-specific mortality to make the program cost-effective. Second, there are disparities in uptake between different sociodemographic groups, which means that low uptake of screening could contribute to widening inequalities in cancer survival. Third, those most at risk of cancer may be least likely to be screened – an example of the ‘inverse care law’ [18] – potentially compromising the effectiveness of screening.

The benefits of a cancer screening program should outweigh the harms. Potential benefits include a reduction in cancer-specific mortality, reduced health service costs, greater awareness of the disease and its symptoms and emotional reassurance. Potential harms can include diagnosis of a cancer that would not have caused a problem during the patient’s lifetime (‘overdiagnosis’), false-positive results and unnecessary treatment leading to greater costs, associated risks and complications of diagnostic procedures and emotional distress to the patient. It is not the goal simply to achieve greater uptake but to achieve uptake based on informed decisions that involve understanding and consideration of the potential costs and benefits of taking part in screening [19]. This requires the provision of information explaining the potential consequences in a way that can be understood so that an autonomous and informed decision can be made that is consistent with individual values and beliefs [20]. Cancer screening participation should therefore be a personal choice and not a directive from an authority.

Data from the National Health Interview Survey in the US indicate that uptake of cancer screening varies according to cancer type: 81.3% for cervical screening, 71.7% for breast screening and 63.4% for colorectal screening [21]. Uptake of National Health Service cancer screening programs in England is 72.2% for cervical screening [22], 69.1% for breast screening [23] and 57.9% for colorectal screening [24]. Variations in uptake between cancer screening programs highlight the challenges of understanding barriers to screening that may vary across screening programs, each of which utilizes a different screening method and targets a distinct ‘at-risk’ population group ([Table 1](#)).

Table 2. Overview of patient factors examined in relation to uptake of cancer screening.

Sociodemographic factors	Capability factors	Motivational factors	Opportunity factors
Sex	Knowledge	Emotions	Social norms and stigma
Age	Mental and physical capability	Habits	Environment and resources
Socioeconomic status	Health literacy	Attitudes and beliefs	
Race/ethnicity		Perceived efficacy and response efficacy	
		Perceived risk	
		Intentions	

Screening modalities can change over time; for example, the guaiac fecal occult blood test (FOBT) for colorectal screening has been replaced in many countries by the simpler to use fecal immunochemical test (FIT), whereas more invasive flexible sigmoidoscopy and colonoscopy methods are also in use as a primary screening tool in some countries. Eligibility guidelines for screening are also regularly reviewed; for example, a proposed age extension to National Health Service breast cancer screening is currently being trialed [25]. Despite such developments, much of the previous research into patient factors and the various influences on screening behavior remains relevant to current screening strategies.

To reduce cancer mortality, there is a need to understand patient factors associated with cancer screening uptake (including sociodemographic characteristics such as age and psychosocial factors such as perceived risk of cancer) and to draw on behavioral science to inform interventions to promote greater engagement with screening programs. It is acknowledged that patient factors represent only one component of the multilevel influences on screening behavior [26], but they are central to increasing uptake of cancer screening.

This review aims to narratively summarize evidence of the association between patient factors and cancer screening participation, describe advances in behavioral strategies to promote uptake and consider current and future challenges in the field of cancer screening behavior. The authors consider the role of sociodemographic and psychosocial factors, including those that contribute to an individual's capability, motivation and opportunity to engage in cancer screening. Similarly, the authors consider interventions that operate at the individual level via a range of behavioral mechanisms. Considerations for future directions in the field include developments in cancer screening that could significantly impact patient engagement. This review gives a broad overview of the association between patient factors and cancer screening uptake along with intervention approaches that have been evaluated for their effectiveness at promoting uptake. Although the authors do not systematically present comparable quantitative data for these associations and effects, the overview facilitates consideration of knowledge gaps and future directions that should be addressed through the further collection of such data in future research.

Patient factors associated with uptake of cancer screening

Patient factors summarized in this review, with psychosocial factors organized by the 'capability,' 'opportunity' and 'motivation' system (COM-B) [27], are shown in [Table 2](#).

Sociodemographic factors

Sex

Uptake of colorectal cancer screening in the UK is consistently higher in women than men [24,28,29], and women report slightly higher uptake than men in the US [21]. Men are less likely than women to adhere to three annual colorectal screens in Australia [30]. However, the relationship between sex and colorectal cancer screening uptake can depend on the screening modality and context [31]. A pilot study comparing FIT testing with FOBT in England observed a greater increase in uptake of FIT in men than women, reducing the absolute difference from 5.7 to 3.6% [32].

Uptake of lung cancer screening may be lower in women than men, but much of this evidence originates from trial contexts and so is not necessarily representative of the general screen-eligible population [33]. In the US, where uptake of lung cancer screening has been very low (~18%) since it was recommended, there are no differences between men and women in uptake [34,35] or in returning for a second annual screen [36]. Overall, differences between the sexes are small, and there are likely to be other more important factors influencing cancer screening uptake.

Age

Uptake of breast cancer screening increases with age in both the UK and US. For example, in England in 2018–2019, there was a 68.2% uptake of breast cancer screening in women aged 50–52 years, increasing to 73.2% in those aged 65–70 years [23]. This gradient is supported by data that include those invited as part of the age extension trial, with only 66.5% uptake in women aged 45–49 years. Age differences in breast cancer screening participation in the US are smaller than in the UK. The participation of women aged 65–74 years is slightly greater than that seen in those aged 50–64 years (72.2 vs 71.3%) [37]. Uptake of colorectal cancer screening is also higher in older age groups [38], a trend observed particularly in men [28].

There is a more complex association between age and cervical screening, reflecting the broader age range targeted. Coverage (the percentage of the eligible population screened adequately within a specified period) in England increases with age from the 25–29 to 50–54 age groups but then declines in older groups [22]. In the US, uptake peaks in the 30–39 age group [39]. Evidence from the research context suggests adherence to lung cancer screening is higher in the 60–74 age group than in younger and older age groups [36]. The relationship is less clear within implemented screening in the US, where two analyses found no difference in uptake by age [34,40] and one found greater uptake in the 65–80 age group than the 55–64 age group (16.5 vs 12.4%) [35]. There appears to be no difference in lung cancer screening uptake by age in pilot UK programs [41].

Socioeconomic status

There is a well-established socioeconomic gradient associated with cancer screening uptake. Colorectal cancer screening uptake is consistently lower in areas of greater deprivation in England [28,29,42], and women living in more socioeconomically deprived areas are less likely to attend breast, cervical and colorectal cancer screening [43,44] and to have ever been screened for these three cancers [45]. The association between greater deprivation and lower uptake was stronger for breast and colorectal screening than cervical screening in a study of women in Scotland [44]. In the US, higher education, higher income and health insurance are associated with greater likelihood of recent breast, cervical and colorectal cancer screening [21,39,46,47], although the gradient is less evident for income and cervical screening [21]. Lower uptake of colorectal screening has been observed in more disadvantaged groups in other countries, including Italy and South Korea [48]. Participation in lung cancer screening in the US is higher in those with a high school education than those without, reinforcing the importance of socioeconomic status markers in cancer screening uptake [47]. However, those with more than a high school education are also less likely to have been screened, an anomaly compared with other types of cancer screening, and time will tell if this association persists as lung screening becomes more established.

Race/ethnicity

Lower uptake of cancer screening has been consistently observed in nonwhite ethnic groups. In the UK, there is good evidence that uptake of all three of the main cancer screening programs is lower in more ethnically diverse areas [29,49,50], especially in South Asians [50–53]. In the US, non-Hispanic Black women have higher mammography coverage than white women (69.7 vs 65.8%), whereas other ethnic groups all have lower coverage (e.g., 60.9% in Hispanic women) [37]. A review of ethnic group participation in FOBT colorectal cancer screening programs found that there were minimal available data from countries other than the UK, preventing conclusions from being drawn [48]. US data show that African American/Black women have higher uptake of cervical screening (74.6%) than white (68.4%) or Hispanic/Latina women (68.6%) [54]. Aboriginal and Torres Strait Islander communities in Australia are less likely to engage in cancer screening than non-Indigenous groups (e.g., 34 vs 56% for cervical screening) [55,56]. In a meta-analysis, white participants were more likely to attend lung cancer screening compared with nonwhites [36]. Disparities between ethnic groups may be influenced by factors associated with minority group status, such as language and cultural barriers. For example, uptake of breast cancer screening in Norway was found to be 53.1% in immigrants versus 76.1% in nonimmigrants [57]. The Norway data showed that the difference reduced with increased duration of residency, suggesting that barriers are linked to assimilation to the country.

Capability factors

Knowledge

Lack of knowledge of cancer and screening is an important barrier to screening participation [58]. Awareness of the existence of cancer screening programs has generally been found to be high, especially for longer established

programs [59–61]. Nevertheless, there can be misconceptions in the general public about the purpose of cancer screening [62,63] or about the necessity of screening in the absence of cancer symptoms [63,64]. Avoidance of cancer risk information was associated with lower participation in colorectal cancer screening in a nationally representative US sample [65]. Knowledge was lower in several minority ethnic groups compared with a white sample in England [66], and knowledge deficits may be associated with language barriers [67]. A population-based survey in England found knowledge regarding the purpose of breast and FOBT screening, but not cervical or flexible sigmoidoscopy screening, to be lower in ethnic minority groups and lower social grades and higher in previous screening participants [63]. Knowledge about the benefits and harms of screening is essential for informed uptake; however, screening invitations can lack the information necessary to promote knowledge and informed choice [68], and it is unclear to what extent screening participants understand the information they are given [69].

Mental & physical capability

Individuals with a learning disability are less likely than other people to attend cancer screening [70]. In Scotland, women with learning disabilities were found to have lower levels of participation in all three cancer screening programs [44]. In the same study, women with depression or greater multimorbidity were less likely to participate in colorectal and breast but not cervical cancer screening. Individuals with psychosis or more severe mental health problems have particularly low uptake of cancer screening [71–73]. Better self-rated health was associated with colorectal cancer screening participation in England and significantly mediated the relationship between socioeconomic status and uptake [74]. Some patients do not attend screening because they are already undergoing treatment for the cancer of interest or have other medical reasons that would make participation inappropriate [75].

Health literacy

Lower health literacy, numeracy and cognitive ability are associated with lower uptake of cancer screening [76,77]. Studies have demonstrated that better health literacy is associated with greater screening knowledge, lower cancer fatalism (the belief that death is inevitable when cancer is present) and a more positive attitude toward screening, so it is likely that low health literacy and numeracy are also a significant barrier to informed uptake of cancer screening [78].

Motivational factors

Emotions

Theories that explain protective health behavior often provide a greater role for negative emotions, such as worry and fear, than positive emotions. Cancer worry is a motivator for breast, cervical and colorectal cancer screening [79–81], although moderate levels of worry appear more motivating than low or high levels. Fear may be an important factor in cancer screening in general [82] and has been shown to have a complex relationship with uptake, operating as both a barrier and a facilitator. For example, fear, worry and disgust are more prevalent in groups least likely to participate in cancer screening [83,84], whereas fear of cancer in the absence of screening can motivate screening attendance [85]. Other sources of fear as a barrier can include screening invitations, screening methods and the prospect of abnormal test results [86]. Fear of potential embarrassment, discomfort or pain is a barrier to breast, cervical and colorectal screening [81,87–90]. Greater disgust, such as that associated with handling stool samples, is a predictor of colorectal cancer screening avoidance [91]. The evidence overall suggests that emotions are associated with uptake, but different aspects of emotions can impact on decision and action processes.

Habits

Research in a wide range of contexts has consistently found that past behavior is the best predictor of future behavior. It is unsurprising, then, that past screening attendance is the largest single predictor of future attendance [92] and those who participate in one cancer screening program are significantly more likely to participate in others [44]. This suggests, given the different levels of uptake observed, that there are barriers that are common across screening programs and others that are unique [93]. Promoting first-time participation may be key to improving uptake in nonattenders.

Attitudes & beliefs

Despite its potential risks, most individuals report enthusiasm for cancer screening [94,95]. It is unclear to what extent attitudes are influenced by information about benefits and harms of screening. For example, positive attitudes

toward cancer screening are observed even where individuals have been presented with information about potential harms [69]. Women who had previously received a false-positive mammography result were slightly more tolerant of the associated harm than other women [96]. ‘Popularity paradox’ is a term used to describe the increased likelihood for those who have been misdiagnosed and overtreated as a result of screening to believe that they owe their health to screening [97]. This evidence indicates that attitudes are resistant to information about the risks of screening and that people do not necessarily make informed decisions about screening attendance via a deliberative assessment of the risks and benefits.

Cancer fatalism is associated with nonuptake of breast, cervical and colorectal cancer screening both in the UK and the US [74,98]. Dislike of the screening test appears to be a stronger barrier to colorectal cancer screening than breast or cervical screening [45], further highlighting concerns around the practicalities and cleanliness of the test method. Altruistic reasons for attending cancer screening have been reported, underpinned by beliefs that screening is a good use of health service resources [64,99] and is a form of medical research that can advance science [100].

Perceived efficacy & response efficacy

Higher efficacy beliefs about cancer screening were associated with greater uptake of colorectal cancer screening in a sample of adults aged 60–69 in England but did not mediate the relationship between socioeconomic status and uptake [74]. Perceived efficacy of mammography was surveyed among women in the US, UK, Italy and Switzerland, with overestimations of effectiveness observed in all four countries and a greater number of accurate estimates negatively associated with being screened in the previous 2 years [101]. Self-efficacy to participate in colorectal cancer screening was associated with lower health literacy in a UK study [102]. Self-efficacy mediated the relationship between South Asian ethnicity and lower uptake in regions of England and Scotland [103].

Perceived risk

Risk perceptions are known to be an important factor in preventative health behavior but are difficult to measure, limiting understanding of the relationship with screening uptake. Perceptions of greater cancer risk are associated with participation in breast [104] and colorectal cancer screening [64], but individuals can have an optimistic bias about their cancer risk [105]. Qualitative research has found that there are benchmarks, or ‘candidates,’ against which people measure their personal risk, which influences screening attendance decisions [106,107]. Risk perceptions can be closely related to illness beliefs, such as the perceived severity of cancer, and known risk factors, such as family history of cancer and tobacco use, and can generate an emotional response, or ‘affective risk perception’ [108]. Risk perceptions may be only weakly associated with objective cancer risk factors. There is a need to improve the understanding of the nature and impact of risk perceptions through further research.

Intentions

A proportion of people who are motivated to attend screening and intend to take part fail to do so. This gap between intentions and behavior is well recognized in health psychology and may account for more than half of screening nonattendance [109]. This could be due to a range of factors, but research has found that having to book an appointment can be a barrier, especially in people without language proficiency [110], and that many people report putting off or forgetting to take part [64]. This suggests that interventions that aim to promote the translation of intentions into action could be effective at increasing screening attendance in those who are motivated to attend.

Opportunity factors

Social norms & stigma

Perceived norms have been shown to predict intentions to be screened for breast, colorectal and prostate cancer in the US [111]. A survey in England found that cancer stigma was associated with irregular or nonparticipation in all three national screening programs and was higher in men and in those from ethnic minority backgrounds [112]. Cervical screening can carry greater stigma for some cultural groups, such as those in which cancer is a taboo subject, exposing one’s body to a stranger is forbidden or cervical cancer is associated with promiscuity [86]. Stigma associated with cancer as a perceived self-inflicted disease has been identified as a barrier to lung cancer screening [113]. This may be a factor in why smokers in the US display less willingness to consider lung cancer screening compared with never-smokers [114], whereas smokers in the UK are less likely to attend colorectal screening [80].

Environment & resources

An individual's environment and resources can be important influences on cancer screening uptake. People living in urban locations may be less likely to attend in the UK, whereas the opposite has been observed in the US [47,115]. This may reflect the geographic spread of deprivation in the respective countries, combined with a greater distance barrier in rural US areas. Other practical barriers to cancer screening can include difficulty making an appointment and dependency on others to carry out activities of daily living [81,92]. Low social support is associated with nonattendance [116], and being unmarried is another commonly reported factor [31,88]. Colorectal cancer screening is often offered as a home test kit away from a medical setting, which can be perceived as a barrier to participation [93,99]. It is probable that a proportion of screening nonattenders do not receive the invitation [117], perhaps because they have moved to a different address.

In summary, there are a range of psychosocial factors that play a role in cancer screening uptake and some evidence regarding how they explain the influence of established sociodemographic factors. The socioeconomic gradient in uptake may be explained by more deprived groups experiencing more barriers to screening, such as lower health literacy and knowledge, greater cancer fatalism and greater perceived cancer stigma [74,84,118]. Psychosocial factors tend to predict screening intention better than they predict behavior, and sociodemographic factors may also have an influence by contributing to the intention–behavior gap [119]. This knowledge has informed the development and targeting of behavioral interventions, incorporating behavioral theory to promote cancer screening uptake.

Behavioral interventions to increase cancer screening uptake

Individual-level behavioral interventions aim to target mechanisms of cancer screening participation through environmental restructuring, information design or planning support and have been evaluated with randomized controlled trials and evidence syntheses.

Environmental restructuring

Reminders

Screening invitation reminders are an effective strategy for increasing uptake. They can be delivered by post, telephone or text message, all of which have been shown to increase uptake. In England, a postal reminder 1 week before a scheduled breast cancer screening appointment achieved uptake of 75% compared with 72% in the control group [120], whereas a text message reminder 48 h before an appointment for first-time invitees was associated with 64% uptake compared with 59% in the control group [121]. In Sweden, a postal reminder for women who did not respond to a first invitation increased cervical screening uptake by 9% in absolute terms compared to no postal reminder. In a group who had still not responded, a subsequent telephone reminder increased uptake to a level 31% higher than without a telephone reminder [122]. Text message reminders did not impact overall uptake of colorectal screening in England, although messages significantly increased uptake in first-time invitees compared with a control group (40.5 vs 34.9%) [123]. A systematic review concluded that text messaging interventions moderately increase uptake of breast and cervical cancer screening and may have a small effect on colorectal cancer screening [124]. Advance notification letters that are sent before a screening kit can improve rates of colorectal cancer kit return [125] but are ineffective at promoting cervical screening self-sampling kit return in the UK [126]. Adherence to lung cancer screening was increased with reminders in a systematic review of international studies [36]. Targeted reminders have also been evaluated. For example, a reminder letter that restated the invitation to colorectal cancer screening was sent to individuals who had not responded to the first invitation; it increased uptake overall and was more effective in the most deprived than the least deprived areas [127]. A meta-analysis of electronic physician and primary care provider prompts in ambulatory settings to recommend screening for nonattenders found they increased uptake of breast and colorectal cancer screening but not cervical screening [128]. Reminders can reduce the risk of forgetting and can be a cue for patients to form intentions to attend by planning how they are going to do so. Reminders may be an effective strategy for minimizing inequalities in cancer screening [129], as they appear to be particularly effective in first-time invitees and areas of greater deprivation.

Fixed & flexible appointments

Individuals have a strong tendency to behave according to the default or preset option, as it is usually easier to do so. Screening programs have harnessed the power of a default option by providing a fixed appointment time on invitations, a technique that has been found to increase uptake of breast and cervical screening compared with an

Figure 1. Uptake of colorectal cancer screening by deprivation level in Scotland using FOBT versus new, more acceptable and convenient FIT. FOBT November 20, 2016, to October 31, 2017; FIT November 20, 2017, to October 31, 2018.

†As measured by Scottish Index of Multiple Deprivation 2016.

FIT: Fecal immunochemical test; FOBT: Fecal occult blood test.

Data taken from [134].

open invitation [92,130]. A second timed appointment has also been found to be effective when sending reminders to people who did not attend their first breast cancer screening appointment [131]. This strategy reduces the planning burden on the invitee; however, it should be implemented carefully to avoid inefficiency and waste as a result of missed appointments. There is a need for home screening kits, such as FIT and HPV self-sampling, to incorporate goal-setting and planning techniques to avoid the ‘easier’ option of delay and nonresponse. Flexible appointments can also improve uptake; for example, the option to change an office hour breast cancer screening appointment to an evening or weekend appointment was associated with an absolute increase in uptake of 2.8%, with 7% choosing the out-of-hours option [132].

Modifications to screening test

Modifications to the screening test itself can improve acceptability, usability and convenience. For example, using FIT rather than FOBT for colorectal cancer screening, which requires fewer stool samples, was associated with greater perceived ease of completion and lower disgust than FOBT [133] and an increase in uptake in Scotland from 56.2 to 64.1%, with a greater increase in people from more deprived areas (Figure 1) [134]. The HPV self-sampling test has been found to have high acceptability [135] and to significantly improve uptake [126] compared with clinician sampling, creating an opportunity to engage those who do not participate in traditional cervical screening.

Publicity & mass media

Mass media campaigns can lead to increases in cancer screening uptake in areas where there is good availability of organized screening [136]. Such campaigns can seek to provide information about screening, modify beliefs, address concerns and model screening attendance. For example, television advertisement campaigns in Australia were associated with an 18% increase in cervical screening [137] and an 11% increase in colorectal cancer screening kit return, with a significantly greater impact in those who had never previously participated [138]. Furthermore, media coverage of high-profile cancer deaths can be associated with increases in screening uptake [139].

Social support

Interventions targeting social support, such as tailored counseling about screening, produced stronger effects on colorectal cancer screening uptake than other intervention techniques in a meta-analysis [140]. The same study also found that interventions delivered in the community were more effective than those delivered in a primary care context, indicating the importance of individuals’ social environment in promoting uptake.

Information design

Strategies to modify screening information aim to improve knowledge and understanding of screening, reduce negative attitudes or improve self-efficacy to successfully participate in screening.

Content modification

Materials that addressed known barriers to colorectal cancer screening were found to reduce negative attitudes, promote anticipation of a positive screening experience and increase attendance by 3.6% compared with standard materials [141]. An enhanced procedural leaflet increased colorectal cancer screening participation by 6% [142]. However, a supplementary leaflet containing simplified summaries of key information and a narrative leaflet containing personal screening stories designed to improve comprehension in people with low literacy and/or numeracy were ineffective at improving uptake both overall and in lower socioeconomic groups [127]. Redesign of written information may have limited ability to improve uptake, especially where literacy is low. A US study evaluated brief education delivered by a clinic-based research assistant, including demonstration of how to complete the FOBT kit, in a sample in which the majority had low literacy and found that 11.4% returned all three subsequent annual kits compared with 4.7% without the education [143]. Another group in the study received more intensive support from a clinic nurse, including telephone contact and problem-solving, resulting in greater uptake (13.6%). This demonstrates the potential for personal support to promote uptake without reliance on written materials, although uptake is still low and such support requires significantly greater resources. Other evidence-based health communication methods should be explored, such as the use of illustrations and social media techniques [144,145].

Primary care endorsement

An endorsement letter from a patient's general practitioner can increase uptake of colorectal screening [127,142,146,147], breast cancer screening [148,149] and cervical screening [150,151]. This provides a recommendation from a trusted source with which patients have an existing relationship, carrying 'source credibility.' This may be particularly effective for colorectal cancer screening because it does not normally involve contact with a healthcare professional. It may also be effective for some underserved cultural groups, although this approach could conflict with the goal of informed choice, with evidence that screening invitations can be viewed as an instruction to be obeyed in cultures where the doctor is highly revered and seen as the sole decision maker about health [67,110].

Message framing

Framing screening messages using social comparison via descriptive social norms (highlighting what is commonly done) may have more impact than injunctive norms (highlighting what others approve of) [111]. However, injunctive norms could limit the risk of 'reactance' and unintended consequences of descriptive norms. The effects of subjective norms on prostate cancer screening participation in African Americans are stronger in those with greater racial identity [152], highlighting a potential strategy for promoting uptake in underserved groups with a shared identity. Loss-framed messages, where individuals are prompted to think of the negative consequences of not attending screening, may be slightly more effective than gain-framed messages at increasing intentions to be screened for breast cancer [153]. Similar findings were noted in a study on colorectal cancer screening [154]. The authors of this study found, however, that in the gain-framed condition an accompanying 'affective booster' – for example, an opportunity to anticipate and feel relief at receiving a negative test – increased message persuasiveness. A theory-based intervention that aimed to promote uptake through anticipated regret via a questionnaire delivered with prenotification letters found no impact on uptake on colorectal cancer screening participation, although there was higher uptake in those with low intention to participate [155]. A similar intervention reported greater uptake of cervical screening in those who were definitely exposed to the anticipated regret messages [156]. Such approaches target automatic and affective decision-making rather than rational and reflective cognitive decision-making and as such can raise questions about whether they facilitate autonomous and informed decisions. There is a need to assess the impact of information design strategies on comprehension of information and decisions that are consistent with one's values as well as the effect on uptake.

Planning support

Interventions to support individuals in making specific plans about screening participation aim to reduce the intention–behavior gap. They seek to achieve this through goal setting and action planning (e.g., making if-then plans, or implementation intentions). The evidence of effectiveness is mixed, however; for example, a colorectal

cancer screening information leaflet with three preformulated implementation intentions was not effective at improving uptake [157]. Women who were asked in a study to complete three implementation intentions about attending breast cancer screening were no more likely to attend than controls, but this was partly explained by the failure of some to write down their plans [158]. Existing motivation or intention to participate in screening and engagement with the support tool are among the factors that may determine the effectiveness of planning interventions [159], so it is important that users are involved in their development and design. Attending a screening appointment requires a different type of action than completing and returning a postal test kit. The former involves time, travel and a social situation, whereas the latter involves greater personal control about where and when screening takes place. Planning support tools are known to be effective at promoting a range of other health behaviors [160], suggesting a need to further explore their utility in cancer screening contexts.

In this review, the authors have summarized evidence of individual-level behavioral interventions that seek to restructure the individual's environment, modify information design and support planning. The effectiveness of interventions is likely to be improved through the use of multifaceted approaches that combine reminders, simplified information and tests that are easy to undertake [161]. A theoretically guided approach to intervention design improves the understanding of how and why interventions achieve their effects, and interventions at multiple levels (e.g., provider and patient level) may have greater potential to improve cancer screening uptake [162].

Conclusion

There are sociodemographic and psychosocial factors known to be associated with cancer screening uptake. Some factors vary between screening programs, whereas others appear to be associated with cancer screening uptake in general. Such knowledge allows evidence-based interventions to be developed and evaluated. Behavioral support holds much potential for reducing cancer mortality through improved screening uptake, but it is important that intervention development builds on existing research and theory. There is a need to further simplify messages, reduce the effort required to participate in screening and support people in planning their participation and their response to barriers. Interventions shown to be effective, many of which are simple, low-cost approaches, should be universally implemented by screening providers.

Future perspective

There is growing interest in whether variations in individual cancer risk and the potential to benefit from cancer screening could be used to improve the efficiency of cancer screening programs and reduce associated harms. This represents a shift to a risk-stratified screening approach, targeting screening to those with higher cancer risk and screening those at low risk less frequently or not at all. There are already efforts to introduce risk stratification into national breast cancer screening programs. A 2019 independent review of screening in England recommended that targeted screening should have equal weight to population screening and that there should be a single advisory body covering both types of programs [163]. In addition, risk prediction models for lung cancer screening are under evaluation to optimize criteria used to select eligible patients [164] using multivariate models rather than only age and smoking history, as currently recommended in the US. Behavioral science can provide evidence-based approaches to personalized risk communication. There may be greater opportunity to promote engagement using tailored screening information to address individual beliefs and concerns alongside a tailored risk approach. Public attitudes, beliefs, risk perceptions and emotions should also be explored in the context of risk-stratified screening to ensure that such strategies do not exacerbate existing inequalities in screening uptake.

With the development of new technologies and improvements in the understanding of genomics and the cellular characteristics of cancer, other approaches to risk stratification have focused on genetic tests or simple biomarker tests [165]. Biomarker tests include analysis of samples of saliva, exhaled breath, urine and blood for potentially multiple cancers in one test. These tests might be more effective and less harmful at detecting early cancer than existing tests by being quicker and cheaper to perform and allowing the targeting of imaging to those at greater risk. Novel screening methods may better detect at a treatable stage cancers that cannot be effectively detected through population screening using currently available modalities alone, such as ovarian, liver and pancreatic cancer. Such developments raise questions about patient factors in cancer screening. For example, what will be the acceptability and perceived efficacy of a blood test to detect lung cancer? How can individuals be supported to understand and make informed decisions about an increasing number of screening tests with different attributes and associated potential harms? Behavioral science can seek to address these questions and develop evidence-based interventions to inform and promote uptake, which may be key to the success of a cancer screening program offering a novel test.

With the development of new tests and a potential increase in cancer screening activity in many countries, more people may be at risk of screening harm through overdiagnosis. It is vital that public understanding of overdiagnosis is improved and the ‘popularity paradox’ prevented. This is a prerequisite to informed decision-making about cancer screening participation but may be challenging to achieve and should draw on evidence-based health communication methods. Greater awareness of screening harms, accompanied by awareness that the screening program is effective at reducing the cancer burden provided that individuals participate, does not have to result in lower uptake. In the pursuit of greater uptake alongside informed uptake, there is a need for behavioral interventions that prioritize patient autonomy. This may involve a shift toward behavioral techniques that seek to educate rather than manipulate and support people to act in accordance with their values and intentions. Decision aids can be used to facilitate screening decision-making that is consistent with a patient’s values, priorities and attitudes toward risk. Decision aids have been associated with lower uptake, however, when evaluated for breast and colorectal cancer screening [166,167]. A risk-based approach may necessitate an acceptance that better informed decisions may result in lower overall uptake, particularly where there is uncertainty about the balance of benefits and risks for an individual.

The roll-out of lung cancer screening requires special consideration because of the distinct ‘at-risk’ group who will be invited, consisting predominantly of individuals with a substantial smoking history. Public knowledge of the cancer risk associated with smoking is high, which may increase perceptions of risk and cancer fear in those eligible for screening. Behavioral theory tells us that, in the absence of high self-efficacy to undertake screening, high cancer fear may lead to screening avoidance rather than attendance [168]. American Thoracic Society recommendations to engage high-risk groups include the use of patient navigators to serve as outreach workers and help the most vulnerable overcome barriers, shared decision-making tools that are suitable for low literacy and numeracy levels and for different cultural backgrounds and the use of telehealth and mobile screening units to overcome geographic barriers [169]. Media such as letters and leaflets are also recommended and were associated with uptake of 53% in a UK sample of predominantly smokers living in areas of greater deprivation [170]. There is also a risk of smokers receiving false reassurance from negative screening results, forming a potential unintended harm of lung cancer screening via reduced motivation to quit smoking [171]. As lung cancer screening becomes more commonplace, patient factors should be carefully monitored and appropriate behavioral interventions developed, such as smoking cessation support tailored to individual screening experiences.

Inequalities in uptake between the highest and lowest levels of deprivation in England have significantly reduced for breast cancer screening but not for cervical screening, suggesting that efforts to reduce inequalities have had some success [172]. There is still a need to improve service design to overcome cultural and language barriers to increase trust and confidence in screening providers and improve uptake in underserved groups. Similarly, unique barriers experienced by groups, such as those living with a learning disability or a mental illness, should be addressed, an area where there is currently a lack of evidence about appropriate behavioral support [173]. The need for informed choice means that screening information should explain clearly the possible benefits and harms, but this assumes that people make rational decisions, when the evidence in this review suggests that automatic motivation (e.g., emotions, habits) is an important determinant of screening participation. Nonresponders to screening invitations are usually very difficult to engage in research, often limiting the available evidence to influences of sociodemographic factors rather than psychosocial ones. Greater resources will be required to undertake research methods that can effectively engage nonresponders to better elucidate relationships between screening participation and different patient factors in underserved groups.

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Executive summary

Background

- There are established screening programs for breast, cervical, colorectal and lung cancer.
- Improving uptake of cancer screening is crucial to reducing cancer mortality.
- Variations in uptake between cancer screening programs highlight the importance of understanding patient factors.

Patient factors associated with uptake of cancer screening

- Women are more likely than men to take part in colorectal cancer screening.
- Older age is associated with greater uptake of breast and colorectal cancer screening.
- People with low socioeconomic status, low health literacy or learning disability and those from minority ethnic groups are less likely to participate in cancer screening.
- Knowledge, attitudes and beliefs about cancer and screening are important modifiable patient factors.
- Cancer fear and perceptions of cancer risk can be both motivators and barriers to screening.
- Motivated people who intend to take part in cancer screening often fail to do so.
- Cancer stigma is a barrier to screening, especially in smokers and some cultural groups.
- Practical barriers and a lack of social support are associated with nonattendance.

Behavioral interventions to increase cancer screening uptake

- Reminders are a well-researched behavioral strategy that can increase uptake.
- Fixed appointment times on invitations or reminders increase uptake of breast and cervical screening.
- Modifications to colorectal and cervical screening tests can improve acceptability, usability and convenience, leading to higher uptake.
- Mass media campaigns and high-profile cancer deaths can promote screening uptake.
- General practitioner endorsement is associated with greater uptake of colorectal, breast and cervical screening.
- Message framing and planning support are behavioral approaches in need of further research.

Future perspective

- Risk-stratified screening and expansion of lung cancer screening pose new challenges for behavioral research.
- Novel screening methods raise questions about the acceptability and perceived efficacy of tests.
- Public understanding of screening harms should be improved through evidence-based health communication.
- Lung cancer screening requires special consideration, and patient factors should be monitored and behavioral interventions developed.
- There is a need to further simplify messages, support planning and problem-solving and reduce the effort required to participate in cancer screening.
- Inequalities in screening uptake persist, and further efforts are required to ensure equitable access to cancer screening for all.

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