Screening for Prevention and Early Diagnosis of Cancer

Jane Wardle — *University College London*
Kathryn Robb — *University of Glasgow*
Sally Vernon — *University of Texas School of Public Health at Houston*
Jo Waller — *University College London*

The poor outcomes for cancers diagnosed at an advanced stage have been the driver behind research into techniques to detect disease before symptoms are manifest. For cervical and colorectal cancer, detection and treatment of "precancers" can prevent the development of cancer, a form of primary prevention. For other cancers—breast, prostate, lung, and ovarian—screening is a form of secondary prevention, aiming to improve outcomes through earlier diagnosis. International and national expert organizations regularly assess the balance of benefits and harms of screening technologies, issuing clinical guidelines for population-wide implementation. Psychological research has made important contributions to this process, assessing the psychological costs and benefits of possible screening outcomes (e.g., the impact of false positive results) and public tolerance of overdiagnosis. Cervical, colorectal, and breast screening are currently recommended, and prostate, lung, and ovarian screening are under active review. Once technologies and guidelines are in place, delivery of screening is implemented according to the health care system of the country, with invitation systems and provider recommendations playing a key role. Behavioral scientists can then investigate how individuals make screening decisions, assessing the impact of knowledge, perceived cancer risk, worry, and normative beliefs about screening, and this information can be used to develop strategies to promote screening uptake. This article describes current cancer screening options, discusses behavioral research designed to reduce underscreening and minimize inequalities, and considers the issues that are being raised by informed decision making and the development of risk-stratified approaches to screening.

Keywords: screening uptake, screening predictors, cancer prevention, screening communication, social inequalities

Until the latter part of the 20th century, cancer was diagnosed only when symptoms of tumor growth were manifest. In many cases, the cancer would already have spread, limiting the efficacy of surgical or radiological treatment. Symptomatic presentation is still the predominant route to diagnosis across all cancers, but for some cancer sites, tests have been developed to identify tissue changes that are indicative either of cancer precursors or early-stage tumors. Where there is a recognizable precursor stage (e.g., cervical intraepithelial neoplasia, colorectal polyps), removal of abnormal tissue *prevents* the development of cancer and could therefore be termed *primary prevention.* Where the target is an early-stage tumor (e.g., shown in mammography or fecal occult blood testing), screening is termed *secondary prevention* because it is designed to improve long-term outcomes by treating the cancer when it is more likely to be localized.

Cancer Screening

The first cancer screening test was developed by George Papanicolaou, whose 1943 monograph provided a method of identifying both precancerous and malignant cervical cells. At around the same time, the value of x-rays to diagnose early breast cancers began to be recognized, with screening mammography becoming a viable option once lower dose x-ray machines were available. Guaiac had been used to detect occult blood lost from colorectal cancers in stool samples, but in 1958 Eric Mueller successfully impregnated guaiac resin onto a filter paper, which was the basis of the commercially developed Hemoccult (fecal occult blood; FOB) test.

In 1968, the World Health Organization published a set of criteria to guide decisions about whether to introduce population-based screening (Wilson & Jungner, 1968). They argued that for a screening test to be worthwhile, the condition being screened for must be an important public health problem, whose natural history is well understood,

Editor's note. This article is one of 13 in the "Cancer and Psychology" special issue of the *American Psychologist* (February–March 2015). Paige Green McDonald, Jerry Suls, and Russell Glasgow provided the scholarly lead for the special issue.

Authors' note. Jane Wardle, Cancer Research UK Health Behaviour Research Centre, Department of Epidemiology and Public Health, University College London; Kathryn Robb, Institute of Health and Wellbeing and MRC/CSO Social and Public Health Sciences Unit, University of Glasgow; Sally Vernon, Center for Health Promotion and Prevention Research, Division of Health Promotion and Behavioral Sciences, University of Texas School of Public Health at Houston; Jo Waller, Cancer Research UK Health Behaviour Research Centre, Department of Epidemiology and Public Health, University College London.

Correspondence concerning this article should be addressed to Jane Wardle, Cancer Research UK Health Behaviour Research Centre, Department of Epidemiology and Public Health, University College London, Gower Street, London WC1E 6BT, United Kingdom. E-mail: j.wardle@ucl.ac.uk

© 2015 American Psychological Association 0003-066X/15/$12.00
Vol. 70, No. 2, 119–133 http://dx.doi.org/10.1037/a0037357

Jane Wardle

and must have an identifiable early stage at which treatment is demonstrably more effective. The test itself must be acceptable, with adequate infrastructure for follow-up, and any risk of harm from the test must be outweighed by the likelihood of benefit. Screening for cervical, breast, and colorectal cancers has been judged to meet these criteria, and all three screenings are recommended in international guidelines and implemented to varying degrees in all middle- and higher income countries. By the 1980s, screening took pride of place as one of the major public health advances against cancer.

In this article we begin with an introduction to cancer screening programs, focusing primarily on two countries (the United States and the United Kingdom) with very different health care systems (Fuchs & Schaeffer, 2012) and then discuss demographic and psychological predictors of screening participation. In the final sections we discuss recent debates about screening, issues of public communication, and likely new directions.

Cancer Screening Programs

Cervical. Cervical cancer is still the third most common female cancer worldwide (International Agency for Research on Cancer, World Health Organization [IARC, WHO], 2008). However, incidence and mortality rates have been reduced dramatically in countries that provide screening; and the reductions are even more striking when one takes into account the increased exposure to cervical cancer risk factors that followed the sexual revolution of the 1960s (Peto, Gilham, Fletcher, & Matthews, 2004). Cytological examination of exfoliated cells from the cervix (the Papanicolaou, or Pap, test) is still the most widely used test, primarily focused on identifying very early neoplastic changes, termed precancers. If abnormalities are detected, the Pap test is followed up with a colposcopy examination, and in some cases biopsy, to confirm the grade of abnormality. Treatment involves removal of abnormal cells using excisional or destructive techniques (Jordan et al., 2009).

The discovery that infection with high-risk human papillomavirus (HPV) is the primary cause of cervical cancer (Walboomers et al., 1999) has been one of the great breakthroughs in cancer research, for which Harald zur Hausen won the Nobel Prize in 2008. It led to the development of vaccines to prevent HPV infection (Harper et al., 2006; Villa et al., 2005), which will ultimately reduce the need for frequent screening and may even eradicate the disease. Testing for HPV DNA in the cervix is also being introduced both as a primary screen and to triage women with abnormal cytology. HPV testing has the additional advantage that tissue samples can be self-collected and mailed for analysis; potentially reducing some of the barriers to cervical screening uptake, particularly in less developed countries. The recommended age range for and frequency of cervical screening vary internationally, but screening usually begins between the ages of 20 and 30 years and is repeated every 3–5 years until ages 60–65 (International Cancer Screening Network, 2008b). There are no randomized controlled trials (RCTs) of the efficacy of Pap test screening, but the well-understood course of the disease, the acceptability and safety of the test to identify precancerous changes, the availability of effective and low-risk treatment for precancers, and the reduction in incidence that followed the introduction of screening together make it one of the most successful of all cancer screening methods.

Breast. Breast cancer is the most commonly diagnosed cancer in women worldwide (IARC, WHO, 2008), and its incidence in many wealthy developed nations is rising, partly as a consequence of changes in reproductive practices and lifestyle but probably also as a result of detection of early breast cancers through screening. The only widely recommended screening test is mammography, which uses x-rays of the breasts to detect tumors before they become palpable lumps.[1] Eleven RCTs of mammography were carried out between 1963 and 1991 in North America, Scandinavia, and the United Kingdom. Meta-analyses have mostly found that the relative risk reduction for breast cancer mortality associated with mammography is around 20% given adequate follow-up (Independent UK Panel on Breast Cancer Screening, 2012), but there is little evidence of any effect on all-cause mortality and much debate about the balance of harms and benefits (Gotzsche & Nielsen, 2011).

Most guidelines recommend that breast screening should start around age 50 and continue until around age 70, with a recommended frequency of every one to three

[1] Breast self-examination, which was recommended at one time, is now widely understood to be ineffective, and its promotion has been discontinued in favor of advocating more general "breast awareness" (Kösters & Gotzsche, 2003).

Kathryn Robb

years (International Cancer Screening Network, 2008a). Survival rates have improved where breast screening is introduced, but reductions in breast cancer mortality have not been as high as expected; indicating that a proportion—and some would argue a substantial proportion—of the screen-detected breast cancers could be described as "overdiagnosis." Given the intensive surgical, radiotherapy, and chemotherapy protocols that are used for breast cancer treatment, the possibility that significant numbers of women are "overtreated" has raised considerable concern in the oncology community (see the section Balancing the Risks and Benefits of Screening).

Colorectal. Colorectal cancer (CRC) is the third most common cancer worldwide when both sexes are considered together (IARC, WHO, 2008). CRC screening uses a range of testing modalities. The first to be in widespread use was the FOB test, a stool test in which the samples can be collected at home and mailed for analysis. If blood is detected, a diagnostic colonoscopy is recommended. The first RCT demonstrated a 33% reduction in CRC mortality with annual screening and a 6% (nonsignificant) reduction with biennial screening (Mandel et al., 1993). Long-term results from biennial screening in the Nottingham trial in the United Kingdom showed a 13% reduction in mortality at 19-year follow-up (Scholefield, Moss, Mangham, Whynes, & Hardcastle, 2012). FOB is the test modality used in the U.K. program and in many other European and Asian countries, although the recommended age and frequency for the test vary. There is now a newer stool-based test, the fecal immunochemical test (FIT), which is more straightforward for the user and provides the option to vary test sensitivity. The main outcome is earlier detection of cancers, that is, secondary rather than primary prevention.

However, like cervical cancer, CRC has a well-established precancerous stage. Endoscopic visualization of the entire colon is regarded as the best available test to detect both cancers and precancers. Polyps can be removed during endoscopy, preventing the development of CRC. To date there are no RCTs of colonoscopy screening; but the public health case has been made on the basis of the natural history and case-control studies (Levin et al., 2008). Flexible sigmoidoscopy (FS) is an alternative test that can be done without sedation and performed by nurses or other trained health care professionals. It examines only the distal colon, but this is where most polyps form, and individuals found to have multiple or higher risk polyps can be followed up with colonoscopy. Trials in the United Kingdom and the United States have demonstrated reductions in incidence as well as mortality (Atkin et al., 2010; Schoen et al., 2012), and a single FS at age 55 is now being introduced into the U.K. screening program. The U.S. Preventive Services Task Force (USPSTF) recommends people age 50 to 75 years follow one of the following three regimes: colonoscopy every 10 years; FS every five years plus an FOB test every three years; or an FOB test every year.

Prostate. Prostate cancer occupies a unique position in the screening spectrum. It is the second most common cancer in men worldwide (IARC, WHO, 2008), and the second most common cause of male cancer death in many countries (American Cancer Society, 2012a; Cancer Research UK, 2012). A blood test measuring serum levels of prostate specific antigen (PSA) is widely used as an indicator of prostate cancer risk, alongside a digital rectal examination to assess the prostate. This is followed up with a biopsy if the PSA test and the digital rectal exam suggest high risk. However, many prostate cancers are slow growing and unlikely to cause problems within a man's lifetime, while treatments for prostate cancer have significant negative side effects. The USPSTF has therefore recently recommended against screening, concluding that "the benefits of PSA-based screening for prostate cancer, as currently used and studied in randomized, controlled trials, do not outweigh the harms" (Moyer, 2012, p. 764). Given the high rates of PSA testing in the United States (41% of men over the age of 50 reported having a recent PSA test; Swan et al., 2010), adherence to the new recommendation will involve substantial behavior change. PSA testing is not recommended in the United Kingdom, but asymptomatic men can discuss PSA testing with their primary care doctors, and once they understand the risks, may elect to have the test. Uptake rates in the United Kingdom are substantially lower than those in the United States; one study found that 6% of men ages 45–89 years had had a PSA test in 2007 (Williams et al., 2011).

Lung and ovarian. There are active research efforts to develop other screening tests, with lung and ovarian cancer being important targets. Lung cancer is the most common cause of cancer death worldwide (IARC, WHO, 2008). It is generally diagnosed in its late stages, when prognosis is poor, and early identification has the potential for significant health benefits. Trials of lung cancer screening include the use of low-dose computed tomography (CT) scans, chest x-rays, and sputum cytology, with

Sally Vernon

efforts focused on high-risk groups such as smokers and people with preexisting lung disease (Aberle et al., 2013; Marcus et al., 2006; Oken et al., 2011). A recent review of low-dose CT screening concluded that it may be beneficial for very high-risk individuals but that the harms are not well enough understood (Bach et al., 2012). The USPSTF has recently recommended annual screening for 55–80-year-olds with a history of heavy smoking (USPSTF, 2013).

Ovarian cancer is one of the rarer female cancers, but it typically presents at an advanced stage with an extremely poor survival rate, making it the seventh most common cause of cancer death in women worldwide (IARC, WHO, 2008) but the fourth and fifth most common in the United Kingdom and the United States, respectively (American Cancer Society, 2012b; Cancer Research UK, 2012). Because the survival rate is good if the disease is detected early, there has been a long-standing interest in using transvaginal ultrasonography or serum levels of the tumor marker CA125 to give an indication of disease before symptoms are manifest. However, although there is some evidence for a survival benefit in screen-detected cases, the largest randomized trial to date found no reduction in mortality (Buys et al., 2011). There was also significant morbidity as a consequence of follow-up investigations for women with false positive findings. The USPSTF has therefore consistently advised against population-based screening, although research efforts are in progress both to improve the screening technology and to risk-stratify the population and screen only higher risk groups for whom the risk/benefit payoff may be better (Gentry-Maharaj & Menon, 2012).

Organization of Screening

Countries with nationalized health systems, such as the United Kingdom, have centrally organized screening programs where all eligible individuals are invited and reinvited at appropriate intervals using a "call–recall" system. When eligibility or test interval recommendations change, these can be implemented easily in the call–recall system. Organized programs are also used in some managed health care plans in the United States, but otherwise cancer screening in the United States is opportunistic and reliant on a physician recommendation or the individual's request to be screened. These factors can influence whether screening guidelines issued by national bodies like the USPSTF or the Centers for Disease Control and Prevention (CDC) are followed.

Balancing Benefits and Risks of Screening

Physical Risks

Cancer screening is evaluated as a public health program, with evidence for efficacy coming primarily from demonstrating reduced risk (incidence, survival, or mortality) in populations who have screening available. In common with other public health measures, the individual-level benefit cannot be estimated with any precision but is likely to be small. Most individuals who undergo cancer screening are not only free of the target disease but never likely to develop it. This means that all those screened are exposed to the risk associated with the test, but only a minority stand to benefit in health terms; although reassurance of disease-free status can constitute a psychological benefit. Physical risks are therefore important. No screening modality is risk free: Mammography involves x-ray exposure, colonoscopy and polyp removal are invasive procedures in which errors are possible, and treatment following an abnormal Pap test can cause cervical damage. Furthermore, none of the tests is 100% specific, so there are inevitably false positives with follow-up investigations that carry further risk, although public attitudes appear to be highly tolerant of false positives—with a "better safe than sorry" perspective holding sway.

Overdiagnosis

Another concern is overdiagnosis. The detection rate of precancers (abnormal Pap tests, colorectal polyps) exceeds the expected rates of cervical and colorectal cancer, indicating that some of the apparent pathology must be nonprogressive, but at present it is not possible to distinguish progressive from nonprogressive abnormalities. However, the risks of intervention in the case of precancers within the recommended age groups are modest, and there is consensus on the value of treatment. The situation is different in relation to overdiagnosis of breast cancer because breast cancer treatment involves significant loss to the patient's quality of life and risk to future health. The rising incidence rate of breast cancer since the introduction of screening, combined with the limited impact of screening on mortal-

Jo Waller

ity, suggest that a proportion—and perhaps a large proportion—of tumors detected are unlikely ever to have caused harm, so mammography programs may not be yielding the benefit that was expected (Bleyer & Welch, 2012; Gotzsche & Nielsen, 2011). Ductal carcinoma in situ accounts for a significant proportion of screen-detected cancers, and although the risk of invasion is probably low, it is usually treated with surgery and radiation (Virnig, Tuttle, Shamliyan, & Kane, 2010). Given the psychological and physical costs of diagnosis and treatment, overdiagnosis of breast cancer is a major challenge. However, a recent U.K. review confirmed the recommendations of the USPSTF (2009) and the Canadian Task Force on Preventive Health Care (2011) that breast screening confers significant benefit, although the review concluded that women need to be assisted to make an informed decision about screening participation, including understanding the risk of overdiagnosis (Independent UK Panel on Breast Cancer Screening, 2012).

Risk of Psychological Harm

In the past, a good deal of attention has been paid to the psychological costs of screening, particularly anxiety in advance of the test or while waiting for results and distress if abnormalities are detected. The early literature on cervical screening, especially results from qualitative studies, provided evidence of distress over abnormal results (Posner & Vessey, 1988). Despite attempts to improve the way that abnormal results are communicated, studies have continued to find that confusion and anxiety are common in women with abnormal cytology results and that distress can continue after colposcopic follow-up (Kitchener et al., 2004; Sharp et al., 2013). With the introduction of HPV testing to cervical screening protocols, qualitative studies have identified concern about acquisition and transmission of a sexually transmitted infection and a need for high-quality information (Hendry et al., 2012). Quantitative findings have been more mixed, with some studies finding adverse psychological outcomes associated with HPV testing (Maissi et al., 2004) and others not (Kitchener et al., 2008; McCaffery et al., 2010). More research is still needed to quantify the associated psychological costs and develop appropriate educational materials to minimize adverse effects.

In contrast to cervical screening, there has been little evidence that colorectal screening has significant psychological costs. FS screening, with or without follow-up colonoscopy, has not been associated with postscreening anxiety in the trial context despite the invasive nature of the test (Wardle et al., 2003b). A small study of colonoscopy found a decrease in anxiety postscreening (Condon, Graff, Elliot, & Ilnyckyj, 2008).

The greatest psychological cost of screening is likely to derive from false positive results, particularly when the test gives an indication of an early cancer rather than a preinvasive condition. In the mammography context, most of the evidence suggests that an abnormal result understandably causes significant anxiety in the short term, while longer term adverse effects are comparatively rare and can be minimized with appropriate information (Brett, Bankhead, Henderson, Watson, & Austoker, 2005). The impact of a false positive mammogram on future screening attendance is mixed, with U.S., Canadian, and European studies showing different patterns of reattendance (Brewer, Salz, & Lillie, 2007).

Present evidence indicates that the public perceives screening, whatever its shortcomings, to be a bulwark against an otherwise unpredictable and often fatal disease and values it highly. Such is the public fear of cancer that negative results can be psychologically beneficial by virtue of the reassurance they provide (Brett et al., 2005; Korfage et al., 2012). Even women with personal experience of false positive results appear extremely tolerant of a procedure that involves very many false positives if it saves one life from breast cancer (Schwartz, Woloshin, Sox, Fischhoff, & Welch, 2000); for reviews, see Brett et al. (2005) and Cullen, Schwartz, Lawrence, Selby, and Mandelblatt (2004).

Optimizing Screening Participation

Assessing and improving screening participation rates, both overall and in underserved groups, is a key focus of research. The National Health Interview Survey (NHIS) carries out annual assessments of self-reported adherence to USPSTF screening recommendations. In 2010, 72% of women reported mammography within the recommended period, and 83% reported cervical screening, but only 59% of men and women were up to date with CRC screening (CDC, 2012), although the possibility of selection bias into the NHIS and inaccurate self-reporting of screening history may mean that these figures are likely to be overestimates (Rauscher, Johnson, Cho, & Walk, 2008). Data on attendance in the U.K. National Screening Programs come from

National Health Service records and are not subject to any self-report bias. They indicate that breast screening uptake for the most recent invitation was 77%, cervical screening coverage was 78%, and colorectal screening uptake was 54% (Health and Social Care Information Centre, 2013a, 2013b; von Wagner et al., 2011).

Sociodemographic Predictors of Screening Participation

Understanding sociodemographic patterning of screening participation is important for a number of reasons. Any health technology in which uptake is unequal across groups runs the risk of creating or widening health inequalities. Monitoring uptake across demographic groups therefore helps to ensure that underserved populations are not being disadvantaged and identifies target groups for more active promotion.

Gender. CRC screening participation was expected to be lower in men than in women in light of the widespread assumption that men are less willing to engage with health care systems. However, there was no gender difference in the 2010 NHIS results (CDC, 2012). Examining specific screening modalities, the Behavioral Risk Factor Surveillance System found that men reported slightly higher uptake of FOB testing than women, while women reported slightly higher uptake of colonoscopy (Joseph, King, Miller, & Richardson, 2012), but the differences were no more than one or two percentage points. These slight shifts from one analysis to another are also seen in the United Kingdom: FOB testing in the National Screening Program is higher in women than in men (von Wagner et al., 2011), but FS uptake in the U.K. Flexible Sigmoidoscopy Trial was higher in men (Wardle, Miles, & Atkin, 2005). On the whole, men are proving less disadvantaged in screening than was expected.

Age. Within the USPSTF-recommended age range, the 2010 NHIS found no significant age differences in breast screening participation (CDC, 2012), and there were similar findings in a U.K. survey (K. Moser, Patnick, & Beral, 2009). Cervical screening participation is higher in younger women in the United States (CDC, 2012), while the reverse appears to be true in England (NHS Cervical Screening Programme, 2011), possibly owing to a specific decline in uptake in the youngest age group, a phenomenon that has been noted in several countries but is not yet well understood (Lancucki et al., 2010). Participation in CRC screening is higher among older people in the United States (CDC, 2012) and the United Kingdom (von Wagner et al., 2011). These results indicate that older adults are being reasonably well served by screening programs.

Socioeconomic status. Socioeconomic inequalities have been observed across almost all health behaviors, and screening is no exception. Screening participation is higher in higher socioeconomic status (SES) groups wherever in the world it is studied, and whether SES markers relate to material resources (e.g., income), social status (occupation), or education, and for all forms of cancer screening. Recent U.S. data show a strong association between self-reported mammography participation and both education and income, in addition to an effect of insurance status (Miller, King, Joseph, & Richardson, 2012), and similar associations with income and education are found in Great Britain (K. Moser et al., 2009). Reported cervical screening uptake is lower among women with less education and without insurance in the United States (CDC, 2012), and recorded coverage is lower in more deprived geographic areas in the United Kingdom (Bang, Yadegarfar, Soljak, & Majeed, 2012). Likewise, self-reported CRC screening is positively associated with education, income, and insurance in the United States (Joseph et al., 2012), and FOB test completion ranged from 35% in the most deprived quintile of neighborhoods in the United Kingdom to over 70% in the least deprived quintile (von Wagner et al., 2011). It is important to note that none of these effects reflects a specifically low participation rate in the most deprived group; rather, there is a linear association across the distribution of SES. SES differences are a largely unmet challenge for research and implementation and raise the specter of growing inequalities in cancer mortality in the years to come.

Race/ethnicity. In both the United States and the United Kingdom, there is evidence for ethnic disparities in screening participation. In the United Kingdom, breast, cervical and colorectal screening rates are all higher in White than in non-White groups even after controlling for available markers of SES (Bang et al., 2012; Bansal, Bhopal, Steiner, & Brewster, 2012; von Wagner et al., 2011). NHIS data show that African Americans, compared with non-Hispanic White Americans, have lower CRC screening rates but similar rates of breast and cervical screening, while Hispanic Americans are less likely than either of these groups to be up to date with breast, cervical, or CRC screening (CDC, 2012).

Understanding and tackling racial disparities in screening uptake should be a key issue for future research. Overall, there is an urgent need for research aimed at understanding the processes underpinning the observed demographic patterning of screening behavior to inform the development of interventions to address inequalities.

Physician Endorsement

The role of health professionals in recommending screening or endorsing screening programs has received research attention as a possible "cue to action" or injunctive norm within the context of the social cognition models described below and as part of more pragmatically driven attempts to increase screening participation. The organizational context affects the way this is done. In the United Kingdom, general practitioners can provide endorsement by putting their names on screening invitations issued in the call–recall system, a strategy that has been found to increase participation in the CRC program (Hewitson, Ward, Heneghan, Halloran, & Mant, 2011). They also play a direct role in delivering cervical screening and are incentivized to achieve high coverage among their patients. In the United States, where screening is mainly opportunistic, health care providers are directly involved in recommending screening to patients, and prompting them to be

screened has been shown to be an effective means of increasing uptake (Balas et al., 2000). Thus it is sometimes clinicians rather than patients who are the targets of behavioral interventions.

Individual Determinants of Cancer Screening Participation

A major challenge for behavioral science is to understand why upwards of 2 in 10 women do not participate in breast or cervical screening and why 4 in 10 men and women do not participate in CRC screening. Comparisons between the United States and the United Kingdom can give clues to potential barriers. Even if U.S. data overestimate slightly, participation rates do not differ dramatically from U.K. statistics. One implication of this is that factors other than cost (which is not an issue in the United Kingdom) must be a deterrent. The other is that a call–recall program in which all eligible adults receive invitations and reminders (as practiced in the United Kingdom), does not achieve complete coverage or eradicate disparities.

The lower rate of participation in CRC screening than in breast or cervical screening has attracted particular attention. CRC screening participation is low in women as well as men, so the effect is not due to men's being unfamiliar with screening. One explanation put forward in the United States is that the variety of CRC screening options (colonoscopy, FS, FOB), compared with just one test for cervical and breast screening, leads to confusion or decision delay (Calderwood & Roy, 2013). However, the similarity of uptake rates in the United States and the United Kingdom, where currently only FOB testing is offered, suggests that this is not the full explanation.

Behavioral research has mostly been concerned both with understanding the determinants of uptake and identifying modifiable psychological variables as targets for intervention.

Many of the social psychological theories developed in the 1970s and 1980s have been applied to cancer screening participation. These models broadly assume a process of deliberative decision making based on weighing the pros and cons of screening; these include the perceived threat of the cancer, the perceived efficacy of the test, the difficulty of participation, and the social norms around testing. Model-based applications have used the health belief model (Bish, Sutton, & Golombok, 2000), the theories of reasoned action and planned behavior (Cooke & French, 2008), the transtheoretical model (Spencer, Pagell, & Adams, 2005), and protection motivation theory (Orbell & Sheeran, 1998) to predict screening intentions or screening attendance. Constructs from these models are also frequently included as stand-alone items in studies of cancer screening.

Knowledge. Knowledge, both of the risk of cancer and of screening as a strategy to reduce risk, is assumed to be a necessary, though not sufficient, precursor to participation. People with higher knowledge of cancer and cancer screening have higher uptake (Berkowitz, Hawkins, Peipins, White, & Nadel, 2008; Rakowski et al., 2006). A study in the United Kingdom indicated very poor awareness of the high prevalence of CRC, which could contribute to lower uptake of CRC screening (Juszczyk, Simon, Waller, Ramirez, & Wardle, 2011). Differential knowledge about cancer screening may also be a mediator of SES differences in participation.

Probably the most important aspect of knowledge is that screening is designed for the asymptomatic population, and therefore good health and a healthy lifestyle should not in themselves be reasons to decline screening. However, lack of symptoms has consistently been associated with lower perceived risk (see *Perceived risk* section below) and lower uptake of cancer screening in both qualitative and quantitative research (Power, Miles, von Wagner, Robb, & Wardle, 2009; Schueler, Chu, & Smith-Bindman, 2008) and indicates a clear health education target.

The landscape of knowledge research is also changing with the emergence of the informed decision making perspective. For people to make informed decisions about screening participation, they need to know more about it. This could include understanding the difference between screening as primary prevention and screening as secondary prevention, understanding why some potential screening programs are recommended and others are not, understanding why specific age groups are selected, and recognizing the risks of overdiagnosis. These all bring challenges of communication, especially in populations with relatively low health literacy/numeracy, little interest in health issues, and decades of exposure to health promotion messages presenting the simple case for early detection.

Attitudes. In broad terms, public attitudes toward screening are positive, some would say too positive (Schwartz, Woloshin, Fowler, & Welch, 2004). The public believes that screening helps detect cancer earlier and that early detection improves the chance of survival. People with stronger beliefs about the efficacy of screening are more likely to participate (Berkowitz et al., 2008). A negative screening result is also perceived as an important indicator of safety from a greatly feared disease, and again, the belief that screening will provide peace of mind is associated with higher likelihood of participation (Cantor, Volk, Cass, Gilani, & Spann, 2002; Power et al., 2009). In contrast, fatalistic beliefs—that health events are out of individual control or that cancer is always fatal—have been associated with lower uptake (Chavez, Hubbell, Mishra, & Valdez, 1997; Powe & Finnie, 2003; Schueler et al., 2008; Vernon, 1997).

Social norms. Several social cognition models suggest that social norms may be important in understanding behavior. So-called *injunctive norms* refer to the extent to which important others are perceived to endorse a behavior, while *descriptive norms* refer to the extent to which other people are perceived to engage in the behavior. Recent intervention research suggests that manipulating the descriptive norm may be a way of increasing intentions to participate in screening (Sieverding, Matterne, & Ciccarello, 2010)—if a behavior is seen as normative, people may be more likely to participate, which could be an example of System 1 processing (see section on *Dual-Process Models* below). Injunctive norms have also been

found to be important in predicting cancer screening intentions (Smith-McLallen & Fishbein, 2008), which is consistent with findings on physician endorsement and recommendation (see earlier section on *Physician Endorsement*).

Perceived risk. Perceived risk features in most social cognition models and is often seen as the engine of preventive action, although associations with screening participation have been somewhat mixed. Higher perceived risk of breast cancer was positively associated with having a mammogram in 27 out of the 32 studies in a meta-analysis, although the effect size was small (Katapodi, Lee, Facione, & Dodd, 2004). Evidence for a relationship between perceived risk and cervical and CRC screening is less clear (Vernon, 1999). Part of the explanation for the low predictive value of perceived risk may be failure to control for past and anticipated future screening behavior in cross-sectional studies (Weinstein & Nicolich, 1993) and heterogeneous measurement of risk perceptions (Vernon, 1999). A recent study comparing different measures of perceived risk found that the "feelings of risk" item "If I don't get screened, I would feel very vulnerable to getting colon cancer sometime in my life" had the strongest association with colonoscopy intention (Dillard, Ferrer, Ubel, & Fagerlin, 2012). The relationship with screening behavior is yet to be explored, although a study of vaccination found that "feelings of risk" was a stronger predictor than were other measures of risk probability (Weinstein et al., 2007), and it is clear that affective responses to risk information play a major role in decision making (Slovic, Peters, Finucane, & Macgregor, 2005).

The origins of perceived cancer risk are complex. Family history is clearly important (DiLorenzo et al., 2006; Montgomery, Erblich, DiLorenzo, & Bovbjerg, 2003)—although there are subtle themes in family contact indicating that perceived family history is not necessarily veridical. People discount relatives whose disease history is unknown, who died young from other causes (before they reached the age at which they might get a cancer diagnosis), and with whom they have little contact (Robb, Miles, & Wardle, 2007). Awareness and beliefs about cancer and its risk factors also contribute. The public may have a view of risk different from that of the experts, with relatively less emphasis on early age of onset and less distinction between cancer sites. Furthermore, they may be relatively unaware of the fact that the earlier stages of cancer can be asymptomatic. Symptoms clearly influence perceived risk, with lack of symptoms being a frequent explanation for the lack of need for screening (Oscarsson, Wijma, & Benzein, 2008) even though asymptomatic disease is the screening target. Individual characteristics seem also to inform perception of personal risk, including sociodemographic, health, and lifestyle factors (e.g. McQueen, Vernon, Meissner, & Rakowski, 2008). The fact that cancer is such a dreaded disease is also likely to influence risk perceptions via the affect heuristic, with negative emotional responses making it difficult for people to process numerical risk information (Peters, McCaul, Stefanek, & Nelson, 2006)).

Cancer worry. Cancer worry can be distinguished from general anxiety (Jensen, Bernat, Davis, & Yale, 2010). It is correlated with perceived risk but also appears to have some independent origins (Jensen et al., 2010; Lipkus et al., 2000; R. P. Moser, McCaul, Peters, Nelson, & Marcus, 2007). Levels of cancer worry are consistently found to be high. A U.S. study from the 1960s indicated that almost a third of adults (31%) endorsed cancer as a significant cause for worry in their lives (Kirscht, Haefner, Kegeles, & Rosenstock, 1966), and a recent U.K. survey showed that 20% of people worried more about cancer than knife crime, debt, or losing a job (Cancer Research UK, 2010).

The relationship between cancer worry and cancer screening behaviors has not been entirely elucidated. Two contrasting hypotheses—that worry deters screening and that worry promotes screening—have both found support in empirical research (Hay, Buckley, & Ostroff, 2005). Data from the 2003 Health Information National Trends Survey (HINTS) suggested a positive association between worry and both breast and CRC screening (R. P. Moser et al., 2007). Similarly, a meta-analysis found a small but reliable association between higher levels of worry and greater screening participation (Hay, McCaul, & Magnan, 2006). However, cancer worry has also been found to be a barrier to screening, particularly among certain ethnic groups (Friedman, Neff, Webb, & Latham, 1996; Good, Niziolek, Yoshida, & Rowlands, 2010; Khankari et al., 2007). One possible explanation for these conflicting results is that the relationship between cancer worry and screening participation may be characterized by an inverted U shape (Consedine, Magai, Krivoshekova, Ryzewicz, & Neugut, 2004; Hay et al., 2005), with moderate levels of worry facilitating screening, and both high and low levels inhibiting it. This idea is supported in analyses of the U.K. Flexible Sigmoidoscopy Trial data, where both low and high levels of worry were associated with lower attendance rates for FS screening, while individuals who reported being "a bit worried" had the highest attendance rate (Sutton et al., 2000).

Interventions to Increase Screening Participation

While many psychological variables are consistently associated with actual or intended screening, their utility as targets for intervention is less certain. For example, risk perceptions seem resistant to a variety of different interventions designed to shift them (Robb, Campbell, Evans, Miles, & Wardle, 2008; Weinstein & Klein, 1995; Weinstein et al., 2004) and may not be a legitimate target because of adverse psychological effects. Likewise, promoting cancer worry would probably not be considered an appropriate approach; indeed, ensuring that the offer of screening does not increase worry has been a specific concern of some interventions (Wardle et al., 2003a). As a result, many attempts to develop interventions to promote screening have taken a more atheoretical approach, targeting structural and organizational factors rather than psychological barriers.

There have been several recent reviews on the effectiveness of interventions for breast, cervical, and colorectal

screening (Everett et al., 2011; Holden, Jonas, Porterfield, Reuland, & Harris, 2010; Rawl, Menon, Burness, & Breslau, 2012; Sabatino et al., 2012). They concur in finding strong evidence for the efficacy of client reminders across breast, cervical, and CRC screening in the United States. Other recommended strategies include reducing structural barriers and providing one-to-one education for breast and cervical screening. A systematic review of interventions to increase cervical screening uptake in the United States found that invitation letters were effective and that there was some evidence for the value of educational interventions (Everett et al., 2011).

A meta-analysis of tailored interventions, in which breast screening messages were individually designed to address each woman's unique beliefs or characteristics, found a slight benefit of tailored information (Sohl & Moyer, 2007), but the authors also noted that studies based on the health belief model and including a physician recommendation had the strongest effects. A systematic review and meta-analysis of repeat breast screening found only modest effects of educational/motivational interventions, with odds ratios between 1.2 and 1.4 (Vernon, McQueen, Tiro, & del Junco, 2010). The authors concluded that for promoting regular mammography screening, greater gains could be made by shaping behavior at the system level (e.g., insurance coverage and standards of preventive care).

Patient navigation for cancer screening has been embraced in the United States to address disparities in uptake of screening and cancer care more generally. Recent reviews have concluded that there is some evidence for efficacy, but many studies have methodological limitations, and the definition of *patient navigation* remains unclear, as do the active components of the patient–navigator interaction (Paskett, Harrop, & Wells, 2011; Wells et al., 2008).

Attention has also turned to use of the Internet as a communication channel that may be as effective as, and perhaps more cost-effective than, traditional psychoeducational approaches. However, early indications are disappointing, and a recent RCT comparing print- and Web-based educational information on CRC screening tailored to attentional style found no effect on uptake (Weinberg et al., 2013).

Dual-Process Models as a Framework for Guiding Screening Interventions?

The growth in interest in dual-process models of decision making, which distinguish between System 1 (intuitive, fast, emotion-focused) and System 2 (deliberative, slow, reflective) processing (e.g. Kahneman, 2011), could have application in the area of screening behavior. Provision of information that encourages people to engage in deliberative decision making is most likely to engage System 2 (e.g., print- and screen-based psychoeducational materials). This may be particularly appropriate where the risks and benefits of screening are finely balanced (e.g., in PSA testing, where individual preferences and values are germane to the testing decision), although the heuristics and biases inherent in emotion-laden decisions must be taken into account when designing communication strategies for this type of decision. It is clear that even when people are making a deliberative decision, affective responses can play a major role (Peters et al., 2006; Slovic et al., 2005). In the case of cervical screening or endoscopic CRC screening, where there is little disagreement about the public health benefits, trying to engage System 1 may be appropriate. Interventions such as provider recommendations, invitations, and reminders may encourage people to make a "default" decision to attend without the need to fully evaluate the case for screening themselves. Indeed, these approaches have provided the strongest evidence for efficacy in recent reviews.

Interventions that focus on making it easier to participate in screening and reducing the burden of deliberative decision making are somewhat at odds with moves toward informed decision making (see next section). However, the reliance the public places on provider recommendations (Brawarsky, Brooks, Mucci, & Wood, 2004; Waller et al., 2012), the positive impact of invitation letters (Cole et al., 2007; de Jonge et al., 2008; Everett et al., 2011), and the findings that many nonattenders would like to go for screening but simply don't get around to it (Waller, Bartoszek, Marlow, & Wardle, 2009) suggest that these approaches are legitimate and should be explored further. Applying theory from cognitive psychology is beginning to advance the science in this area. Important steps have been made by considering the way that heuristic short-cuts can influence risk perceptions, decision making, and behavior in the cancer prevention context (Peters et al., 2006). Reyna's fuzzy-trace theory (Reyna, 2008) has been helpful in beginning to conceptualize the way that people extract the "gist" from health information and use it to make intuitive, System 1–type decisions.

Informed Decision Making

When screening programs were first introduced, the emphasis was on maximizing uptake to achieve the greatest possible public health benefit. Much of the psychological research described above was carried out from that perspective. However, as part of a more general paradigm shift in clinical practice, there has been growing interest in informed decision making in the screening context. Although there is no universally accepted definition of *informed decision making,* it has been conceptualized as occurring when a person has adequate knowledge about the intervention in terms of its likely risks and benefits as well as its limitations and uncertainties and makes a decision that is in line with his or her personal values and preferences (Mullen et al., 2006). In many lower income countries, access to screening is still the primary concern and there are few debates about informed decision making, but in wealthier countries with established screening programs, there is increasing concern about whether the public understands the limitations of cancer screening. This concern has been driven partly by evidence of overdiagnosis and partly by a belief that the benefits of screening have been oversold in public health communications.

The advantages of the informed decision making approach are that it recognizes nonparticipation as a legitimate choice and aims to help people understand the possible risks as well as the likely benefits. However, little is known about how information on the risks and benefits of screening is understood by the public and what impact it will have on decision making, although it is increasingly clear that affective responses to risk information play an important role (Slovic et al., 2005). There is particular concern that such information could have a differential impact depending on the respondent's educational background and health literacy/numeracy. A recent trial in Australia compared standard information on FOB testing with a decision aid designed to facilitate informed decision making in a population with relatively low levels of education. The intervention increased the indicators of informed decision making but significantly reduced participation (Smith et al., 2010). In contrast, there was no impact on participation in a similar study with a more educated German population (Steckelberg, Hulfenhaus, Haastert, & Muhlhauser, 2011). Any intervention that might widen health inequalities must be treated with caution.

Entwistle and colleagues described an alternative approach to screening communication that they termed *consider an offer* (Entwistle et al., 2008); it allows screening to be recommended but encourages the public to consider the trustworthiness of the source and to seek further information if they need to. This approach appears to be consistent with public preferences in the United Kingdom to have a clear recommendation from the National Health Service (Waller et al., 2012). It is also compatible with the U.S. system in which a health provider may recommend a particular screening test but be able to discuss different options (Anhang, Price, Zapka, Edwards, & Taplin, 2010; Zapka et al., 2011).

It may be possible to tailor the style of communication to the particular screening test being offered. The scientific consensus is that there is insufficient evidence of benefit to recommend population-based PSA testing, so an informed decision making approach for men who request a PSA test may be appropriate. Similarly, the finely balanced risks and benefits of mammography could make an informed decision making approach the right one for breast screening. Women need to consider their personal preferences and values concerning overdiagnosis to make a decision about participation, although it may be difficult to provide information that can counter the very high levels of enthusiasm for screening (Schwartz et al., 2004).

For screening tests where the benefits are more certain, and particularly those that test for precancers, the "consider an offer" approach in which participation is the default could be seen as more appropriate. Wheeler and colleagues suggested a "libertarian paternalistic" approach in which framing, defaults, and other ideas from behavioral economics are used to help people make a "good" decision (Wheeler, Szymanski, Black, & Nelson, 2011). This is also consistent with the notions of "bounded rationality" (Gigerenzer & Goldstein, 1996) and "intellectual outsourcing" (Appiah, 2005), which suggest that in some circumstances it can be rational not to spend valuable time making a personal decision but instead to delegate the process by following the advice of a trusted source. Fuzzy-trace theory also suggests that this is the way people often make decisions, using categorical "gist" information to inform choices, rather than more detailed "verbatim" information (Reyna, 2008).

The informed decision making debate in screening is highly polarized. It involves ethical as well as psychological and medical considerations, but psychology has an important role to play in providing an understanding of the impact of different types of information on attitudes, beliefs, and screening behavior as well as public preferences for involvement in decisions about screening.

Communicating With the Public About Changes to Screening Recommendations

In the context of generally positive attitudes, difficulties can arise when screening recommendations change in response to new scientific evidence. Recent examples include increasing the age for the first cervical screen in England from 20 to 25 years in 2003; the recommendation against PSA-based screening for prostate cancer from the USPSTF in the United States in 2011; and the recommendation against routine mammography screening for women under 50 years of age by the USPSTF in 2009. In all of these cases there was public outcry at the reduced availability of screening. Psychological theory has been useful in understanding this phenomenon (Arkes & Gaissmaier, 2012). One factor is the greater impact of anecdotal stories compared with statistical information; thus statistically reasoned explanations of the change in recommendation may have limited potency compared with stories about the value of the test from friends or family. Similarly, personal experience has a greater impact than epidemiological evidence. Another issue is that people think about risks at an individual level and not at the level of the whole population as do epidemiologists. Overdiagnosis in the breast screening program is a good example. The evidence comes from the mismatch between the rising rate of screen-diagnosed disease and the limited decrease in mortality. But many nonexperts are baffled by the idea that scientists can know that overdiagnosis occurs without being able to tell any individual whether or not he or she is overdiagnosed (Waller, Douglas, Whitaker, & Wardle, 2013).

Health professionals are susceptible to the same cognitive biases. When the cervical screening age was increased to 25 in England, there was resistance from the gynecology community (Herbert, Holdsworth, & Kubba, 2008). Many clinicians would have had experience of treating young women for cervical cancer, which is likely to have made it difficult to accept the arguments against screening very young women. In the United States, where changes to screening recommendations have to be implemented by individual clinicians rather than in an organized program, communicating the rationale for change is of vital importance. If gynecologists are used to carrying out annual Pap tests, for example, persuading them that a 2- or 3-year interval is safe can be challenging, particularly as

there is likely to be demand for more frequent screening from patients (Sirovich, Woloshin, & Schwartz, 2005). Such overuse has been reported to be widespread in the United States, with relatively few physicians reporting behavior that is consistent with national guidelines for cervical screening (Yabroff et al., 2009). Overuse has also been found in CRC screening, although underuse is a problem too (Holden et al., 2010).

Future Directions

Cancer screening is an evolving technology, and the role that psychologists can play will change with advances in biomedicine. One important future direction is the use of risk-stratified screening; potentially reducing harms by targeting screening to groups who stand to gain more. This would be novel in the United Kingdom's system of national provision of screening (currently limited only by age and sex). It may appear to be more compatible with the U.S. approach in which discussions with a provider already include consideration of risk, although the risk stratification algorithms for population screening will not necessarily map onto individuals' sense of increased risk. Population-based Research Optimizing Screening through Personalized Regimens (PROSPR) is a National Cancer Institute-sponsored research initiative taking this approach. In one study, participants used touchscreen computers to help them assess their own risks of CRC using questions about health and family history, and the program made a recommendation for the type of CRC screening. Studies in the United Kingdom are using a combination of genetic, life-course, and family-risk information to offer risk-stratified screening for breast (Evans et al., 2012) and ovarian cancer (PROMISE) (Cancer Research UK, 2013). These initiatives raise issues that psychology is well placed to investigate, including public understanding of risk information, the social and psychological consequences of being diagnosed as having higher versus lower risk, and the implications for preventive behaviors (Meisel et al., 2013). Psychological expertise could also help to identify methods of framing and presenting risk information to improve understanding, promote healthy behavior change, and minimize distress.

Combining screening with cancer prevention education is another likely development. Screening makes cancer particularly salient and could therefore offer an opportunity for other prevention or early detection advice (Howell et al., 2012; Senore, Giordano, Bellisario, Di Stefano, & Segnan, 2012). The term *teachable moment* is widely used in this regard (Brawley, 2009; Red et al., 2010), although research has yet to define its parameters and determine whether information is best transmitted before or after the screening result, whether it should be specific to the cancer concerned or general, and whether it should focus only on early detection or include primary prevention through lifestyle change. There have been some small-scale studies demonstrating the utility of preventive advice given alongside screening (Baker & Wardle, 2002; Robb, Power, Kralj-Hans, Atkin, & Wardle, 2010), but there is considerable scope to take advantage of screening as an opportunity to engage with brief face-to-face education on primary and secondary prevention.

The basic concepts involved in screening may need to be better understood by the public in the future as we move away from paternalistic approaches to systems in which consumers play an active role. Direct-to-consumer marketing may become more common. More screening tests will become available, and people will be required to make judgments about whether to have a test based not only on their knowledge of its risks and benefits but also on their own values and preferences. Psychologists have a vital role to play in developing strategies for communicating screening information in a way that is understandable and helpful in decision making.

Conclusion

Over the last 30 years, screening has become a major element of cancer control through a combination of primary and secondary prevention. Behavioral science has helped in understanding nonparticipation and optimizing communication about the harms and benefits of screening. More needs to be done to understand the social patterning of screening participation and to reduce social inequalities. Developments in psychological theory, particularly dual-process models, will be useful in enhancing public communication about screening and, where appropriate, in promoting uptake. As new screening technologies are developed and risk stratification and informed decision making become an increasingly important part of medical practice, there will be an even greater need to discover how to communicate complex risk information and a key role for behavioral science in developing effective communication strategies to optimize screening behavior.

REFERENCES

Aberle, D. R., DeMello, S., Berg, C. D., Black, W. C., Brewer, B., Church, T. R., . . . Sicks, J. (2013). Results of the two incidence screenings in the National Lung Screening Trial. *New England Journal of Medicine, 369*(10), 920–931. doi:10.1056/NEJMoa1208962

American Cancer Society. (2012a). *Cancer facts and figures 2012*. Retrieved from http://www.cancer.org/acs/groups/content/@epidemiologysurveilance/documents/document/acspc-031941.pdf

American Cancer Society. (2012b). *What are the key statistics about ovarian cancer?* Retrieved from http://www.cancer.org/cancer/ovariancancer/detailedguide/ovarian-cancer-key-statistics

Anhang Price, R., Zapka, J., Edwards, H., & Taplin, S. H. (2010). Organizational factors and the cancer screening process. *Journal of the National Cancer Institute Monographs, 2010*(40), 38–57. doi:10.1093/jncimonographs/lgq008

Appiah, K. A. (2005). *The ethics of identity*. Princeton, NJ: Princeton University Press.

Arkes, H. R., & Gaissmaier, W. (2012). Psychological research and the prostate-cancer screening controversy. *Psychological Science, 23*(6), 547–553. doi:10.1177/0956797612437428

Atkin, W. S., Edwards, R., Kralj-Hans, I., Wooldrage, K., Hart, A. R., Northover, J. M., . . . Cuzick, J. (2010). Once-only flexible sigmoidoscopy screening in prevention of colorectal cancer: A multicentre randomised controlled trial. *The Lancet, 375*(9726), 1624–1633. doi:10.1016/S0140-6736(10)60551-X

Bach, P. B., Mirkin, J. N., Oliver, T. K., Azzoli, C. G., Berry, D. A., Brawley, O. W., . . . Detterbeck, F. C. (2012). Benefits and harms of CT screening for lung cancer: A systematic review. *JAMA: Journal of the*

American Medical Association, 307(22), 2418–2429. doi:10.1001/jama.2012.5521

Baker, A. H., & Wardle, J. (2002). Increasing fruit and vegetable intake among adults attending colorectal cancer screening: The efficacy of a brief tailored intervention. *Cancer Epidemiology, Biomarkers and Prevention, 11,* 203–206.

Balas, E. A., Weingarten, S., Garb, C. T., Blumenthal, D., Boren, S. A., & Brown, G. D. (2000). Improving preventive care by prompting physicians. *Archives of Internal Medicine, 160*(3), 301–308. doi:10.1001/archinte.160.3.301

Bang, J. Y., Yadegarfar, G., Soljak, M., & Majeed, A. (2012). Primary care factors associated with cervical screening coverage in England. *Journal of Public Health (Oxford, England), 34*(4), 532–538. doi:10.1093/pubmed/fds019

Bansal, N., Bhopal, R. S., Steiner, M. F., & Brewster, D. H. (2012). Major ethnic group differences in breast cancer screening uptake in Scotland are not extinguished by adjustment for indices of geographical residence, area deprivation, long-term illness and education. *British Journal of Cancer, 106*(8), 1361–1366. doi:10.1038/bjc.2012.83

Berkowitz, Z., Hawkins, N. A., Peipins, L. A., White, M. C., & Nadel, M. R. (2008). Beliefs, risk perceptions, and gaps in knowledge as barriers to colorectal cancer screening in older adults. *Journal of the American Geriatrics Society, 56*(2), 307–314. doi:10.1111/j.1532-5415.2007.01547.x

Bish, A., Sutton, S., & Golombok, S. (2000). Predicting uptake of a routine cervical smear test: A comparison of the health belief model and the theory of planned behaviour. *Psychology & Health, 15*(1), 35–50. doi:10.1080/08870440008400287

Bleyer, A., & Welch, H. G. (2012). Effect of three decades of screening mammography on breast-cancer incidence. *New England Journal of Medicine, 367*(21), 1998–2005. doi:10.1056/NEJMoa1206809

Brawarsky, P., Brooks, D. R., Mucci, L. A., & Wood, P. A. (2004). Effect of physician recommendation and patient adherence on rates of colorectal cancer testing. *Cancer Detection and Prevention, 28*(4), 260–268. doi:10.1016/j.cdp.2004.04.006

Brawley, O. W. (2009). Prostate cancer screening; is this a teachable moment? *Journal of the National Cancer Institute, 101*(19), 1295–1297. doi:10.1093/jnci/djp310

Brett, J., Bankhead, C., Henderson, B., Watson, E., & Austoker, J. (2005). The psychological impact of mammographic screening. A systematic review. *Psycho-Oncology, 14*(11), 917–938. doi:10.1002/pon.904

Brewer, N. T., Salz, T., & Lillie, S. E. (2007). Systematic review: The long-term effects of false-positive mammograms. *Annals of Internal Medicine, 146*(7), 502–510. doi:10.7326/0003-4819-146-7-200704030-00006

Buys, S. S., Partridge, E., Black, A., Johnson, C. C., Lamerato, L., Isaacs, C., . . . PLCO Project Team. (2011). Effect of screening on ovarian cancer mortality: The Prostate, Lung, Colorectal and Ovarian (PLCO) Cancer Screening Randomized Controlled Trial. *JAMA: Journal of the American Medical Association, 305*(22), 2295–2303. doi:10.1001/jama.2011.766

Calderwood, A. H., & Roy, H. K. (2013). Increasing colorectal cancer screening adherence: Comment on "A Randomized Comparison of Print and Web Communication on Colorectal Cancer Screening". *JAMA Internal Medicine, 173*(2), 129–131. doi:10.1001/jamainternmed.2013.2527

Canadian Task Force on Preventive Health Care. (2011). Recommendations on screening for breast cancer in average-risk women aged 40–74 years. *Canadian Medical Association Journal, 183*, 1991–2001. doi:10.1503/cmaj.110334

Cancer Research UK. (2010). *Cancer is biggest fear but 34 per cent put it down to fate*. Retrieved from http://www.cancerresearchuk.org/about-us/cancer-news/press-release/cancer-is-biggest-fear-but-34-per-cent-put-it-down-to-fate

Cancer Research UK. (2012). *Cancer mortality for common cancers*. Retrieved from http://www.cancerresearchuk.org/cancer-info/cancerstats/mortality/cancerdeaths/uk-cancer-mortality-statistics-for-common-cancer

Cancer Research UK. (2013). Ian Jacobs research projects: Risk stratification, early detection and diagnosis of ovarian cancer. Retrieved from http://www.cancerresearchuk.org/science/research/who-and-what-we-fund/browse-by-location/manchester/university-of-manchester/grants/ian-jacobs-12677-risk-stratification-early-detection-and

Cantor, S. B., Volk, R. J., Cass, A. R., Gilani, J., & Spann, S. J. (2002). Psychological benefits of prostate cancer screening: The role of reassurance. *Health Expectations, 5*(2), 104–113. doi:10.1046/j.1369-6513.2002.00166.x

Centers for Disease Control and Prevention. (2012). Cancer screening – United States, 2010. *Morbidity and Mortality Weekly Report, 61*(3), 41–45.

Chavez, L. R., Hubbell, F. A., Mishra, S. I., & Valdez, R. B. (1997). The influence of fatalism on self-reported use of Papanicolaou smears. *American Journal of Preventive Medicine, 13*(6), 418–424.

Cole, S. R., Smith, A., Wilson, C., Turnbull, D., Esterman, A., & Young, G. P. (2007). An advance notification letter increases participation in colorectal cancer screening. *Journal of Medical Screening, 14*(2), 73–75. doi:10.1258/096914107781261927

Condon, A., Graff, L., Elliot, L., & Ilnyckyj, A. (2008). Acceptance of colonoscopy requires more than test tolerance. *Canadian Journal of Gastroenterology, 22*(1), 41–47.

Consedine, N. S., Magai, C., Krivoshekova, Y. S., Ryzewicz, L., & Neugut, A. I. (2004). Fear, anxiety, worry, and breast cancer screening behavior: A critical review. *Cancer Epidemiology, Biomarkers and Prevention, 13*(4), 501–510.

Cooke, R., & French, D. P. (2008). How well do the theory of reasoned action and theory of planned behaviour predict intentions and attendance at screening programmes? A meta-analysis. *Psychology & Health, 23*(7), 745–765. doi:10.1080/08870440701544437

Cullen, J., Schwartz, M. D., Lawrence, W. F., Selby, J. V., & Mandelblatt, J. S. (2004). Short-term impact of cancer prevention and screening activities on quality of life. *Journal of Clinical Oncology, 22*(5), 943–952. doi:10.1200/JCO.2004.05.191

de Jonge, E., Cloes, E., Op de Beeck, L., Adriaens, B., Lousbergh, D., Orye, G. G., & Buntinx, F. (2008). A quasi-randomized trial on the effectiveness of an invitation letter to improve participation in a setting of opportunistic screening for cervical cancer. *European Journal of Cancer Prevention, 17*(3), 238–242. doi:10.1097/CEJ.0b013e3282b6fe2e

Dillard, A. J., Ferrer, R. A., Ubel, P. A., & Fagerlin, A. (2012). Risk perception measures' associations with behavior intentions, affect, and cognition following colon cancer screening messages. *Health Psychology, 31*(1), 106–113. doi:10.1037/a0024787

DiLorenzo, T. A., Schnur, J., Montgomery, G. H., Erblich, J., Winkel, G., & Bovbjerg, D. H. (2006). A model of disease-specific worry in heritable disease: The influence of family history, perceived risk and worry about other illnesses. *Journal of Behavioral Medicine, 29*(1), 37–49. doi:10.1007/s10865-005-9039-y

Entwistle, V. A., Carter, S. M., Trevena, L., Flitcroft, K., Irwig, L., McCaffery, K., & Salkeld, G. (2008). Communicating about screening. *BMJ: British Medical Journal, 337*, a1591. doi:10.1136/bmj.a1591

Evans, D. G., Warwick, J., Astley, S. M., Stavrinos, P., Sahin, S., Ingham, S., . . . Howell, A. (2012). Assessing individual breast cancer risk within the U.K. National Health Service Breast Screening Program: A new paradigm for cancer prevention. *Cancer Prevention Ressearch (Philadelphia), 5*(7), 943–951. doi:10.1158/1940-6207.CAPR-11-0458

Everett, T., Bryant, A., Griffin, M. F., Martin-Hirsch, P. P., Forbes, C. A., & Jepson, R. G. (2011). Interventions targeted at women to encourage the uptake of cervical screening. *Cochrane Database of Systematic Reviews, 2011*(5). doi:10.1002/14651858.CD002834.pub2

Friedman, L. C., Neff, N. E., Webb, J. A., & Latham, C. K. (1996). Early breast cancer detection behaviors among ethnically diverse low-income women. *Psycho-Oncology, 5*, 283–289. doi:10.1002/(SICI)1099-1611(199609)5:3<283::AID-PON229>3.0.CO;2-M

Fuchs, V. R., & Schaeffer, L. D. (2012). If accountable care organizations are the answer, who should create them? *JAMA: Journal of the American Medical Association, 307*(21), 2261–2262. doi:10.1001/jama.2012.5564

Gentry-Maharaj, A., & Menon, U. (2012). Screening for ovarian cancer in the general population. *Best Practice & Research Clinical Obstetrics & Gynaecology, 26*(2), 243–256. doi:10.1016/j.bpobgyn.2011.11.006

Gigerenzer, G., & Goldstein, D. G. (1996). Reasoning the fast and frugal way: Models of bounded rationality. *Psychological Review, 103*(4), 650–669. doi:10.1037/0033-295X.103.4.650

Good, K., Niziolek, J., Yoshida, C., & Rowlands, A. (2010). Insights into barriers that prevent African Americans from seeking colorectal screen-

ings: A qualitative study. *Gastroenterology Nursing, 33*(3), 204–208. doi:10.1097/SGA.0b013e3181e379ed
Gotzsche, P. C., & Nielsen, M. (2011). Screening for breast cancer with mammography. *Cochrane Database of Systematic Reviews, 2011*(1). doi:10.1002/14651858.CD001877.pub4
Harper, D. M., Franco, E. L., Wheeler, C. M., Moscicki, A. B., Romanowski, B., Roteli-Martins, C. M., . . . HPV Vaccine Study Group. (2006). Sustained efficacy up to 4.5 years of a bivalent L1 virus-like particle vaccine against human papillomavirus types 16 and 18: Follow-up from a randomised control trial. *The Lancet, 367,* 1247–1255. doi:10.1016/S0140-6736(06)68439-0
Hay, J. L., Buckley, T. R., & Ostroff, J. S. (2005). The role of cancer worry in cancer screening: A theoretical and empirical review of the literature. *Psycho-Oncology, 14*(7), 517–534. doi:10.1002/pon.864
Hay, J. L., McCaul, K. D., & Magnan, R. E. (2006). Does worry about breast cancer predict screening behaviors? A meta-analysis of the prospective evidence. *Preventive Medicine, 42*(6), 401–408. doi:10.1016/j.ypmed.2006.03.002
Health and Social Care Information Centre. (2013a). *Breast Screening Programme, England 2011–12*. Retrieved from http://www.hscic.gov.uk/catalogue/PUB10339/bres-scre-prog-eng-2011-12-rep.pdf
Health and Social Care Information Centre. (2013b). *Cervical Screening Programme, England 2012–13*. Retrieved from http://www.hscic.gov.uk/catalogue/PUB11889/cerv-scre-prog-eng-2012-13-rep.pdf
Hendry, M., Pasterfield, D., Lewis, R., Clements, A., Damery, S., Neal, R. D., . . . Wilkinson, C. (2012). Are women ready for the new cervical screening protocol in England? A systematic review and qualitative synthesis of views about human papillomavirus testing. *British Journal of Cancer, 107*(2), 243–254. doi:10.1038/bjc.2012.256
Herbert, A., Holdsworth, G., & Kubba, A. A. (2008). Cervical screening: Why young women should be encouraged to be screened. *Journal of Family Planning and Reproductive Health Care, 34*(1), 21–25. doi:10.1783/147118908783332078
Hewitson, P., Ward, A. M., Heneghan, C., Halloran, S. P., & Mant, D. (2011). Primary care endorsement letter and a patient leaflet to improve participation in colorectal cancer screening: Results of a factorial randomised trial. *British Journal of Cancer, 105*(4), 475–480. doi:10.1038/bjc.2011.255
Holden, D. J., Jonas, D. E., Porterfield, D. S., Reuland, D., & Harris, R. (2010). Systematic review: Enhancing the use and quality of colorectal cancer screening. *Annals of Internal Medicine, 152*(10), 668–676. doi:10.7326/0003-4819-152-10-201005180-00239
Howell, A., Astley, S., Warwick, J., Stavrinos, P., Sahin, S., Ingham, S., . . . Evans, D. G. (2012). Prevention of breast cancer in the context of a national breast screening programme. *Journal of Internal Medicine, 271*(4), 321–330. doi:10.1111/j.1365-2796.2012.02525.x
Independent UK Panel on Breast Cancer Screening. (2012). The benefits and harms of breast screening: An independent review. *The Lancet, 380,* 1778–1786. doi:10.1016/S0140-6736(12)61611-0
International Agency for Research on Cancer, World Health Organization. (2008). *GLOBOCAN 2008: Estimated cancer incidence, mortality, prevalence and disability-adjusted life years (DALYs) worldwide in 2008*. Retrieved from http://globocan.iarc.fr/
International Cancer Screening Network. (2008a). *Organization of breast cancer screening programs in 27 ICSN countries, 2007–2008*. Retrieved from http://appliedresearch.cancer.gov/icsn/breast/screening.html
International Cancer Screening Network. (2008b). *Organization of cervical cancer screening programs in 20 ICSN countries, 2007–2008*. Retrieved from http://appliedresearch.cancer.gov/icsn/cervical/screening.html
Jensen, J. D., Bernat, J. K., Davis, L. A., & Yale, R. (2010). Dispositional cancer worry: Convergent, divergent, and predictive validity of existing scales. *Journal of Psychosocial Oncology, 28*(5), 470–489. doi:10.1080/07347332.2010.498459
Jordan, J., Martin-Hirsch, P., Arbyn, M., Schenck, U., Baldauf, J. J., Da Silva, D., . . . Prendiville, W. (2009). European guidelines for clinical management of abnormal cervical cytology, part 2. *Cytopathology, 20*(1), 5–16. doi:10.1111/j.1365-2303.2008.00636.x
Joseph, D. A., King, J. B., Miller, J. W., & Richardson, L. C. (2012). Prevalence of colorectal cancer screening among adults–Behavioral Risk Factor Surveillance System, United States, 2010. *Morbidity and Mortality Weekly Report, 61*(Suppl.), 51–56.
Juszczyk, D., Simon, A. E., Waller, J., Ramirez, A. J., & Wardle, J. (2011). Do the UK public realise that colorectal cancer is a common cancer? *Colorectal Disease, 13*(2), 227–228. doi:10.1111/j.1463-1318.2010.02489.x
Kahneman, D. (2011). *Thinking, fast and slow*. New York, NY: Farrar, Straus & Giroux.
Katapodi, M. C., Lee, K. A., Facione, N. C., & Dodd, M. J. (2004). Predictors of perceived breast cancer risk and the relation between perceived risk and breast cancer screening: A meta-analytic review. *Preventive Medicine, 38*(4), 388–402. doi:10.1016/j.ypmed.2003.11.012
Khankari, K., Eder, M., Osborn, C. Y., Makoul, G., Clayman, M., Skripkauskas, S., . . . Wolf, M. S. (2007). Improving colorectal cancer screening among the medically underserved: A pilot study within a federally qualified health center. *Journal of General Internal Medicine, 22*(10), 1410–1414. doi:10.1007/s11606-007-0295-0
Kirscht, J. P., Haefner, D. P., Kegeles, S. S., & Rosenstock, I. M. (1966). A national study of health beliefs. *Journal of Health and Human Behavior, 7*(4), 248–254. doi:10.2307/2948771
Kitchener, H. C., Burns, S., Nelson, L., Myers, A. J., Fletcher, I., Desai, M., . . . Maguire, P. (2004). A randomised controlled trial of cytological surveillance versus patient choice between surveillance and colposcopy in managing mildly abnormal cervical smears. *BJOG: An International Journal of Obstetrics and Gynaecology, 111*(1), 63–70. doi:10.1046/j.1471-0528.2003.00007.x
Kitchener, H. C., Fletcher, I., Roberts, C., Wheeler, P., Almonte, M., & Maguire, P. (2008). The psychosocial impact of human papillomavirus testing in primary cervical screening—a study within a randomized trial. *International Journal of Gynecological Cancer, 18*(4), 743–748. doi:10.1111/j.1525-1438.2007.01113.x
Korfage, I. J., van Ballegooijen, M., Wauben, B., Looman, C. W., Habbema, J. D., & Essink-Bot, M. L. (2012). Having a Pap smear, quality of life before and after cervical screening: A questionnaire study. *BJOG: An International Journal of Obstetrics and Gynecology, 119*(8), 936–944. doi:10.1111/j.1471-0528.2012.03344.x
Kösters, J. P., & Gotzsche, P. C. (2003). Regular self-examination or clinical examination for early detection of breast cancer. *Cochrane Database of Systematic Reviews, 2003*(2). doi:10.1002/14651858.CD003373
Lancucki, L., Fender, M., Koukari, A., Lynge, E., Mai, V., Mancini, E., . . . Patrick, J. (2010). A fall-off in cervical screening coverage of younger women in developed countries. *Journal of Medical Screening, 17*(2), 91–96. doi:10.1258/jms.2010.010017
Levin, B., Lieberman, D. A., McFarland, B., Smith, R. A., Brooks, D., Andrews, K. S., . . . American College of Radiology Colon Cancer Committee. (2008). Screening and surveillance for the early detection of colorectal cancer and adenomatous polyps, 2008: A joint guideline from the American Cancer Society, the US Multi-Society Task Force on Colorectal Cancer, and the American College of Radiology. *CA: A Cancer Journal for Clinicians, 58*(3), 130–160. doi:10.3322/CA.2007.0018
Lipkus, I. M., Kuchibhatla, M., McBride, C. M., Bosworth, H. B., Pollak, K. I., Siegler, I. C., & Rimer, B. K. (2000). Relationships among breast cancer perceived absolute risk, comparative risk, and worries. *Cancer Epidemiology, Biomarkers and Prevention, 9*(9), 973–975.
Maissi, E., Marteau, T. M., Hankins, M., Moss, S., Legood, R., & Gray, A. (2004). Psychological impact of human papillomavirus testing in women with borderline or mildly dyskaryotic cervical smear test results: Cross sectional questionnaire study. *BMJ: British Medical Journal, 328*(7451), 1293. doi:10.1136/bmj.328.7451.1293
Mandel, J. S., Bond, J. H., Church, T. R., Snover, D. C., Bradley, G. M., Schuman, L. M., & Ederer, F. (1993). Reducing mortality from colorectal cancer by screening for fecal occult blood. Minnesota Colon Cancer Control Study. *New England Journal of Medicine, 328*(19), 1365–1371. doi:10.1056/NEJM199305133281901
Marcus, P. M., Bergstralh, E. J., Zweig, M. H., Harris, A., Offord, K. P., & Fontana, R. S. (2006). Extended lung cancer incidence follow-up in the Mayo Lung Project and overdiagnosis. *Journal of the National Cancer Institute, 98*(11), 748–756. doi:10.1093/jnci/djj207
McCaffery, K. J., Irwig, L., Turner, R., Chan, S. F., Macaskill, P., Lewicka, M., . . . Barratt, A. (2010). Psychosocial outcomes of three triage methods for the management of borderline abnormal cervical

smears: An open randomised trial. *BMJ: British Medical Journal, 340,* b4491. doi:10.1136/bmj.b4491

McQueen, A., Vernon, S. W., Meissner, H. I., & Rakowski, W. (2008). Risk perceptions and worry about cancer: Does gender make a difference? *Journal of Health Communication, 13*(1), 56–79. doi:10.1080/10810730701807076

Meisel, S. F., Side, L., Fraser, L., Gessler, S., Wardle, J., & Lanceley, A. (2013). Population-based, risk-stratified genetic testing for ovarian cancer risk: A focus group study. *Public Health Genomics, 16*(4), 184–191. doi:10.1159/000352028

Miller, J. W., King, J. B., Joseph, D. A., & Richardson, L. C. (2012). Breast cancer screening among adult women–Behavioral Risk Factor Surveillance System, United States, 2010. *Morbidity and Mortality Weekly Report, 61*(Suppl.), 46–50.

Montgomery, G. H., Erblich, J., DiLorenzo, T., & Bovbjerg, D. H. (2003). Family and friends with disease: Their impact on perceived risk. *Preventive Medicine, 37*(3), 242–249. doi:10.1016/S0091-7435(03)00120-8

Moser, K., Patnick, J., & Beral, V. (2009). Inequalities in reported use of breast and cervical screening in Great Britain: Analysis of cross sectional survey data. *BMJ: British Medical Journal, 338,* b2025. doi:10.1136/bmj.b2025

Moser, R. P., McCaul, K., Peters, E., Nelson, W., & Marcus, S. E. (2007). Associations of perceived risk and worry with cancer health-protective actions: Data from the Health Information National Trends Survey (HINTS). *Journal of Health Psychology, 12*(1), 53–65. doi:10.1177/1359105307071735

Moyer, V. A. (2012). Screening for prostate cancer: U.S. Preventive Services Task Force recommendation statement. *Annals of Internal Medicine, 157*(2), 120–134. doi:10.7326/0003-4819-157-2-201207170-00459

Mullen, P. D., Allen, J. D., Glanz, K., Fernandez, M. E., Bowen, D. J., Pruitt, S. L., . . . Pignone, M. (2006). Measures used in studies of informed decision making about cancer screening: A systematic review. *Annals of Behavioral Medicine, 32*(3), 188–201. doi:10.1207/s15324796abm3203_4

NHS Cervical Screening Programme. (2011). *NHS Cervical Screening Programme: Annual review 2011*. Retrieved from http://www.cancerscreening.nhs.uk/cervical/publications/cervical-annual-review-2011.pdf

Oken, M. M., Hocking, W. G., Kvale, P. A., Andriole, G. L., Buys, S. S., Church, T. R., . . . PLCO Project Team. (2011). Screening by chest radiograph and lung cancer mortality: The Prostate, Lung, Colorectal, and Ovarian (PLCO) randomized trial. *JAMA: Journal of the American Medical Association, 306*(17), 1865–1873. doi:10.1001/jama.2011.1591

Orbell, S., & Sheeran, P. (1998). 'Inclined abstainers': A problem for predicting health-related behaviour. *British Journal of Social Psychology, 37*(Pt. 2), 151–165. doi:10.1111/j.2044-8309.1998.tb01162.x

Oscarsson, M. G., Wijma, B. E., & Benzein, E. G. (2008). 'I do not need to . . . I do not want to . . . I do not give it priority . . .'—why women choose not to attend cervical cancer screening. *Health Expectations, 11*(1), 26–34. doi:10.1111/j.1369-7625.2007.00478.x

Paskett, E. D., Harrop, J. P., & Wells, K. J. (2011). Patient navigation: An update on the state of the science. *CA: A Cancer Journal for Clinicians, 61*(4), 237–249. doi:10.3322/caac.20111

Peters, E., McCaul, K. D., Stefanek, M., & Nelson, W. (2006). A heuristics approach to understanding cancer risk perception: Contributions from judgment and decision-making research. *Annals of Behavioral Medicine, 31*(1), 45–52. doi:10.1207/s15324796abm3101_8

Peto, J., Gilham, C., Fletcher, O., & Matthews, F. E. (2004). The cervical cancer epidemic that screening has prevented in the UK. *The Lancet, 364*(9430), 249–256. doi:10.1016/S0140-6736(04)16674-9

Posner, T., & Vessey, M. (1988). *Prevention of cervical cancer: The patients' view*. London, England: King's Fund.

Powe, B. D., & Finnie, R. (2003). Cancer fatalism: The state of the science. *Cancer Nursing, 26*(6), 454–465. doi:10.1097/00002820-200312000-00005

Power, E., Miles, A., von Wagner, C., Robb, K., & Wardle, J. (2009). Uptake of colorectal cancer screening: System, provider and individual factors and strategies to improve participation. *Future Oncology, 5*(9), 1371–1388. doi:10.2217/fon.09.134

Rakowski, W., Meissner, H., Vernon, S. W., Breen, N., Rimer, B., & Clark, M. A. (2006). Correlates of repeat and recent mammography for women ages 45 to 75 in the 2002 to 2003 Health Information National Trends Survey (HINTS 2003). *Cancer Epidemiology, Biomarkers and Prevention, 15*(11), 2093–2101. doi:10.1158/1055-9965.EPI-06-0301

Rauscher, G. H., Johnson, T. P., Cho, Y. I., & Walk, J. A. (2008). Accuracy of self-reported cancer-screening histories: A meta-analysis. *Cancer Epidemiology, Biomarkers and Prevention, 17*(4), 748–757. doi:10.1158/1055-9965.EPI-07-2629

Rawl, S. M., Menon, U., Burness, A., & Breslau, E. S. (2012). Interventions to promote colorectal cancer screening: An integrative review. *Nursing Outlook, 60*(4), 172–181. doi:10.1016/j.outlook.2011.11.003

Red, S. N., Kassan, E. C., Williams, R. M., Penek, S., Lynch, J., Ahaghotu, C., & Taylor, K. L. (2010). Underuse of colorectal cancer screening among men screened for prostate cancer: A teachable moment? *Cancer, 116*(20), 4703–4710. doi:10.1002/cncr.25229

Reyna, V. F. (2008). A theory of medical decision making and health: Fuzzy trace theory. *Medical Decision Making, 28*(6), 850–865. doi:10.1177/0272989X08327066

Robb, K. A., Campbell, J., Evans, P., Miles, A., & Wardle, J. (2008). Impact of risk information on perceived colorectal cancer risk: A randomized trial. *Journal of Health Psychology, 13*(6), 744–753. doi:10.1177/1359105308093858

Robb, K. A., Miles, A., & Wardle, J. (2007). Perceived risk of colorectal cancer: Sources of risk judgments. *Cancer Epidemiology, Biomarkers and Prevention, 16*(4), 694–702. doi:10.1158/1055-9965.EPI-06-0151

Robb, K. A., Power, E., Kralj-Hans, I., Atkin, W. S., & Wardle, J. (2010). The impact of individually-tailored lifestyle advice in the colorectal cancer screening context: A randomised pilot study in North-West London. *Preventive Medicine, 51*(6), 505–508. doi:10.1016/j.ypmed.2010.10.002

Sabatino, S. A., Lawrence, B., Elder, R., Mercer, S. L., Wilson, K. M., DeVinney, B., . . . Community Preventive Services Task Force. (2012). Effectiveness of interventions to increase screening for breast, cervical, and colorectal cancers: Nine updated systematic reviews for the guide to community preventive services. *American Journal of Preventive Medicine, 43*(1), 97–118. doi:10.1016/j.amepre.2012.04.009

Schoen, R. E., Pinsky, P. F., Weissfeld, J. L., Yokochi, L. A., Church, T., Laiyemo, A. O., . . . PLCO Project Team. (2012). Colorectal-cancer incidence and mortality with screening flexible sigmoidoscopy. *New England Journal of Medicine, 366*(25), 2345–2357. doi:10.1056/NEJMoa1114635

Scholefield, J. H., Moss, S. M., Mangham, C. M., Whynes, D. K., & Hardcastle, J. D. (2012). Nottingham trial of faecal occult blood testing for colorectal cancer: A 20-year follow-up. *Gut, 61*(7), 1036–1040. doi:10.1136/gutjnl-2011-300774

Schueler, K. M., Chu, P. W., & Smith-Bindman, R. (2008). Factors associated with mammography utilization: A systematic quantitative review of the literature. *Journal of Women's Health, 17*(9), 1477–1498. doi:10.1089/jwh.2007.0603

Schwartz, L. M., Woloshin, S., Fowler, F. J., Jr., & Welch, H. G. (2004). Enthusiasm for cancer screening in the United States. *JAMA: Journal of the American Medical Association, 291*(1), 71–78. doi:10.1001/jama.291.1.71

Schwartz, L. M., Woloshin, S., Sox, H. C., Fischhoff, B., & Welch, H. G. (2000). US women's attitudes to false-positive mammography results and detection of ductal carcinoma in situ: Cross-sectional survey. *Western Journal of Medicine, 173*(5), 307–312. doi:10.1136/ewjm.173.5.307

Senore, C., Giordano, L., Bellisario, C., Di Stefano, F., & Segnan, N. (2012). Population based cancer screening programmes as a teachable moment for primary prevention interventions. A review of the literature. *Frontiers in Oncology, 2,* 45. doi:10.3389/fonc.2012.00045

Sharp, L., Cotton, S., Carsin, A. E., Gray, N., Thornton, A., Cruickshank, M. et al. (2013). Factors associated with psychological distress following colposcopy among women with low-grade abnormal cervical cytology: A prospective study within the Trial Of Management of Borderline and Other Low-grade Abnormal smears (TOMBOLA). *Psycho-Oncology, 22*(2), 368–380. doi:10.1002/pon.2097

Sieverding, M., Matterne, U., & Ciccarello, L. (2010). What role do social norms play in the context of men's cancer screening intention and

behavior? Application of an extended theory of planned behavior. *Health Psychology, 29*(1), 72–81. doi:10.1037/a0016941
Sirovich, B. E., Woloshin, S., & Schwartz, L. M. (2005). Screening for cervical cancer: Will women accept less? *American Journal of Medicine, 118*(2), 151–158. doi:10.1016/j.amjmed.2004.08.021
Slovic, P., Peters, E., Finucane, M. L., & Macgregor, D. G. (2005). Affect, risk, and decision making. *Health Psychology, 24*(4, Suppl.), S35–S40. doi:10.1037/0278-6133.24.4.S35
Smith, S. K., Trevena, L., Simpson, J. M., Barratt, A., Nutbeam, D., & McCaffery, K. J. (2010). A decision aid to support informed choices about bowel cancer screening among adults with low education: Randomised controlled trial. *BMJ: British Medical Journal, 341,* c5370. doi:10.1136/bmj.c5370
Smith-McLallen, A., & Fishbein, M. (2008). Predictors of intentions to perform six cancer-related behaviours: Roles for injunctive and descriptive norms. *Psychology, Health & Medicine, 13*(4), 389–401. doi:10.1080/13548500701842933
Sohl, S. J., & Moyer, A. (2007). Tailored interventions to promote mammography screening: A meta-analytic review. *Preventive Medicine, 45*(4), 252–261. doi:10.1016/j.ypmed.2007.06.009
Spencer, L., Pagell, F., & Adams, T. (2005). Applying the transtheoretical model to cancer screening behavior. *American Journal of Health Behavior, 29*(1), 36–56. doi:10.5993/AJHB.29.1.4
Steckelberg, A., Hulfenhaus, C., Haastert, B., & Muhlhauser, I. (2011). Effect of evidence based risk information on "informed choice" in colorectal cancer screening: Randomised controlled trial. *BMJ: British Medical Journal, 342,* d3193. doi:10.1136/bmj.d3193
Sutton, S., Wardle, J., Taylor, T., McCaffery, K., Williamson, S., Edwards, R., . . . Atkin, W. (2000). Predictors of attendance in the United Kingdom flexible sigmoidoscopy screening trial. *Journal of Medical Screening, 7*(2), 99–104. doi:10.1136/jms.7.2.99
Swan, J., Breen, N., Graubard, B. I., McNeel, T. S., Blackman, D., Tangka, F. K., & Ballard-Barbash, R. (2010). Data and trends in cancer screening in the United States: Results from the 2005 National Health Interview Survey. *Cancer, 116*(20), 4872–4881. doi:10.1002/cncr.25215
U.S. Preventive Services Task Force. (2009). Screening for breast cancer: U.S. Preventive Services Task Force recommendation statement. *Annals of Internal Medicine, 151,* 716–726. doi:10.7326/0003-4819-151-10-200911170-00008
U.S. Preventive Services Task Force. (2013). *Screening for lung cancer: U.S. Preventive Services Task Force recommendation statement*. Retrieved from http://www.uspreventiveservicestaskforce.org/uspstf13/lungcan/lungcanfinalrs.htm
Vernon, S. W. (1997). Participation in colorectal cancer screening: A review. *Journal of the National Cancer Institute, 89*(19), 1406–1422. doi:10.1093/jnci/89.19.1406
Vernon, S. W. (1999). Risk perception and risk communication for cancer screening behaviors: A review. *Journal of the National Cancer Institute Monographs, 1999*(25), 101–119. doi:10.1093/oxfordjournals.jncimonographs.a024184
Vernon, S. W., McQueen, A., Tiro, J. A., & del Junco, D. J. (2010). Interventions to promote repeat breast cancer screening with mammography: A systematic review and meta-analysis. *Journal of the National Cancer Institute, 102*(14), 1023–1039. doi:10.1093/jnci/djq223
Villa, L. L., Costa, R. L., Petta, C. A., Andrade, R. P., Ault, K. A., Giuliano, A. R., . . . Barr, E. (2005). Prophylactic quadrivalent human papillomavirus (types 6, 11, 16, and 18) L1 virus-like particle vaccine in young women: A randomised double-blind placebo-controlled multicentre phase II efficacy trial. *Lancet Oncology, 6*(5), 271–278. doi:10.1016/S1470-2045(05)70101-7
Virnig, B. A., Tuttle, T. M., Shamliyan, T., & Kane, R. L. (2010). Ductal carcinoma in situ of the breast: A systematic review of incidence, treatment, and outcomes. *Journal of the National Cancer Institute, 102*(3), 170–178. doi:10.1093/jnci/djp482
von Wagner, C., Baio, G., Raine, R., Snowball, J., Morris, S., Atkin, W., . . . Wardle, J. (2011). Inequalities in participation in an organized national colorectal cancer screening programme: Results from the first 2.6 million invitations in England. *International Journal of Epidemiology, 40*(3), 712–718. doi:10.1093/ije/dyr008
Walboomers, J. M., Jacobs, M. V., Manos, M. M., Bosch, F. X., Kummer, J. A., Shah, K. V., . . . Muñoz, N. (1999). Human papillomavirus is a necessary cause of invasive cervical cancer worldwide. *Journal of Pathology, 189*(1), 12–19. doi:10.1002/(SICI)1096-9896(199909)189:1<12::AID-PATH431>3.0.CO;2-F
Waller, J., Bartoszek, M., Marlow, L., & Wardle, J. (2009). Barriers to cervical cancer screening attendance in England: A population-based survey. *Journal of Medical Screening, 16*(4), 199–204. doi:10.1258/jms.2009.009073
Waller, J., Douglas, E., Whitaker, K. L., & Wardle, J. (2013). Women's responses to information about overdiagnosis in the UK Breast Cancer Screening Programme: A qualitative study. *BMJ Open, 3*(4), e002703. doi:10.1136/bmjopen-2013-002703
Waller, J., Macedo, A., von Wagner, C., Simon, A. E., Jones, C., Hammersley, V., . . . Campbell, C. (2012). Communication about colorectal cancer screening in Britain: Public preferences for an expert recommendation. *British Journal of Cancer, 107*(12), 1938–1943. doi:10.1038/bjc.2012.512
Wardle, J., Miles, A., & Atkin, W. (2005). Gender differences in utilization of colorectal cancer screening. *Journal of Medical Screening, 12*(1), 20–27. doi:10.1258/0969141053279158
Wardle, J., Williamson, S., McCaffery, K., Sutton, S., Taylor, T., Edwards, R., & Atkin, W. (2003a). Increasing attendance at colorectal cancer screening: Testing the efficacy of a mailed, psychoeducational intervention in a community sample of older adults. *Health Psychology, 22*(1), 99–105. doi:10.1037/0278-6133.22.1.99
Wardle, J., Williamson, S., Sutton, S., Biran, A., McCaffery, K., Cuzick, J., & Atkin, W. (2003b). Psychological impact of colorectal cancer screening. *Health Psychology, 22*(1), 54–59. doi:10.1037/0278-6133.22.1.54
Weinberg, D. S., Keenan, E., Ruth, K., Devarajan, K., Rodoletz, M., & Bieber, E. J. (2013). A randomized comparison of print and web communication on colorectal cancer screening. *JAMA Internal Medicine, 173*(2), 122–129. doi:10.1001/2013.jamainternmed.1017
Weinstein, N. D., Atwood, K., Puleo, E., Fletcher, R., Colditz, G., & Emmons, K. (2004). Colon cancer: Risk perceptions and risk communication. *Journal of Health Communication, 9*(1), 53–65. doi:10.1080/10810730490271647
Weinstein, N. D., & Klein, W. M. (1995). Resistance of personal risk perceptions to debiasing interventions. *Health Psychology, 14*(2), 132–140. doi:10.1037/0278-6133.14.2.132
Weinstein, N. D., Kwitel, A., McCaul, K. D., Magnan, R. E., Gerrard, M., & Gibbons, F. X. (2007). Risk perceptions: Assessment and relationship to influenza vaccination. *Health Psychology, 26*(2), 146–151. doi:10.1037/0278-6133.26.2.146
Weinstein, N. D., & Nicolich, M. (1993). Correct and incorrect interpretations of correlations between risk perceptions and risk behaviors. *Health Psychology, 12*(3), 235–245. doi:10.1037/0278-6133.12.3.235
Wells, K. J., Battaglia, T. A., Dudley, D. J., Garcia, R., Greene, A., Calhoun, E., . . . Patient Navigation Research Program. (2008). Patient navigation: State of the art or is it science? *Cancer, 113*(8), 1999–2010. doi:10.1002/cncr.23815
Wheeler, D. C., Szymanski, K. M., Black, A., & Nelson, D. E. (2011). Applying strategies from libertarian paternalism to decision making for prostate specific antigen (PSA) screening. *BMC Cancer, 11,* Article No. 148. doi:10.1186/1471-2407-11-148
Williams, N., Hughes, L. J., Turner, E. L., Donovan, J. L., Hamdy, F. C., Neal, D. E., . . . Metcalfe, C. (2011). Prostate-specific antigen testing rates remain low in UK general practice: A cross-sectional study in six English cities. *BJU International, 108*(9), 1402–1408. doi:10.1111/j.1464-410X.2011.10163.x
Wilson, J. M. G., & Jungner, G. (1968). *Principles and practice of screening for disease* (World Health Organization Public Health Paper No. 34). Retrieved from http://whqlibdoc.who.int/php/WHO_PHP_34.pdf
Yabroff, K. R., Saraiya, M., Meissner, H. I., Haggstrom, D. A., Wideroff, L., Yuan, G., . . . Coughlin, S. S. (2009). Specialty differences in primary care physician reports of papanicolaou test screening practices: A national survey, 2006 to 2007. *Annals of Internal Medicine, 151*(9), 602–611. doi:10.7326/0003-4819-151-9-200911030-00005
Zapka, J. M., Klabunde, C. N., Arora, N. K., Yuan, G., Smith, J. L., & Kobrin, S. C. (2011). Physicians' colorectal cancer screening discussion and recommendation patterns. *Cancer Epidemiology, Biomarkers and Prevention, 20*(3), 509–521. doi:10.1158/1055-9965.EPI-10-0749