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Author

Potter, Michael B

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Strategies and Resources to Address Colorectal Cancer Screening Rates and Disparities in the United States and Globally

Michael B. Potter

Department of Family and Community Medicine, University of California, San Francisco, California 94143; email: potterm@fcm.ucsf.edu

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Abstract

Colorectal cancer is a significant cause of mortality in the United States and globally. In the United States, increased access to screening and effective treatment has contributed to a reduction in colorectal cancer incidence and mortality for the general population, though significant disparities persist. Worldwide, the disparities are even more pronounced, with vastly different colorectal cancer mortality rates and trends among nations. Newly organized colorectal cancer screening programs in economically developed countries with a high burden of colorectal cancer may provide pathways to reduce these disparities over time. This article provides an overview of colorectal cancer incidence, mortality, screening, and disparities in the United States and other world populations. Promising strategies and resources are identified to address colorectal cancer screening rates and disparities in the United States and worldwide.

INCIDENCE

Colorectal cancer is common in the United States. More than 143,000 cases are expected to be diagnosed in 2012 (75). It is the third most commonly diagnosed serious form of cancer in men and in women. Incidence varies by state; the highest incidence has been observed in North Dakota (56.9/100,000), and the lowest in Utah (34.7/100,000), according to 2010 data (2). Men have modestly higher incidence than women (55.7/100,000 versus 41.4/100,000), and the incidence is higher for African Americans and lower for Asian and Hispanic Americans relative to whites (75). The incidence of colorectal cancer in the United States peaked in 1985 at 66.3/100,000 and declined to 44.7/100,000 by 2007 (14, 62). The rate of decline in colorectal cancer incidence in the United States has recently accelerated, with an annual percentage decline in incidence of over 3% between 2003 and 2007 (63). The greatest declines have been observed for the diagnosis of late-stage cancers and for cancers located in the left side of the colon (75). The incidence of right-sided colon cancer remained relatively unchanged in the 1990s but has declined by more than 2% per year since 2000 (75). The United States is the only country yet to have observed substantial declines in colorectal cancer incidence over time, presumably because of screening activities that have now been in place for several years and that have reached more than half of the targeted US population. Screening allows for ongoing detection and removal of adenomatous polyps that may otherwise progress to cancer in subsequent years.

Worldwide, 1.2 million new cases of colorectal cancer were expected to be diagnosed in 2008, making it the third most commonly diagnosed serious form of cancer in men and the second in women (42). The highest incidence is reported in Australia and New Zealand, Europe, and North America; the lowest is reported in Africa and Southern and Central Asia (27, 28). Major differences can be seen by region, with the incidence in Australia and New Zealand nearly 10 times greater than in areas with the lowest incidence (**Figure 1**). Incidence has increased substantially in several areas of the developing world that previously had low colorectal cancer screening rates, possibly related to increasing prevalence of high-risk Western behaviors such as smoking, physical inactivity, and less healthy diets (10, 28). In developed countries besides the United States, colorectal cancer incidence has so far declined very little, likely due to the relative newness of screening programs or to the lack of reach of these programs to substantial proportions of their eligible populations.

MORTALITY

In the United States, colorectal cancer is the third leading cause of cancer death for men and for women and the second leading cause of cancer mortality overall. More than 51,000 colorectal cancer deaths were expected in the United States in 2012 (75). In 2007, the District of Columbia reported the highest colorectal cancer death rate (21.1/100,00), and Colorado and Montana had the lowest death rates (14.1/100,000) (63). In the United States, men have a higher colorectal cancer mortality rate than do women (20.7/100,000 versus 14.5/100,000). Mortality is greatest for African Americans and lower for Asian and Hispanic Americans relative to whites (75). Age-adjusted colorectal cancer mortality in the United States has been dropping since the 1970s, declining from 28.6/100,000 in 1976 to 16.7/100,000 in 2007 (14, 62). Most of this decline has occurred since the 1990s. The decline in mortality has accelerated in the most recent decade, with a 3% annual reduction in mortality noted between 2003 and 2007 (63). These declines have varied by state, with the northeastern United States showing the greatest declines and the southeastern United States showing the least progress, especially in southern states along the Appalachian corridor (42). Mortality declines by state strongly correlate with the uptake of screening (42).

Worldwide, more than 600,000 colorectal cancer deaths were expected in 2008 (28).

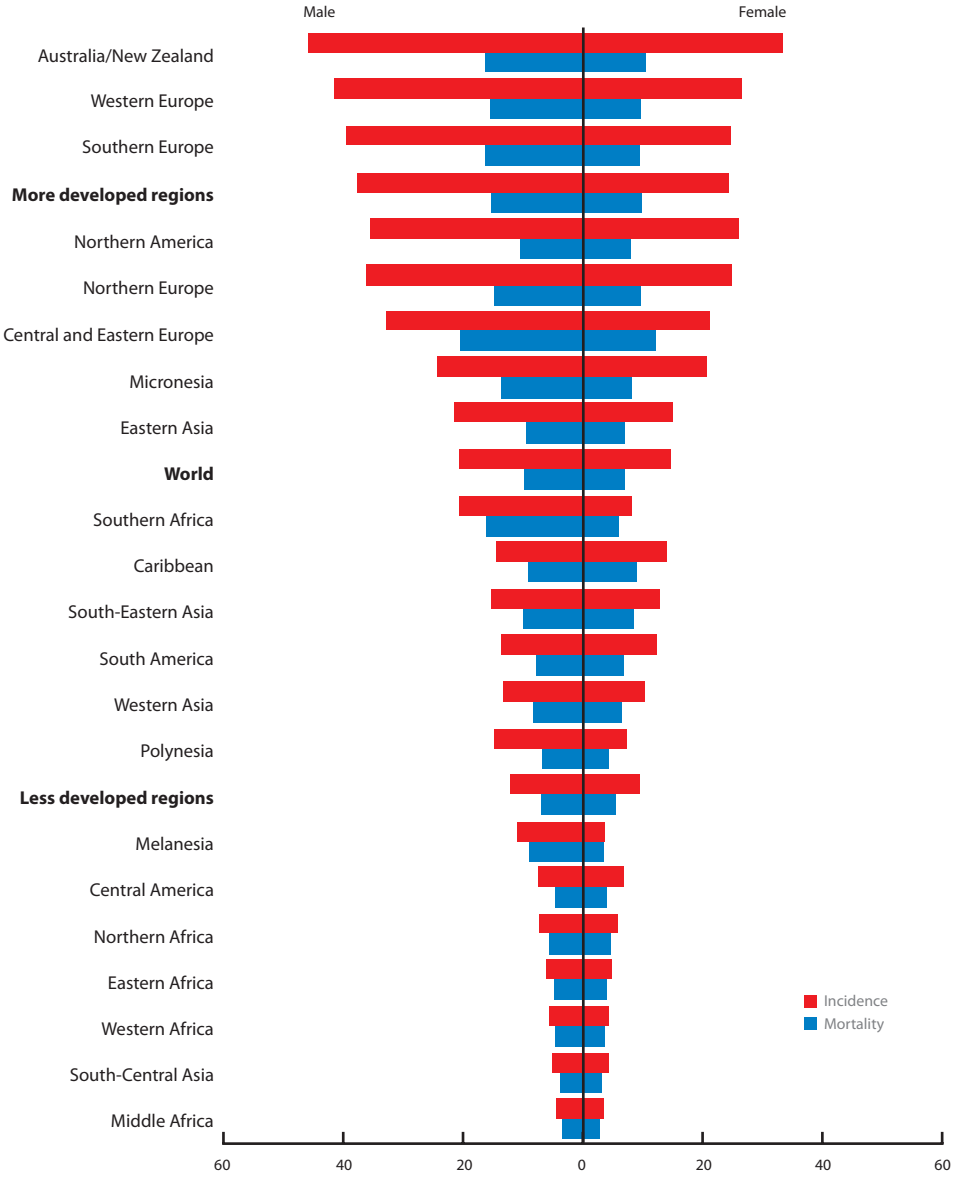

Figure 1

Colorectal cancer incidence and mortality worldwide. Estimated age-standardized rates per 100,000. (From Ref. 26; **http://www.globocan.iarc.fr**)

Mortality rates are declining in many economically developed countries, including most of Western Europe, Australia, New Zealand, and Japan. Mortality is increasing in many rapidly developing countries, such as those of South America, Eastern Europe, and East Asia (10, 28). Declining mortality in economically developed countries is most likely due to a combination of increased screening, with earlier diagnosis and more effective treatment of cancers diagnosed. The increasing mortality that has gone along with increased incidence in more

USPSTF: US Preventive Services Task Force

FOBT: fecal occult blood test

FIT: fecal immunochemical test

IARC: International Agency for Research on Cancer

recently developing countries may, as described above, reflect the adoption of unhealthy Western lifestyles. They may also reflect health care systems that are more equipped than in the past to diagnose colorectal cancer but as yet not providing colorectal cancer screening and early treatment on a large scale. In the poorest countries, colorectal cancer diagnoses are nearly always late stage and fatal. Regional differences in colorectal cancer incidence and mortality from 2008 are presented in **Figure 1** (26).

SCREENING GUIDELINES

The US Preventive Services Task Force (USPSTF) recommends colorectal cancer screening for average-risk adults between the ages of 50 and 75 and on a case-by-case basis for healthy adults without significant life-limiting comorbidities between the ages of 75 and 85 (81). A menu of similarly effective screening options is recommended by the USPSTF: high-sensitivity guaiac fecal occult blood tests (FOBT) or fecal immunochemical tests (FIT) performed at home annually, flexible sigmoidoscopy every 5 years combined with high-sensitivity FOBT or FIT every 3 years, or colonoscopy every 10 years. These testing recommendations are based on the results of a decision analysis by Zauber et al. (83), which concluded that these three screening strategies would result in similar mortality reductions if provided and completed on schedule, with optimal follow-up and treatment. Although colonoscopy is currently the predominant form of average-risk screening used in the United States, the American College of Physicians recently provided guidelines that reinforce the importance of shared decision making to encourage patients to select the test that they are most able and willing to complete (58). These guidelines also support the expert opinions of other groups, such as the American Cancer Society, which advocate that high-risk patients, such as those with a significant family history of colorectal cancer, should be screened proactively with colonoscopy.

In developed countries other than the United States, national approaches have varied. Poland, Germany, and Austria have developed national programs to encourage screening via colonoscopy for the entire average-risk population, generally recommending testing in the sixth decade of life (4, 20, 76). Screening flexible sigmoidoscopy is available in much of Italy, and England is beginning to invest in once-only flexible sigmoidoscopy in response to significant mortality reductions observed in the United Kingdom Flexible Sigmoidoscopy Trial (2, 4). Most countries, however, focus primarily on annual or biennial FOBT or FIT, reserving colonoscopy for higher-risk patients or for diagnostic evaluation after less invasive stool tests are abnormal (4). In 2010, the International Agency for Research on Cancer (IARC) published the first comprehensive set of guidelines for quality assurance in colorectal cancer screening and diagnosis in Europe (16). These guidelines, developed with input from experts from 32 countries, including several countries outside of the European Union, provide a detailed consideration of the entire process of screening, diagnosis, and treatment. Although they endorse the feasibility of several different approaches to screening where adequate resources and quality controls can be established, the EU guidelines principally support FOBT or FIT for average-risk adults aged 50–74 as the standard of care, with an emphasis on developing comprehensive resources and programs for individuals with abnormal home stool test results. The EU guidelines single out FIT as superior to guaiac-based FOBT because a FIT is easier for patients to use and has higher sensitivity for larger adenomas and cancer. This view contrasts with that of the USPSTF, which continues for now to endorse the use of high-sensitivity guaiac tests, which tend to have higher false-positive rates than FIT. On a global level, the World Health Organization recommends that colorectal cancer screening should be offered only in settings where appropriate follow-up can be assured because there is no value to screening without the possibility of timely diagnosis and effective treatment (82).

SCREENING RATES, TRENDS, AND DISPARITIES

According to the National Health Interview Survey, a little more than half of adults in the United States aged 50–75 were up-to-date with colorectal cancer screening in 2010 as defined by having FOBT or FIT in the past year, flexible sigmoidoscopy in the past 5 years, or colonoscopy in the past 10 years (62). The rates for men and women were nearly the same, but non-Hispanic whites were significantly more likely to be up-to-date with screening compared with other racial and ethnic groups. The groups with the lowest screening rates were those with less than a high-school education, who are foreign born, uninsured, or without a usual source of primary care. Screening rates have increased in the United States, primarily owing to an increased use of colonoscopy by people with health insurance. Among adults aged 50–75, colonoscopy use in the past 10 years increased from 19% in 2000 to 47.5% in 2008. However, during the same time, the use of flexible sigmoidoscopy within the past 5 years declined from 9.4% to 2.4%, and the use of FOBT or FIT in the past year declined from 17.4% to 10.9% (33). Only 16.3% of adults aged 50–75 without a usual source of care and 18.1% of those without a visit to a physician in the past year reported being up-to-date with screening according to National Health Interview Survey data from 2008 (74). With the increased use of more expensive tests, the disparities in screening have grown between the insured and the uninsured (13). **Table 1**, from an important study by Klabunde et al. (32), provides an illuminating summary of colorectal cancer screening trends and disparities in the United States between 2000 and 2008. It provides useful insights about the types of disparities that can arise in a decentralized health care system, where a substantial minority of the population does not have health insurance or access to preventive services, even as overall screening rates increase.

Data on colorectal cancer screening rates outside the United States are more limited. However, screening rates remain well below 50% in most countries, even in economically developed countries with national health care systems and active national colorectal cancer screening programs (65, 70, 77). Most countries with national programs emphasize the use of FOBT or FIT, which is then followed up with colonoscopy when needed (4). Japan's FIT program, for example, has screened nearly 7 million people out of a target population of 35 million over age 40. Germany's program, which includes a menu of screening test options, has screened more than 4 million people out of a target population of 28 million people over age 50. Several EU nations, as well as other developed countries such as Australia, Israel, and Taiwan, have also implemented national programs that have supported higher colorectal cancer screening rates. The extent to which individuals in these countries are also obtaining colorectal cancer screening through episodic primary care provided outside of these organized national screening programs is not yet well characterized. Nonetheless, as in the United States, disparities in screening participation have begun to appear in some countries. In England, FOBT adherence rates have been lower in localities with higher proportions of immigrants from the Indian subcontinent (41). Also in England, investigators have observed lower levels of adherence to both FOBT and flexible sigmoidoscopy among individuals with higher levels of social deprivation (41, 64). In Australia, the indigenous population has had lower participation in colorectal cancer screening programs than has the nonindigenous population (11). An Italian study in which individuals were randomly assigned to receive one of three different screening modalities discovered that women were more likely than men to complete a FIT, whereas men were more likely to complete flexible sigmoidoscopy or colonoscopy than were women (69). These findings indicate that, as screening initiatives are implemented, health care providers will need to monitor for the development of disparities in uptake among different demographic

Table 1 Trends in colorectal cancer test use among vulnerable US populations. Up-to-date[a] with colorectal cancer screening, US adults aged 50–75, National Health Interview Survey 2000–2008[b]

	2000 percentage (95% CI)	2003 percentage (95% CI)	2005 percentage (95% CI)	2008 percentage (95% CI)	Percentage point change, 2000–2008
Overall	38.6 (37.4–39.9)	43.3 (41.9–44.7)	48.6 (47.2–50.1)	54.5 (52.9–56.2)	+15.9
Race/ethnicity					
NH white	40.5 (39.1–41.8)	45.3 (43.7–46.8)	51.7 (50.0–53.3)	57.0 (55.1–58.9)	+16.5
NH black	33.0 (29.6–36.7)	37.7 (34.0–41.6)	38.7 (35.3–42.3)	51.4 (47.1–55.6)	+18.4
Hispanic	26.4 (22.4–30.9)	30.3 (25.9–35.0)	32.4 (27.5–37.9)	39.1 (34.8–43.6)	+12.7
NH Asian	32.2 (25.8–39.3)	33.6 (25.6–42.5)	40.7 (34.4–47.4)	50.8 (43.2–58.4)	+18.6
Education					
More than high school	45.3 (43.4–47.3)	50.2 (48.3–52.1)	55.3 (53.5–57.1)	62.0 (60.0–64.0)	+16.7
High school graduate	37.4 (35.1–39.8)	42.2 (39.9–44.4)	45.8 (43.4–48.2)	50.5 (47.7–53.2)	+13.1
Less than high school	26.0 (24.0–28.2)	28.4 (25.8–31.2)	35.3 (32.3–38.5)	37.5 (34.1–41.0)	+11.5
Time in the United States					
Born in the United States	39.9 (38.5–41.2)	44.5 (43.1–46.0)	50.2 (48.6–51.8)	56.5 (54.7–58.3)	+16.6
Immigrant, living in the United States 10+ years	32.0 (28.2–35.9)	35.5 (31.6–39.6)	39.2 (35.3–43.3)	42.4 (38.5–46.7)	+10.4
Immigrant, living in the United States <10 years	10.0 (6.1–15.9)	16.0 (10.0–24.7)	16.6 (10.2–26.0)	25.7 (17.2–36.6)	+15.7
Family income (% FPL)					
500%+	49.1 (45.8–52.4)	55.1 (52.5–57.6)	58.3 (55.4–61.1)	66.0 (63.2–68.8)	+16.9
400%–<500%	39.8 (34.7–45.2)	43.1 (38.4–48.0)	53.7 (47.9–59.5)	60.3 (55.1–65.3)	+20.5
300%–<400%	37.5 (33.9–41.3)	45.7 (42.1–49.4)	48.5 (44.9–52.1)	53.0 (49.0–56.8)	+15.5
200%–<300%	36.2 (32.8–39.8)	38.3 (35.3–41.4)	45.5 (41.7–49.2)	50.9 (47.0–54.9)	+14.7
<200%	29.8 (27.6–32.1)	32.3 (30.0–34.6)	37.1 (34.7–39.5)	40.1 (37.2–43.1)	+10.3
Health insurance—ages 50–64					
Private non-HMO	36.9 (34.9–38.9)	41.8 (39.5–44.0)	45.2 (43.3–47.2)	55.2 (52.8–57.5)	+18.3
Private HMO	36.5 (34.1–39.1)	43.1 (40.2–46.0)	48.5 (45.5–51.5)	55.9 (52.1–59.7)	+19.4
Public	30.7 (26.8–34.8)	37.3 (33.5–41.2)	42.1 (38.6–45.7)	45.3 (41.4–49.2)	+14.6
Uninsured	14.7 (12.0–17.8)	16.2 (13.5–19.3)	17.2 (14.6–20.2)	19.9 (16.1–24.3)	+5.2
Health insurance—ages 65–75					
Medicare + private	51.4 (48.1–54.7)	54.6 (50.9–58.1)	64.0 (60.2–67.6)	67.5 (63.3–71.4)	+16.1
Medicare HMO	51.8 (45.6–57.9)	57.3 (49.5–64.7)	52.6 (44.8–60.4)	62.9 (54.8–70.3)	+11.1
Medicare, no supplemental	31.9 (26.1–38.3)	36.9 (30.8–43.4)	52.3 (47.0–57.6)	52.9 (46.7–59.0)	+21.0
Medicaid, military, and other government	28.5 (22.2–35.9)	49.0 (41.6–56.4)	56.8 (48.3–64.9)	56.8 (48.9–64.3)	+28.3
Uninsured or Medicare Part A only	41.3 (27.8–56.2)	36.3 (19.6–57.2)	39.3 (33.1–45.9)	51.3 (36.4–66.0)	+10.0[c]
Has usual source of care					
Yes (excluding emergency department only)	40.5 (39.2–41.8)	45.4 (44.0–46.8)	50.8 (49.3–52.3)	57.4 (55.7–59.0)	+16.9
No	14.5 (11.4–18.2)	14.9 (10.3–21.2)	21.7 (17.2–27.0)	16.3 (13.1–20.1)	+1.8

(*Continued*)

Table 1 (*Continued*)

	2000 percentage (95% CI)	2003 percentage (95% CI)	2005 percentage (95% CI)	2008 percentage (95% CI)	Percentage point change, 2000–2008
Number of physician visits in past year					
2 or more	44.6 (43.1–46.1)	49.5 (47.9–51.2)	54.8 (53.1–56.4)	61.7 (59.9–63.4)	+17.1
1	29.2 (26.2–32.3)	31.4 (27.6–35.6)	40.1 (36.0–44.4)	43.3 (39.4–47.3)	+14.1
None	10.6 (8.7–12.8)	15.9 (11.9–21.0)	17.9 (14.7–21.6)	18.1 (14.5–22.4)	+7.5

Abbreviations: CI, confidence interval; FOBT, fecal occult blood test; FPL, federal poverty level; HMO, health maintenance organization; NH, non-Hispanic.

[a]Up-to-date is defined as having had a home FOBT in the past year, sigmoidoscopy in the past 5 years, and/or colonoscopy in the past 10 years.

[b]Overall and subgroup trends are statistically significant at $\alpha = 0.05$, unless otherwise noted.

[c]Trend for this subgroup is not statistically significant at $\alpha = 0.05$.

subgroups and to design program adaptations to address and overcome them.

In the developing countries in Africa, Central Asia, and South Asia, colorectal cancer mortality is still relatively low compared with other major diseases that compete for limited health care resources, often making large-scale colorectal cancer screening programs of any type difficult to justify (**Figure 1**). In India, investigators have suggested that a focus on healthy diets and exercise plus a campaign to increase awareness of early symptoms would be more cost-effective than an organized screening program (34). A recent study examining cancer control in Southeast Asia and sub-Saharan Africa concluded that investment in colorectal cancer treatment programs would yield much greater benefits and be more cost-effective than programs focused on screening (18). However, as economies grow, as lifestyles in these regions change, as the burden of higher prevalence diseases are better addressed, and as infrastructures for cancer treatment improve, the balance of costs and benefits for colorectal cancer screening in these countries may shift in favor of developing colorectal cancer screening programs, as well.

STRATEGIES TO INCREASE SCREENING RATES AND REDUCE DISPARITIES

The social-ecological perspective can provide a useful context from which to view colorectal cancer screening strategies (61). This perspective posits that health promotion can occur at many levels, including policy, community, organizations, and influential peer groups—all with the goal of promoting healthy behaviors such as increased uptake and adherence to screening among individuals (**Figure 2**). To achieve high rates of colorectal cancer screening in targeted populations, health promotion strategies must operate at most or all of these levels, tailoring for diverse and often hard-to-reach individuals and communities. The following paragraphs describe selected colorectal cancer screening approaches that operate at one or more of these levels of the social-ecological perspective to address colorectal cancer screening in the United States and globally.

National Colorectal Cancer Screening Programs

The existence of nationally integrated health care systems and infrastructure has the potential to support organized screening programs that cover an entire population and operate at all levels of the social-ecological framework. As of 2011, 18 countries were actively implementing such programs for their entire populations, and several more were testing programs with the intention of scaling them up (4). Leaders of these programs have recently begun to convene to share best practices and develop international collaborations (1, 4, 5). These organized screening programs have been

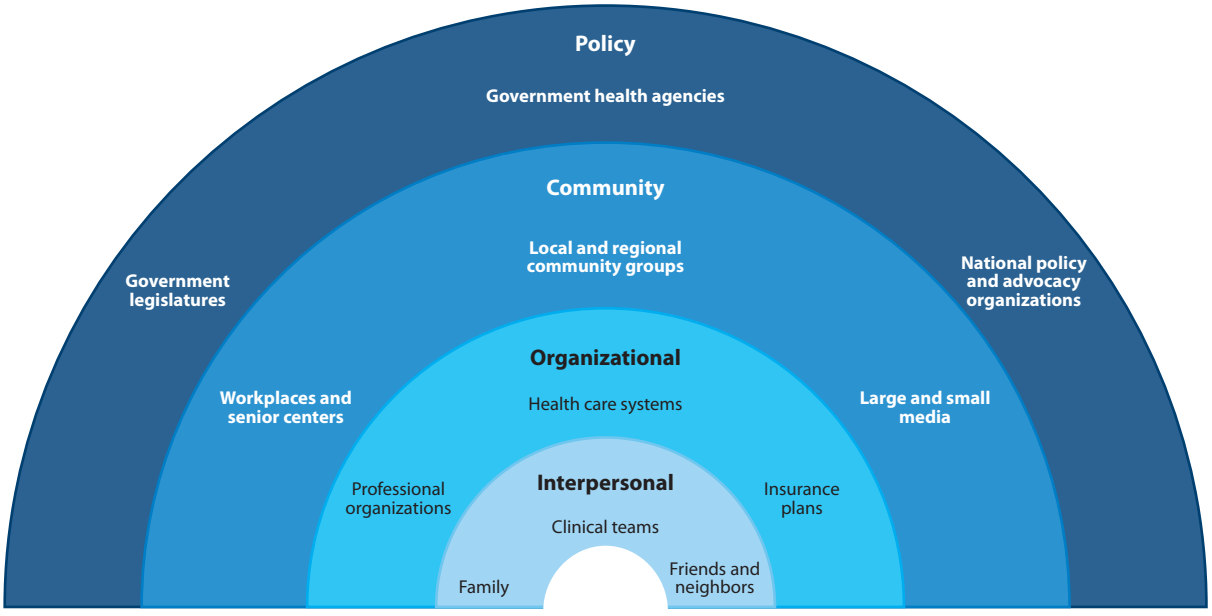

Figure 2

Social-ecological framework for levels at which colorectal cancer screening interventions can operate, adapted from resources developed by the CDC Colorectal Cancer Control Program (**http://www.cdc.gov/cancer/crccp/sem/htm**).

described in terms of targeted populations, outreach method, screening method, age group screened, and interval between screening tests, as well as systems to monitor response rates, follow-up of abnormal screening tests, and quality assurance. The strength of national programs is their potential to reach large swaths of the population that may have never been screened in the past and usually at relatively low cost. However, these programs may yield uneven results in terms of who is reached. For example, the national screening program in Italy yielded dramatically different levels of screening among targeted individuals in different regions of the country; screening rates in 2007 ranged from 71.6% in the north region of the country and 52.1% in the central region to just 7% in the southern region (38). National programs may need to start with pilot testing to identify the best strategies to reach the entire population, and they may need to be retooled or redesigned when initial efforts either strain the existing infrastructure or are less successful than hoped (12, 49). Some have expressed concern that programs with limited objectives, such as one-time or relatively infrequent stool testing with FOBT or FIT, may miss many cancers, especially among those who are at higher-than-average risk for colorectal cancer (59). In Australia, for example, the National Bowel Screening Program currently provides a FIT only at ages 50, 55, and 65, with a plan to introduce biennial screening gradually over the next decade (15). The gradual scaling-up of this national screening program was designed to match the capacity for diagnostic evaluation and treatment. However, in the interim, Australian primary care clinicians may order more frequent or invasive screening independently of the national program when indicated. Each country that chooses to implement a national screening program must develop a process to select colorectal cancer screening outreach and testing strategies that are acceptable to their targeted populations, that match national resources for diagnosis and treatment, and that

support or complement other independent colorectal cancer screening activities conducted in primary care settings.

Primary Care Clinic-Based Screening Programs

The United States has no national program, and the chief mechanism to obtain colorectal cancer screening has been through episodic primary care offices, operating primarily at the interpersonal level of the social-ecological framework. This reliance on primary care clinicians has led to screening disparities, leaving out many eligible adults who are either uninsured or who do not routinely access primary care. Implementation of the Patient Protection and Affordable Care Act of 2010, which requires insurance coverage for colorectal cancer screening for all American citizens, should reduce screening disparities for the previously uninsured (31). However, even with universal health insurance, primary care–based screening is effective only to the extent that timely screening recommendations, resources, and support are delivered to eligible patients. Key primary care systems issues that must be addressed are physician leadership and practice incentives; patient registries that are actively used for telephone, mailed, and Internet-based outreach to eligible patients who are due for screening; reminder systems for clinicians to provide screening to eligible patients at the point of care; office policies that empower nonphysician office staff to participate actively in screening activities; strategies to support effective patient education and shared decision making; and strategies to assure appropriate and timely follow-up of abnormal screening tests (66). Evidence indicates that patient test preferences vary: Some prefer endoscopic screening, and others, often disproportionately including ethnic minorities, prefer more frequent but less invasive annual stool testing, making the case that primary care offices should maintain a menu of screening options for their patients (25). To address potential screening disparities, primary care offices also need to develop screening strategies that are sensitive to issues of literacy, that address language preferences, and that help navigate patients who lack familiarity or experience with colorectal cancer screening through the screening and follow-up process (47, 79). Many, if not all, of these proposed activities are consistent with more general efforts to transform US primary care through the development of patient-centered medical homes (PCMH) that provide comprehensive, coordinated, accessible, high-quality care with an emphasis on the health care needs of individual patients. Sarfaty et al. (67) have rightly suggested that provision of colorectal cancer screening and other preventive services should be an important goal of PCMH initiatives (67).

EHR: electronic health record

Large Integrated Health Delivery Systems

Large integrated health delivery systems, with their robust organizational structures and resources, can combine many of the benefits of national programs and primary care–based colorectal cancer screening programs. One of the best examples of this can be found at Kaiser Permanente Northern California (KPNC), a large health care system employing more than 7,000 physicians caring for more than 3 million insured patients (37). As a privately run health care organization in a competitive marketplace, KPNC has both the incentives and the resources to invest in clinical programs to increase screening rates, leveraging multiple levels of the health care organization. The KPNC electronic health record (EHR) is used to identify patients aged 50–75 who have not completed colorectal cancer screening within recommended time intervals. These patients receive a letter alerting them that they need screening and that a FIT kit will soon be sent to them by mail. Kits are then mailed with a postage-paid return envelope, enabling patients to return completed kits to a central laboratory, where the test kits are processed through an automated process, under strict quality controls. Patients receive additional telephone calls and mailed reminders when needed to encourage test

completion. Patients with normal test results are mailed a new FIT kit through the same process the following year. Patients with abnormal test results are referred for colonoscopy, with a similar set of reminders to assure test completion and follow-up of any abnormal colonoscopy results as appropriate. Other aspects of the KPNC colorectal cancer screening program entail use of EHR-generated point-of-care reminders to prompt the offering of screening tests during primary care or specialty care visits, with standing orders to allow nonphysician clinical staff members to take the initiative to provide FIT when indicated. In all these activities, average-risk patients who decline FIT may elect to receive flexible sigmoidoscopy or colonoscopy instead, and high-risk patients may always be referred directly to colonoscopy when identified by their primary care clinician as being at higher than average risk. Innovation at the local level is incentivized with operating budget allocations and recognition for individual clinical sites that reach annually specified screening targets. This highly integrated and organized program has achieved a screening rate that now surpasses 80% of the nearly 1 million targeted patients. These activities have reached such high levels of participation in part because they intervene with patients and providers at multiple levels, providing additive effects. For example, patients participating in the KPNC FLU-FIT Program, where influenza vaccination clinic attendees are offered FIT kits when indicated, were more likely to complete screening within the next 90 days than were other eligible patients, regardless of whether they had recently received a FIT kit in the mail or attended a recent primary care visit (51, 54). The KPNC approach to colorectal cancer screening provides an important model of what can be accomplished when health care resources are properly aligned and put to work. Many elements of this approach could readily be adopted within health systems in the United States and globally that have a well-defined patient population and an EHR.

Community Health Centers

Community health centers (CHCs) can play a critical role in addressing colorectal cancer screening rate disparities. CHCs are typically public nonprofit community-based and patient-directed organizations serving primary health care needs with an emphasis on health promotion, coordinating with other community services, and emphasizing community development processes to improve the health of individuals and the community. In the United States, CHCs serve a rapidly growing population of more than 20 million patients in more than 8,000 locations across the United States, with service priorities and capacities that are often driven by national policy (43). The CHC service population currently includes patients with low income, the uninsured, those with limited English proficiency, migrant and seasonal farm workers, individuals and families experiencing homelessness, and those living in public housing. CHCs meeting certain service criteria are deemed "federally qualified" and receive financial support from the Health Resources and Services Administration, and others meeting some but not all federal requirements are termed "look-alikes" and do not yet receive such funding. These clinics disproportionately serve primary care patient populations with low baseline colorectal cancer screening rates. The passage of the Health Information Technology for Economic and Clinical Health Act (HITECH Act) in 2009 has provided incentives to accelerate the adoption of EHR systems among clinical providers nationally, including CHCs (17). As part of the HITECH Act, clinical providers can receive "meaningful use" incentive payments for using their EHR to address colorectal cancer screening rates. In 2012, the US Bureau of Primary Healthcare issued new colorectal cancer screening reporting requirements for federally funded CHCs, which should increase attention to colorectal cancer screening among diverse and traditionally medically underserved patient populations (36). Although many communities served by CHCs

lack easily accessible colonoscopy services, an approach focusing on FOBT or FIT followed by diagnostic colonoscopy when needed should be increasingly feasible even in rural and medically underserved settings (3, 6, 22, 68). With this combination of policy-driven incentives to support the development of clinical teams ready to reach out and provide screening recommendations at the interpersonal level, CHCs are increasingly well-positioned to lead the way in addressing colorectal cancer screening disparities in the United States.

Community-Based Colorectal Cancer Screening Programs

Locally organized colorectal cancer screening interventions that reach beyond the walls of traditional health care settings are another important strategy suggested by the social-ecological framework. These strategies may be especially important to increase screening rates and reduce disparities among population groups that do not routinely access clinical care. Most community-based programs have focused on education and referrals for screening rather than on direct provision of services. This is because individuals who have abnormal screening results need to be followed up with diagnostic testing and possibly treatment, which is often beyond the scope of community groups to provide on their own. However, settings with the capacity to develop and provide follow-up referrals, such as work sites, commercial pharmacies, or stand-alone retail clinics, could become important access points for FOBT or FIT (21, 23, 29, 52, 56, 78). Lay health workers using telephone outreach, prevention classes, or social support groups have been shown capable of reducing screening barriers for traditionally underserved minority populations in the United States (35, 40, 80). Churches, senior centers, and hair salons are other promising venues for colorectal cancer screening education and outreach in diverse communities (7, 24, 57, 60). Community-based health fairs are another convenient setting where colorectal cancer screening services can be provided (19). In fact, colorectal cancer screening can be offered by trained individuals in almost any setting where members of the community congregate and could even be offered in such novel settings as election-day polling places (71). Activities such as these may ultimately change community norms and expectations related to screening, creating enthusiasm and reducing barriers related to screening among those who otherwise might not be reached by more conventionally siloed mass screening programs or primary care clinic programs (48).

Bundling Colorectal Cancer Screening With Other Clinical Preventive Services

Interventions focusing solely on colorectal cancer screening can be very effective, but they may also compete with other public health and clinical outreach priorities and may be difficult to sustain as stand-alone activities. Some of these issues may be mitigated when colorectal cancer screening activities are bundled with other high-priority preventive services. On all the intervention levels described by the social-ecological model, for example, cancer screening can be presented and promoted as a package of essential services or in concert with other essential services. At the primary care level, for example, point-of-care reminders are an effective strategy to promote age-specific preventive services together. EHRs can be programmed to provide these reminders to clinical staff during each primary care visit (39). Clinical teams charged with offering annual influenza vaccination clinics each year can be trained to offer FOBT or FIT at the same time (53–56). At some KPNC sites, in fact, annual influenza vaccination clinics are augmented into annual prevention clinics, offering a variety of vaccinations, cancer screening tests, and cardiovascular health assessments to eligible patients in addition to traditionally offered influenza vaccinations each autumn. On a community level, a New England–based organization called Sickness Prevention Achieved through Regional Collaboration (SPARC) has developed a model

to provide influenza vaccinations and mammogram referrals in community settings outside of traditional clinics (73). New US guidelines seek to increase the proportion of older adults who are up-to-date on a core set of clinical preventive services, rather than just on each test individually. Bundling of preventive services may ultimately encourage more efficient and effective delivery of clinical preventive services in the future (9, 72).

RESOURCES FOR COLORECTAL CANCER SCREENING PROGRAM DEVELOPMENT

In the United States, the Community Preventive Services Task Force periodically reviews and provides recommendations on evidence-based cancer screening programs and policies. These recommendations are published in *The Guide to Community Preventive Services Strategies*. For colorectal cancer screening, these recommended strategies currently include patient reminders (such as post cards, phone calls, or reminders at the point of care), small media (such as brochures with tailored messages targeted to specific underscreened minority groups), one-to-one education (such as individual counseling of patients by a member of the health care team), and reducing structural barriers to screening (such as those associated with procedure access, scheduling, or transportation). Other evidence-based strategies targeting health care providers, such as provider assessment, feedback, reminder, and recall systems, are also recommended. Some of the specific programs that support these recommendations have been designated as Research-Tested Intervention Programs (RTIPs) and are publicly posted on the US National Cancer Institute (NCI) website (44).

The NCI also sponsors the Research to Reality website, which links cancer-control practitioners and researchers and provides opportunities for discussion, learning, and enhanced collaboration on moving research into practice (45). One example of a featured Research to Reality collaboration is the "Make it Your Own" program, which allows program planners and health care providers to download and adapt culturally appropriate colorectal cancer screening promotional materials for diverse patient populations without having to develop these materials from scratch. Such resources may provide important support for groups such as CHCs that wish to organize programs to reach and screen more of their patients. These resources may also serve as models for the development of similar programs in other countries.

The United States Centers for Disease Control and Prevention (CDC) created the Colorectal Cancer Control Program (CRCCP) in 2009 (30). This program has received nearly $27 million to fund 25 states and 4 tribes to engage in evidence-based activities to support higher colorectal cancer screening rates on a population level, often with a focus on low-income and medically underserved populations. The CRCCP focuses on evidence-based interventions recommended by the Community Preventive Services Task Force (8). Together, these programs and resources can make a positive impact on colorectal cancer screening rates and disparities in the United States, particularly by increasing state program partnerships with CHCs and community-based organizations (50).

Dozens of private and nonprofit organizations in the United States are working independently to address colorectal cancer screening rates and disparities in diverse populations and settings. In 1997, the American Cancer Society and the CDC founded the National Colorectal Cancer Roundtable (NCCRT) as a coalition of public, private, and voluntary organizations dedicated to reducing the incidence of and mortality from colorectal cancer in the United States through coordinated leadership, strategic planning, and advocacy. The NCCRT has grown to include more than 70 stakeholder organizations, including federal, state, and local government agencies, professional societies, patient advocacy groups, health providers and insurers, and academic medical centers. The NCCRT has developed several resources to

support the goal of increasing colorectal cancer screening rates in diverse communities and clinical settings. These include public awareness and professional training resources, a tool kit to help primary care teams develop effective colorectal cancer screening office procedures, and a program planning and evaluation tool kit for state- and community-based organizations (46).

Finally, and especially important for global screening efforts, the IARC is an internationally funded extension of the World Health Organization. The IARC publishes international statistics on colorectal cancer incidence, mortality, and prevalence worldwide and coordinated the new EU guidelines for quality assurance in colorectal cancer screening, which are the most comprehensive colorectal cancer screening resource yet prepared for an international audience. This document includes detailed evaluations of the effectiveness of different types of screening tests, a thorough description of different types of screening programs, and a comprehensive review of successful models for program implementation and evaluation. Programs and organizations with an international focus, such as the International Cancer Screening Network and the World Endoscopy Association provide opportunities to share colorectal cancer screening research and best practices globally.

SUMMARY

The worldwide incidence of colorectal cancer is likely to increase in the coming decades. However, successful screening and prevention programs are growing in number and diversity. Fortunately, best practices and lessons learned from a growing diversity of successful screening interventions are increasingly being shared and made available through publicly accessible sources, such as websites sponsored by the CDC, NCI, IARC, and others. In most cases, multiple strategies, incorporating the perspectives of the end users of screening programs, will be required to achieve optimal colorectal cancer screening outcomes in countries and communities with differing population characteristics, resources, cultures, and values.

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LITERATURE CITED

1. Atkin WS, Benson VS, Green J, Monk CR, Nadel MR, et al. 2010. Improving colorectal cancer screening outcomes: proceedings of the second meeting of the International Colorectal Cancer Screening Network, a global quality initiative. *J. Med. Screen.* 17:152–57
2. Atkin WS, Edwards R, Kralj-Hans I, Wooldrage K, Hart AR, et al. 2010. Once-only flexible sigmoidoscopy screening in prevention of colorectal cancer: a multicentre randomized controlled trial. *Lancet* 375:1624–33
3. Ballew C, Lloyd BG, Miller SH. 2009. Capacity for colorectal cancer screening by colonoscopy, Montana, 2008. *Am. J. Prev. Med.* 36:329–32

4. Benson VS, Atkin WS, Green J, Nadel MR, Patnick J, et al. 2012. Toward standardizing and reporting colorectal cancer screening indicators on an international level: The International Colorectal Cancer Screening Network. *Int. J. Cancer* 130:2961–73
5. Benson VS, Patnick J, Davies AK, Nadel MR, Smith RA, Atkin WS, ICCSN. 2008. Colorectal cancer screening: a comparison of 35 initiatives in 17 countries. *Int. J. Cancer* 122:1357–67
6. Butterly L, Olenec C, Goodrich M, Carney P, Dietrich A. 2007. Colonoscopy demand and capacity in New Hampshire. *Am. J. Prev. Med.* 32:25–31
7. Campbell MK, James A, Hudson MA, Carr C, Jackson E, et al. 2004. Improving multiple behaviors for colorectal cancer prevention among African American church members. *Health Psychol.* 23:492–502
8. Cent. Dis. Control Prev. (CDC). 2012. *The Guide to Community Preventive Services: Cancer Control and Prevention*. Atlanta, GA: CDC. **http://www.thecommunityguide.org/cancer/index.html**
9. Cent. Dis. Control Prev. (CDC), Adm. Aging, Agency Healthc. Res. Quality (AHRQ), Cent. Medicare and Medicaid Serv. 2011. *Enhancing Use of Clinical Preventive Services Among Older Adult—Closing the Gap*. Washington, DC: AARP. **http://www.cdc.gov/features/preventiveservices/clinical_preventive_services_closing_the_gap_report.pdf**
10. Center MM, Jemal A, Smith RA, Ward E. 2009. Worldwide variations in colorectal cancer. *CA Cancer J. Clin.* 59:366–78
11. Christou A, Katznellenbogen JM, Thompson SC. 2010. Australia's National Bowel Cancer Screening Program: Does it work for indigenous Australians? *BMC Public Health* 10:373
12. Costantino C, Calamusa G, Cusimano R, Firenze A, Romano N, et al. 2011. A proposal for an evidence-based model of the screening for the colorectal carcinoma in an Italian setting. *J. Prev. Med. Hyg.* 52:191–95
13. Courtney RJ, Paul CL, Sanson-Fisher RW, Macrae FA, Carey ML, et al. 2012. Colorectal cancer screening in Australia: a community-level perspective. *Med. J. Aust.* 196:516–20
14. Cress RD, Morris C, Ellison GL, Goodman MT. 2006. Secular changes in colorectal cancer incidence by subsite, stage at diagnosis, and race/ethnicity, 1992–2001. *Cancer* 107(5 Suppl.):1142S–52
15. Dep. Health Ageing. 2012. *National Bowel Cancer Screening Program*. Woden, Aust: Aust. Gov. Dep. Health Ageing. **http://cancerscreening.gov.au/internet/screening/publishing.nsf/content/bowel-about**
16. Eur. Comm. 2010. *European Guidelines for Quality Assurance in Colorectal Cancer Screening and Diagnosis*, ed. N Segnan, J Patnick, L von Karsa. Luxemburg: Publ. Off. Eur. Union
17. Furukawa MF, Poon E. 2011. Meaningful use of health information technology: evidence suggests benefits and challenges lie ahead. *Am. J. Manag. Care* 17(12 Spec. No.):SP76a–SP
18. Ginsberg GM, Lauer JA, Zelle S, Baeten S, Baltussen R. 2012. Cost effectiveness of strategies to combat breast, cervical, and colorectal cancer in sub-Saharan Africa and South East Asia: mathematical modelling study. *BMJ* 344:e614
19. Greenwald B. 2003. Health fairs: an avenue for colon health promotion in the community. *Gastroenterol. Nurs.* 26:191–94
20. Haldinger G, Waldoer T, Vutuc C. 2008. Self-reported colonoscopy screening in Austria. *Eur. J. Cancer Prev.* 17:354–57
21. Hannon PA, Vu T, Ogdon S, Fleury EM, Yette E, et al. 2012. Implementation and process evaluation of a workplace colorectal cancer screening program in Eastern Washington. *Health Promot. Pract.* doi: 10.1177/1524839912443240.
22. Hoffman RM, Stone SN, Herman C, Jung AM, Cotner J, et al. 2005. New Mexico's capacity for increasing the prevalence of colorectal cancer screening with screening colonoscopies. *Prev. Chron. Dis.* 2: A07
23. Hou SI, Chen PH. 2004. Home-administered fecal occult blood test for colorectal cancer screening among worksites in Taiwan. *Prev. Med.* 38:78–84
24. Hou SI, Sealy DA, Kabiru CW. 2011. Closing the disparity gap: cancer screening interventions among Asians—a systematic literature review. *Asian Pac. J. Cancer Prev.* 12:3133–39
25. Inadomi JM, Vijan S, Janz NK, Fagerlin A, Thomas JP, et al. 2012. Adherence to colorectal cancer screening: a randomized clinical trial of competing strategies. *Arch. Intern. Med.* 172:575–82

26. Int. Agency Res. Cancer (IARC). 2010. *Colorectal Cancer Incidence, Mortality and Prevalence Worldwide in 2008*. Lyon, Fr.: WHO. **http://globocan.iarc.fr**
27. Jemal A, Bray F, Center MM, Ferlay J, Ward E, Forman D. 2011. Global cancer statistics. *CA Cancer J. Clin.* 61:69–90
28. Jemal A, Center MM, DeSantis C, Ward EM. 2010. Global patterns of cancer incidence and mortality rates and trends. *Cancer Epidemiol. Biomarkers Prev.* 19:1893–907
29. Jiwa M, Sriram D, Khadaroo Z, Ping-Delfos WC. 2011. Could community pharmacies offer an opportunity to improve outcomes for patients with bowel cancer? *Qual. Prim. Care* 19:105–8
30. Joseph D, Degroff AS, Hayes NS, Wong FL, Plescia M. 2011. The Colorectal Cancer Control Program: partnering to increase population level screening. *Gastrointest. Endosc.* 73:429–34
31. Khatami S, Xuan L, Roman R, Zhang S, McConnel C, et al. 2012. Modestly increased use of colonoscopy when copayments are waived. *Clin. Gastroenterol. Hepatol.* 10:761–66
32. Klabunde CN, Brown M, Ballard-Barbash R, White MC, Thompson T, et al. 2012. Cancer screening—United States 2010. *MMWR* 61:41–45
33. Klabunde CN, Cronin KA, Breen N, Waldron WR, Ambs AH, Nadel MR. 2011. Trends in colorectal cancer test use among vulnerable populations in the United States. *Cancer Epidemiol. Biomarkers Prev.* 20:1611–21
34. Lambert R, Sauvaget C, Sankaranarayanan R. 2009. Mass screening for colorectal cancer is not justified in most developing countries. *Int. J. Cancer* 125:253–56
35. Larkey LK, Herman PM, Roe DJ, Garcia F, Lopez AM, et al. 2012. A cancer screening intervention for underserved Latina women by lay educators. *J. Womens Health* 21:557–66
36. Lebrun LA, Shi L, Chowdhury J, Sripipatana A, Zhu J, et al. 2012. Primary care and public health activities in select US health centers: documenting successes, barriers, and lessons learned. *Am. J. Public Health* 102(Suppl. 3):S383–91
37. Levin TR. 2011. Optimizing colorectal cancer screening by getting FIT right. *Gastroenterology* 141:1551–55
38. Masseria C. 2010. Colorectal cancer in Italy: a review of current national and regional practice on screening and treatment. *Eur. J. Health Econ.* 10(Suppl. 1):S41–49
39. McPhee SJ, Bird JA, Fordham D, Rodnick JE, Osborn EH. 1991. Promoting cancer prevention activities by primary care physicians. Results of a randomized, controlled trial. *JAMA* 266:538–44
40. Mehrotra A, Lave JR. 2012. Visits to retail clinics grew fourfold from 2007 to 2009, although their share of overall outpatient visits remains low. *Health Aff.* doi: 10.1377/hlthaff.2011.1128. In press
41. Moss SM, Campbell C, Melia J, Coleman D, Smith S, et al. 2012. Performance measures in three rounds of the English bowel cancer screening pilot. *Gut* 61:101–7
42. Naishadham D, Lansdorp-Vogelaar I, Siegel R, Cokkinides V, Jemal A. 2011. State disparities in colorectal cancer mortality patterns in the United States. *Cancer Epideimol. Biomarkers Prev.* 20:1296–302
43. Natl. Assoc. Community Health Cent. 2012. *About NACHC.* Bethesda, MD: NACHC. **http://www.nachc.com**
44. Natl. Cancer Inst. (NCI). 2012. *Research-Tested Intervention Programs.* Bethesda, MD: NCI. **http://rtips.cancer.gov/rtips/index.do**
45. Natl. Cancer Inst. (NCI). 2012. *Research to Reality.* Bethesda, MD: NCI. **http://researchtoreality.cancer.gov**
46. Natl. Colorectal Cancer Roundtable. 2012. *Welcome to NCCRT.* Founded by Am. Cancer Soc. (ACS), Cent. Dis. Control Prev. (CDC). **http://nccrt.org**
47. Naylor K, Ward J, Polite BN. 2012. Interventions to improve care related to colorectal cancer among racial and ethnic minorities: a systematic review. *J. Gen. Intern. Med.* 27:1033–46
48. Ogden LL, Richards CL, Shenson D. 2012. Clinical preventive services for older adults: the interface between personal health care and public health services. *Am. J. Public Health* 102:419–25
49. Parente F, Marino B, Ardizzoia A, Ucci G, Ilardo A, et al. 2011. Impact of a population-based colorectal cancer screening program on local health services demand in Italy: a 7-year survey in a northern province. *Am. J. Gastroenterol.* 106:1986–93
50. Plescia M, Richardson LC, Joseph D. 2012. New roles for public health in cancer screening. *CA Cancer J. Clin.* 62:217–19

51. Potter MB, Ackerson LM, Gomez V, Walsh JM, Green LW, et al. 2013. Effectiveness and reach of the FLU-FIT program in an integrated healthcare system: a multisite randomized trial. *Am. J. Public Health.* In press
52. Potter MB, Gildengorin G, Wang Y, Wu M, Kroon L. 2010. Comparative effectiveness of two pharmacy-based colorectal cancer screening interventions during an annual influenza vaccination campaign. *J. Am. Pharm. Assoc.* 50:181–87
53. Potter MB, Phengrasamy L, Hudes ES, McPhee SJ, Walsh JM. 2009. Offering annual fecal occult blood tests at annual flu shot clinics increases colorectal cancer screening rates. *Ann. Fam. Med.* 7:17–23
54. Potter MB, Somkin CP, Ackerson LM, Gomez V, Dao T, et al. 2011. The FLU-FIT program: an effective colorectal cancer screening program for high volume flu shot clinics. *Am. J. Manag. Care* 17: 577–83
55. Potter MB, Walsh JM, Yu TM, Gildengorin G, Green LW, McPhee SJ. 2011. The effectiveness of the FLU-FOBT program in primary care: a randomized trial. *Am. J. Prev. Med.* 41:9–16
56. Potter MB, Yu TM, Gildengorin G, Yu AY, Chan K, et al. 2011. Adaptation of the FLU-FOBT Program for a primary care clinic serving a low-income Chinese American community: new evidence of effectiveness. *J. Health Care Poor Underserved* 22:284–95
57. Powe BD, Ntekop E, Barron M. 2004. An intervention study to increase colorectal cancer knowledge and screening among community elders. *Public Health Nurs.* 21:435–42
58. Qasseem A, Denberg TD, Hopkins RH Jr, Humphrey LL, Levine JL, et al. 2012. Screening for colorectal cancer: a guidance statement from the American College of Physicians. *Ann. Intern. Med.* 156:378–86
59. Regula J, Kaminski MF. 2010. Targeting risk groups for screening. *Best Pract. Res. Clin. Gastroenterol.* 24:407–16
60. Reiter PL, Linnan LA. 2011. Cancer screening behaviors of African American women enrolled in a community-based prevention trial. *J. Womens Health* 20:429–38
61. Richard L, Gauvin L, Raine K. 2011. Ecological models revisited: their uses and evolution in health promotion over two decades. *Annu. Rev. Public Health* 32:307–26
62. Richardson LC, Rim SH, Plescia M. 2010. Vital signs: colorectal cancer screening among adults aged 50–75 years—United States, 2008. *MMWR* 59:808–12
63. Richardson LC, Tai E, Rim SH, Joseph D, Plescia M. 2011. Vital signs: colorectal cancer screening, incidence, and mortality—United States, 2002–2010. *MMWR* 60:884–89
64. Robb K, Power E, Kralj-Hans I, Edwards R, Vance M, et al. 2010. Flexible sigmoidoscopy screening for colorectal cancer: uptake in a population-based pilot programme. *J. Med. Screen.* 17:75–78
65. Saito H. 2006. Colorectal cancer screening using immunochemical faecal occult blood testing in Japan. *J. Med. Screen.* 13(Suppl. 1):S6–7
66. Sarfaty M, Wender R. 2007. How to increase colorectal cancer screening rates in practice. *CA Cancer J. Clin.* 57:354–66
67. Sarfaty M, Wender R, Smith R. 2011. Promoting cancer screening within the patient centered medical home. *CA Cancer J. Clin.* 61:397–408
68. Seeff LC, Richards TB, Shapiro JA, Nadel MR, Manninen DL, et al. 2004. How many endoscopies are performed for colorectal cancer screening? Results from CDC's survey of endoscopy capacity. *Gastroenterology* 127:1670–77
69. Segnan N, Senore C, Andreoni B, Azzoni A, Bisanti L, et al. 2007. Comparing attendance and detection rate of colonoscopy with sigmoidoscopy and FIT for colorectal cancer screening. *Gastroenterology* 132:2304–12
70. Sewitch MJ, Fournier C, Ciampi A, Dyachencko A. 2008. Colorectal cancer screening in Canada: results of a national survey. *Chronic Dis. Can.* 29:9–21
71. Shenson D, Adams M. 2008. The Vote and Vax program: public health at polling places. *J. Public Health Manag. Pract.* 14:476–80
72. Shenson D, Adams M, Bolen J, Wooten K, Clough J, et al. 2012. Developing an integrated strategy to reduce ethnic and racial disparities in the delivery of clinical preventive services for older Americans. *Am. J. Public Health* 102:e44–50

73. Shenson D, Cassarino L, DiMartino D, Marantz P, Bolen J, et al. 2001. Improving access to mammograms through community-based influenza clinics. A quasi-experimental study. *Am. J. Prev. Med.* 20:97–102
74. Shi L, Lebrun LA, Zhu J,Tsai J. 2011. Cancer screening among racial/ethnic and insurance groups in the United States: a comparison of disparites in 2000 and 2008. *J. Health Care Poor Underserved* 22:945–61
75. Siegel R, Naishadham D, Jemal A. 2012. Cancer statistics. *CA Cancer J. Clin.* 62:10–29
76. Stock C, Haug U, Brenner H. 2010. Population-based prevalence estimates of history of colonoscopy or sigmoidoscopy: review and analysis of recent trends. *Gastrointest. Endosc.* 71:366–81
77. Stock C, Ihle P, Schubert I, Brenner H. 2011. Colonoscopy and fecal occult blood test use in Germany: results from a large insurance-based cohort. *Endoscopy* 43:771–81
78. Tilley BC, Vernon SW, Myers R, Glanz K, Lu M, et al. 1999. The Next Step Trial: impact of a worksite colorectal cancer screening promotion program. *Prev. Med.* 28:276–83
79. Tu SP, Yip MP, Chun A, Choe J, Bastani R, Taylor V. 2008. Development of intervention materials for individuals with limited English proficiency: lessons learned from "Colorectal Cancer Screening in Chinese Americans." *Med. Care* 49:S51–61
80. Walsh JM, Salazar R, Nguyen TT, Kaplan C, Nguyen LK, et al. 2010. Healthy colon, healthy life: a novel colorectal cancer screening intervention. *Am. J. Prev. Med.* 39:1–14
81. Whitlock EP, Lin JS, Liles E, Beil TL, Fu R. 2008. Screening for colorectal cancer: a targeted, updated systematic review for the U.S. Preventive Services Task Force. *Ann. Intern. Med.* 149:638–58
82. World Health Organ. (WHO). 2007. *Cancer Control: Knowledge into Action. Early Detection. WHO Guide for Effective Programmes.* Geneva: WHO. **http://www.who.int/cancer/publications/cancer_control_detection/en/index.html**
83. Zauber AG, Lansdorp-Vogelaar I, Knudsen AB, Wilschut J, van Ballegooijen M, Kuntz KM. 2008. Evaluating test strategies for colorectal cancer screening: a decision analysis for the U.S. Preventive Services Task Force. *Ann. Intern. Med.* 149:659–69

Annual Review of Public Health
Volume 34, 2013

Contents

Symposium: Developmental Origins of Adult Disease

Commentary on the Symposium: Biological Embedding, Life Course Development, and the Emergence of a New Science
Clyde Hertzman 1

From Developmental Origins of Adult Disease to Life Course Research on Adult Disease and Aging: Insights from Birth Cohort Studies
Chris Power, Diana Kuh, and Susan Morton 7

Routine Versus Catastrophic Influences on the Developing Child
Candice L. Odgers and Sara R. Jaffee 29

Intergenerational Health Responses to Adverse and Enriched Environments
Lars Olov Bygren 49

Epidemiology and Biostatistics

Commentary on the Symposium: Biological Embedding, Life Course Development, and the Emergence of a New Science
Clyde Hertzman 1

From Developmental Origins of Adult Disease to Life Course Research on Adult Disease and Aging: Insights from Birth Cohort Studies
Chris Power, Diana Kuh, and Susan Morton 7

Causal Inference in Public Health
Thomas A. Glass, Steven N. Goodman, Miguel A. Hernán, and Jonathan M. Samet 61

Current Evidence on Healthy Eating
Walter C. Willett and Meir J. Stampfer 77

Current Perspective on the Global and United States Cancer Burden Attributable to Lifestyle and Environmental Risk Factors
David Schottenfeld, Jennifer L. Beebe-Dimmer, Patricia A. Buffler, and Gilbert S. Omenn 97

The Epidemiology of Depression Across Cultures
Ronald C. Kessler and Evelyn J. Bromet 119

Routine Versus Catastrophic Influences on the Developing Child
Candice L. Odgers and Sara R. Jaffee 29

Intergenerational Health Responses to Adverse and Enriched Environments
Lars Olov Bygren 49

Environmental and Occupational Health

Intergenerational Health Responses to Adverse and Enriched Environments
Lars Olov Bygren 49

Causal Inference Considerations for Endocrine Disruptor Research in Children's Health
Stephanie M. Engel and Mary S. Wolff 139

Energy and Human Health
Kirk R. Smith, Howard Frumkin, Kalpana Balakrishnan, Colin D. Butler, Zoë A. Chafe, Ian Fairlie, Patrick Kinney, Tord Kjellstrom, Denise L. Mauzerall, Thomas E. McKone, Anthony J. McMichael, and Mycle Schneider 159

Links Among Human Health, Animal Health, and Ecosystem Health
Peter Rabinowitz and Lisa Conti 189

The Worldwide Pandemic of Asbestos-Related Diseases
Leslie Stayner, Laura S. Welch, and Richard Lemen 205

Transportation and Public Health
Todd Litman 217

Public Health Practice

Implementation Science and Its Application to Population Health
Rebecca Lobb and Graham A. Colditz 235

Promoting Healthy Outcomes Among Youth with Multiple Risks: Innovative Approaches
Mark T. Greenberg and Melissa A. Lippold 253

Prospects for Tuberculosis Elimination
Christopher Dye, Philippe Glaziou, Katherine Floyd, and Mario Raviglione 271

Rediscovering the Core of Public Health
Steven M. Teutsch and Jonathan E. Fielding 287

Social Environment and Behavior

Routine Versus Catastrophic Influences on the Developing Child
Candice L. Odgers and Sara R. Jaffee 29

HIV Prevention Among Women in Low- and Middle-Income Countries: Intervening Upon Contexts of Heightened HIV Risk
Steffanie A. Strathdee, Wendee M. Wechsberg, Deanna L. Kerrigan, and Thomas L. Patterson 301

Scaling Up Chronic Disease Prevention Interventions in Lower- and Middle-Income Countries
Thomas A. Gaziano and Neha Pagidipati 317

Stress and Cardiovascular Disease: An Update on Current Knowledge
Andrew Steptoe and Mika Kivimäki 337

The Impact of Labor Policies on the Health of Young Children in the Context of Economic Globalization
Jody Heymann, Alison Earle, and Kristen McNeill 355

Commentary on the Symposium: Biological Embedding, Life Course Development, and the Emergence of a New Science
Clyde Hertzman 1

From Developmental Origins of Adult Disease to Life Course Research on Adult Disease and Aging: Insights from Birth Cohort Studies
Chris Power, Diana Kuh, and Susan Morton 7

Intergenerational Health Responses to Adverse and Enriched Environments
Lars Olov Bygren 49

Promoting Healthy Outcomes Among Youth with Multiple Risks: Innovative Approaches
Mark T. Greenberg and Melissa A. Lippold 253

The Behavioral Economics of Health and Health Care
Thomas Rice 431

Health Services

Reducing Hospital Errors: Interventions that Build Safety Culture
Sara J. Singer and Timothy J. Vogus 373

Searching for a Balance of Responsibilities: OECD Countries' Changing Elderly Assistance Policies
Katherine Swartz 397

Strategies and Resources to Address Colorectal Cancer Screening Rates and Disparities in the United States and Globally
Michael B. Potter 413

The Behavioral Economics of Health and Health Care
Thomas Rice 431

Scaling Up Chronic Disease Prevention Interventions in Lower- and Middle-Income Countries
Thomas A. Gaziano and Neha Pagidipati 317

Indexes

Cumulative Index of Contributing Authors, Volumes 25–34 449

Cumulative Index of Article Titles, Volumes 25–34 454

Errata

An online log of corrections to *Annual Review of Public Health* articles may be found at http://publhealth.annualreviews.org/