Fostering Multiple Healthy Lifestyle Behaviors for Primary Prevention of Cancer

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The odds of developing cancer are increased by specific lifestyle behaviors (tobacco use, excess energy and alcohol intakes, low fruit and vegetable intake, physical inactivity, risky sexual behaviors, and inadequate sun protection) that are established risk factors for developing cancer. These behaviors are largely absent in childhood, emerge and tend to cluster over the life span, and show an increased prevalence among those disadvantaged by low education, low income, or minority status. Even though these risk behaviors are modifiable, few are diminishing in the population over time. We review the prevalence and population distribution of these behaviors and apply an ecological model to describe effective or promising healthy lifestyle interventions targeted to the individual, the sociocultural context, or environmental and policy influences. We suggest that implementing multiple health behavior change interventions across these levels could substantially reduce the prevalence of cancer and the burden it places on the public and the health care system. We note important still-unresolved questions about which behaviors can be intervened upon simultaneously in order to maximize positive behavioral synergies, minimize negative ones, and effectively engage underserved populations. We conclude that interprofessional collaboration is needed to appropriately determine and convey the value of primary prevention of cancer and other chronic diseases.

Keywords: cancer prevention, risk behavior, health behavior, smoking, obesity, ecological model

An estimated 14 million people worldwide were newly diagnosed with cancer in 2012, and 8 million died from it (Vineis & Wild, 2014). Yet between one third and one half of these cases could have been prevented by applying existing knowledge about cancer risk factors, most of which are behavioral (American Association for Cancer Research, 2014; Parkin, Boyd, & Walker, 2011; World Health Organization, 2014). Tobacco use, poor-quality diet, excess energy and alcohol intakes, physical inactivity, risky sexual behaviors, and unprotected sun exposure are preventable causes of cancers and other chronic diseases. This article describes the prevalence, disparities, and types of cancers associated with the major risk behaviors and the several ecological levels of intervention that hold potential for preventing cancers. Psychologists have made major contributions to understanding and influencing mechanisms that underpin health-compromising behaviors. To prevent the onslaught of cancers that is expected over the next 30 years, we suggest a need for redoubled engagement in basic and applied research to learn how to foster multiple healthy lifestyle changes.

Cancer and heart disease are two chronic diseases that together account for nearly 48% of all deaths in the United States (Centers for Disease Control [CDC], 2014b). In the year 2010, for example, cancer took 576,691 lives, and heart disease claimed 596,577 (CDC, 2014b). Advances in treatment have made it possible for cancer to be considered a chronic disease (Hewitt, Greenfield, & Stovall, 2005). In 2014, in the United States alone, there were 6,876,600 male and 7,607,230 female survivors affected by the most common 10 cancers (American Cancer Society, 2014).

Cancer is a growing problem internationally. The global burden falls disproportionately on low- and middle-income countries because of their growth, aging population, and increased prevalence of the risk behaviors discussed here (Danaei, Hoorn, Lopez, Murray, & Ezzati, 2005; Vineis & Wild, 2014). The tobacco industry's successful marketing to "replacement smokers" in low-income countries to compensate for loss of smokers in affluent ones will greatly increase burden from chronic diseases, including cancer, in the next several decades (Giovino et al.,

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2012). In addition, around the world, more people are now overweight than underweight, meaning that diseases of excess energy intake and undernutrition coexist in low-income populations (Ott, Ullrich, Mascarenhas, & Stevens, 2011).

There are numerous types of cancer—more than 200, in fact. Cancers can occur in more than 60 organs of the body and in multiple different cell types, but certain types of cancers are the most common. Prostate cancer is the most frequently diagnosed cancer in men, and its incidence has doubled in the past 50 years. Breast cancer and lung cancer are the first and second most often diagnosed cancers in women, respectively, and both have increased in prevalence during the past half century (CDC, 2014a; Schmidt et al., 2014).

The Ecology of Health Behaviors

Basic and applied psychologists both have a long history in the science of health behaviors and key roles to play in cancer prevention. Experimental psychopharmacologists have mapped biobehavioral mechanisms that underlie addictive properties of tobacco, alcohol, and even appealing foods (Bickel, Jarmolowicz, Mueller, & Gatchalian, 2011; Lerman et al., 2007; Spring et al., 2008), shedding light on brain pathways that underlie the transition from recreational to compulsive use (Hogarth, Balleine, Corbit, & Killcross, 2013). Conditioning and reinforcement principles that underlie the acquisition of poor health habits have been harnessed and enriched by social–cognitive constructs (Bandura, 2006) to become mainstays of interventions that help individuals make healthy changes. The individual—whose attitudes, beliefs, and habits behavioral treatments target—is embedded in a complex system that either promulgates or discourages cancer risk behaviors. The sociocultural context in which individuals are nested conveys norms, models, reinforcement, and inclusion when behaviors match expectations. At a still more macro level, the physical environment and public policies establish defaults and options that facilitate or thwart healthy choices.

Ecological psychologists highlight how numerous levels of political, environmental, sociocultural, and familial context surround people, either supporting them or constraining their ability to take good care of their own health (McLeroy, Bibeau, Steckler, & Glanz, 1988; Stokols, 1992). Accordingly, we apply an ecological framework to characterize promising interventions targeted at the individual level, and at the sociocultural and environmental and policy levels for each behavior. The model's premise is that intervention should be maximally effective when it simultaneously targets multiple levels in a system of causal influences on human behavior.

Risk Behavior Prevalence and Interventions

Table 1 shows the annual percent of cancer deaths attributable to each cancer risk behavior. The risk attributable to the behavior in the population is shown separately for males and females in the United States and worldwide. Next, we discuss each behavior in turn, followed the promising intervention approaches shown in Table 2.

Smoking

Cigarette smoking remains the leading cause of preventable illness and death, causing 443,000 premature U.S. deaths annually from smoking-related illness, particularly cancer and heart disease (CDC, 2010; Downs, Parisi, & Schouten, 2011). Each year, smoking costs the United States $96 billion in direct medical expenses and $97 billion in lost productivity (CDC, 2010, 2011c). Currently, 19.3% of adults smoke: 21.5% of men and 17.3% of women (CDC, 2011c). The number of smokers in affluent countries continues to decline, but is rising in low- and middle-income countries. Disparities exist such that non-Hispanic American Indians/Alaska Natives have the highest smoking prevalence (31.4%), followed by non-Hispanic Whites (21.0%) and non-Hispanic Blacks (20.6%; CDC, 2011c). Once a behavior associated with privilege, smoking has come to be a habit of the poor, whose prevalence increases as education decreases, and adults fall below the poverty level (28.9%) rather than at or above it (18.3%; CDC, 2011c).

Smoking may serve as a gateway to the acquisition of other risk behaviors in the course of adolescence. In one large study of youth between the ages of 11 and 16 years, having smoked by Age 11 explained 21.9% of the variance in 16 other risk behaviors, including substance use, violence, and carrying a weapon (DuRant, Smith, Kreiter, & Krowchuk, 1999). Among adults, too, risk behaviors tend to cluster: 52% have at least two of four unhealthy lifestyle habits (physical inactivity, overweight, cigarette smoking, risky drinking; Coups, Gaba, & Orleans, 2004), and 17% have three or more (Fine, Philogene, Gramling, Coups, & Sinha, 2004). Disparities are again evident: Greater clus-

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tering of unhealthy behaviors occurs those with less than a college education and those with high levels of mental distress (Coups et al., 2004; Fine et al., 2004).

So few people smoked in the first part of the 20th century that lung cancer was rare. Future heart surgeon Alton Ochsner's entire medical school class was summoned in 1919 to view the autopsy of a patient with lung cancer because instructors feared the trainees might never see another such case. By 1936, however, Ochsner observed nine patients with lung cancer in 6 months. All had begun smoking during World War I, when cigarettes were made part of the soldier's daily ration.

By 1957, evidence was sufficient for the U.S. Surgeon General to conclude that smoking causes lung cancer. The first Surgeon General's Report on Smoking and Health followed in 1964, reflecting the analysis of 7,000 scientific publications (National Center for Chronic Disease Prevention and Health Promotion, 1964). Compared with a nonsmoker, the average smoker was estimated to have a nine- to tenfold risk, and the heavy smoker at least a 20-fold risk of developing lung cancer. Lung cancer risk was found to rise with the duration of smoking and diminish after smoking cessation (National Center for Chronic Disease Prevention and Health Promotion, 1964). Numerous Surgeon General's reports over ensuing years concluded that smoking impairs health generally and heightens the risk of cancer in many parts of the body (e.g., lung, kidney, cervix, pancreas, larynx, oral cavity and pharynx, esophagus, bladder and kidney, stomach, and bone marrow; U. S. Department of Health and Human Services (DHHS), 1998; DHHS CDC, 2001, 2004, 2006).Quitting smoking reduces the risk

Table 1
Percent of Cancer Deaths Attributable to Each Risk Factor

Behavior	Sex	Schottenfeld, Beebe-Dimmer, Buffler, and Omenn, 2013 – United States	Ott, Ullrich, Mascarenhas, and Stevens, 2011 – World
Smoking	All	30	—
	Male	30–35	31
	Female	20–25	10
Physical inactivity	All	<5	—
	Male	—	2
	Female	—	6
Overweight/Obesity	All	≤10	—
	Male	5–10	1
	Female	8–15	3
Low fruit and vegetable intake	All	—	—
	Male	—	7
	Female	—	5
Excess alcohol intake	All	3–4	—
	Male	4–6	9
	Female	1–2	3
Insufficient sun protection	All	1–2	—
	Male	—	—
	Female	—	—
Risky sex	All	≤5	—
	Male	—	—
	Female	—	7.5

Note. Percents are expressed as the population attributable fraction, i.e., the proportional reduction in the population mortality that would occur if exposure to the risk factor were reduced to an ideal level (e.g., no tobacco use, no unprotected sexual exposure).

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of developing cancers and other diseases and generally improves health (CDC, 2011c).

Because the vast majority of smokers acquire the habit during adolescence, considerable attention has been devoted to programs to prevent tobacco use. School-based prevention programs have proved largely ineffective, but multicomponent community programs have achieved some success (Thomas, McLellan, & Perera, 2006). Multicomponent interventions incorporate a host of features, including targeting of tobacco retailers who sell to underage users, mass media, school- and family-based programs, and use of community and peer leaders (Carson et al., 2011). Environmental and policy interventions, including smoking bans, clean indoor air laws, and price deterrents, are among the factors held most influential in reducing the prevalence of smoking by half in less than 50 years (Thun & Jemal, 2006).

Once they have acquired the habit, most smokers report a desire to quit, but a majority will find cessation challenging. The average smoker makes eight to 10 quit attempts before succeeding in becoming smoke-free. Only 3% to 5% of smokers who quit without any cessation treatment will be smoke-free 6 to 12 months later (Hughes, Keely, & Naud, 2004). Use of quit-smoking treatments is low, which is unfortunate because effective treatments exist. Behavioral counseling that incorporates problem solving, and social support is effective when offered on an individual, group, or telephone-delivered basis (Fiore et al., 2008). Moreover, there is a graded relationship between more intensive treatment (involving longer or more sessions) and greater abstinence rates (Fiore et al., 2008). Pharmacotherapies such as nicotine replacement, bupropion, and varenicline increase the likelihood of successful quitting, and have proved effective in populations of varying age, ethnicity, and mental health comorbidities. Combined treatment with smoking cessation counseling and pharmacotherapy has a particularly strong track record of success.

The 2010 Patient Protection and Affordable Care Act's elimination of copays for cessation counseling services removes an important cost barrier, and the provision of telephone quit lines eliminates a logistical access barrier. A remaining barrier that reflects the interdependence among certain risk behaviors is the valid concern that stopping smoking usually results in increased calorie intake and weight gain (Klesges, Meyers, Klesges, & LaVasque, 1989; Spring et al., 2004).

Physical Activity

Roughly 15% of the U.S. population is sedentary; an additional 38% to 40% falls below national guidelines for required physical activity. (DHHS, 2008; Pleis, Ward, & Lucas, 2010). Independent of physical activity, prolonged sitting is also recognized as a risk factor for several chronic diseases (DHHS, 2008).

Disparities are evident: A low level of physical activity is associated with lower education, less income, racial/ethnic minority status, and female gender (Pleis et al., 2010). Physical activity diminishes across the life course (Troiano et al., 2008), as physical inactivity begins to cluster with other risk behaviors, including smoking, poor dietary habits, and alcohol and drug use. Low physical activity also covaries with depressive and anxiety symptoms, which can, in turn, be relieved by exercise. (DHHS, 2008).

Compared with sedentary people, those who engage in moderate- or vigorous-intensity aerobic physical activity for 3 to 4 hr per week have a 20% to 40% reduction in breast cancer risk and a 30% reduction in colon cancer risk (DHHS, 2008). Regularly active people also have reduced risks of lung, endometrial, and ovarian cancers on the order of 20%, 30%, and 20%, respectively (DHHS, 2008).

Most youth physical activity intervention targets the sociocultural level. School-based intervention that includes organizational (e.g., enhanced physical education classes), policy, and environmental components has been more effective than that targeting classroom curriculum strategies only (Luepker et al., 1996; Timperio, Salmon, & Ball, 2004). In contrast, family physical activity intervention has been less consistently effective (Ransdell, Taylor, Oakland, & Schmidt, 2003). Community-wide and mass-media informational campaigns rarely produce significant impact on physical activity (Marshall, Owen, & Bauman, 2004; Scheiermann et al., 2007), although a recent youth-focused, multiethnic national advertising campaign (CDC's VERB campaign for youth) may hold promise (Inglis et al., 2007).

As a treatment approach to increase regular physical activity, theory-informed, individually adapted programs are strongly recommended (CDC, 2001). Such treatments use a range of interventionists, including behavioral advisors, health professionals, and trained volunteers (Mukerji et al., 2006). Many such programs show promising short-term results (i.e., 12 months or less); longer-term physical

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activity maintenance requires further study (Williams et al., 2008).

Social support interventions in community settings (e.g., the "buddy system," that is, behaviorally based contracting with others) appear effective for increasing physical activity in adults ("Increasing Physical Activity," 2001). Other social influence interventions that warrant further investigation include appropriately targeted public service announcements, dog walking (Pachana, Ford, Andrew, & Dobson, 2005; Wood, Giles-Corti, & Bulsara, 2005), and physical-activity-oriented TV programming; as well as electronic entertainment devices involving physical activity (e.g., Xbox Kinect, Wii-Sport).

Environmental- and policy-level interventions are being tested for both youth and adults. For adults, "point-of-choice" signage is recommended, especially aimed at increased stair use (vs. escalators or elevators), because short bouts of physical activity, particularly at increased intensity, can positively influence risk biomarkers (Boreham, Wallace, & Nevill, 2000; DeBusk, Stenestrand, Sheehan, & Haskell, 1990). Promising policy strategies for physical activity promotion include increasing access and diminishing cost barriers to recreational facilities, and increasing access to programs offered through community settings such as work sites, schools, health care settings (USDHHS, 2008). Environmental policy interventions that hold potential include targeting aspects of the built environment (e.g., sidewalks, bicycle lanes, traffic calming devices) and natural resources (e.g., protecting public green space; pedestrian malls; CDC, 2011b).

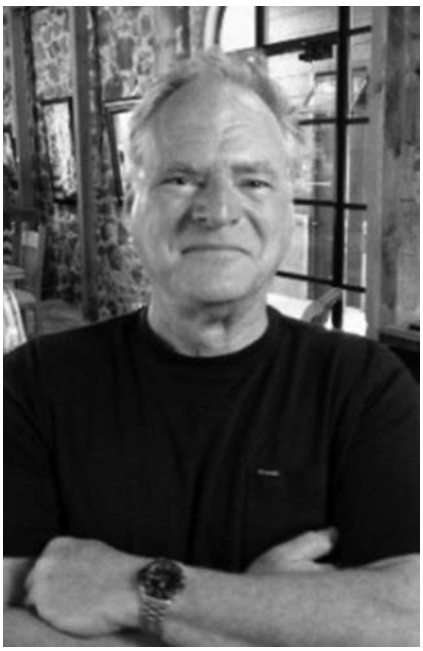
Diet Quality, Overweight, and Obesity

The role of diet in cancer prevention has been studied extensively. Despite high hopes that specific dietary constituents would prove causal or protective for some cancers, a conclusive link has failed to emerge. On the other hand, there is evidence that a plant-based diet offers nutritional and health advantages over the energy-dense, nutrient-poor diet typically consumed in the United States (American Association for Cancer Research, 2014; "U.S. Dietary Guidelines Advisory Committee Report," 2010; World Health Organization, 2014). As Table 1 indicates, intake of a variety of vegetables and fruits is a main element of a nutrient-dense diet that protects against cancer. Although fruit and vegetable intake has increased since the 1980s, consumption of these nutrient-dense foods remains far below recommended levels (N. G. Johnson, 2003). The U.S. Preventive Services Task Force has concluded that medium- and high-intensity counseling effectively improves diet quality, increasing fruit and vegetable intake by between 0.4 and 2 servings per day (LeFevre, 2014). Price subsidies, point-of-purchase prompts, cafeteria redesign, and product labeling are also being studied vigorously to increase fruit and vegetable intake, with promising results, and local and national food industry partnerships are being pursued (Elbel, Taksler, Mijanovich, Abrams, & Dixon, 2013; Kraak, Story, Wartella, & Ginter, 2011).

It is now clear that obesity trumps specific nutrients or foods as the factor most highly and consistently associated with cancer risk (American Institute for Cancer Research, 2007 World Health Organization, 2014). Total energy intake per capita, the main culprit in obesity, has continued to increase from 2057 kcal in 1970 to 2674 kcal in 2008. Americans currently consume 35% of their total calories from solid fats and added sugars (SoFAS), but these foods should contribute no more than 5% to 15% of total calories per day. This means that someone consuming 1,600 calories per day should limit SoFAS to about 120 calories per day (as a referent, a 14-ounce can of coke contains 140 calories). Whereas average intakes of whole grains, vegetables, fruits, milk, fiber, potassium, and fiber fall far short of recommended levels, intakes of SoFAS, added sugars, solid fats, refined grains, and sodium are more than double the recommended amounts (USDA, 2010).

Dramatic changes in the food retail environment have influenced the quality and quantity of food and beverages consumed. From 1977 to 2000, there was a 200% increase in the number of meals and snacks consumed in fast food restaurants, coupled with a 42% decrease in foods consumed at home (N. G. Johnson, 2003). Food and beverage portion sizes also have increased. Current National Health and Nutrition Evaluation Survey data (NHANES, 2013) data show pizza, grain-based desserts (cake, cookies, pie, granola bars, etc.), and sugar-sweetened beverages as the top three contributors to the energy intake of males between ages 2 and 18. Indeed, grain-based desserts rank as the top contributor to the energy intake of the overall U.S. population.

That obesity heightens risk of cancer onset and recurrence is well documented (Schmidt et al., 2014). The prevalence of obesity increased significantly between 1980 and 1999 in both adults and children. Although this growth



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trajectory appears to be leveling off, obesity prevalence does not appear to be declining in any race or gender. The rate of obesity (body mass index ≥30) is 35.5% among adult men and 35.8% among adult women, and is higher among Hispanic men and women as well as among non-Hispanic Black women (Flegal, Carroll, Kit, & Ogden, 2012). In children and adolescents, the prevalence of obesity is 16.9% (Ogden, Carroll, Kit, & Flegal, 2012).

Energy imbalance is the fundamental cause of weight gain: Excess calorie intake, regardless of diet composition, contributes to the development of obesity (Bray et al., 2012; Hall et al., 2011). Once gained, overweight is difficult to treat, and weight loss is even more difficult to maintain because of metabolic changes that evolved to protect the organism during times of famine (Redman et al., 2009). Prevention of excessive weight gain beginning in utero and extending through the life course would, therefore, be the preferred intervention option. Prevention alone cannot control the obesity epidemic, however. Treatment is also needed because so many people, particularly members of ethnic/racial minority groups, already are obese (Lee & Lee, 2011).

In the realm of environmental and policy interventions, school-based interventions have been tested as an obesity preventive strategy, with mostly disappointing results (Khambalia, Dickinson, Hardy, Gill, & Baur, 2012; Williamson et al., 2007). There is considerable interest globally in policy interventions, such as taxes on sugar-sweetened beverages, subsidies for fruits and vegetables, and employee health incentives to foster weight management as well as healthy diet and activity more generally. Findings to date are complex, warranting additional research (Epstein et al., 2012; Timmins, 2011).

Intensive (multisession) lifestyle intervention delivered to individuals, groups, or families is the "gold standard" treatment to promote weight loss, improve diet quality, and increase physical activity among children or adults with risk behaviors (Shaw, O'Rourke, Del Mar, & Kenardy, 2005; Whitlock, O'Connor, Williams, Beil, & Lutz, 2010). These treatments, developed by psychologists, have a strong track record of producing sustained weight loss and improvements in metabolic outcomes in a cost-effective manner, even among those at risk or affected by diabetes (Wadden et al., 2011; World Health Organization, 2008).

For childhood obesity, intensive family treatment involving eight weekly and six monthly in-person sessions has proved successful. Epstein, Valoski, Wing, & McCurley (1990) randomized 6- to 12-year-old obese children and their parents to one of three treatments that either reinforced both children and parents for behavior change and weight loss, only reinforced children for these outcomes, or just reinforced treatment attendance. At 5- and 10-year follow-ups, the children who received family treatment continued to show, respectively, 11.2% and 7.5% reduction in overweight, whereas children in the other intervention conditions showed increased overweight (Epstein, Valoski, Wing, & McCurley, 1990). The efficacy of intensive family treatment for childhood obesity has been replicated for 25 years (Epstein, Paluch, Roemmich, & Beecher, 2007).

A minimum of 16 sessions of intensive weight loss counseling addressing diet, physical activity, and behavioral skills has also been effective in producing sustained weight loss and metabolic improvements in obese adults. In the Diabetes Prevention Program (DPP), intensive individual counseling, and self-monitoring of calories, fat, and physical activity, was implemented with 3,234 hyperglycemic patients randomized to either behavioral weight loss, metformin, or placebo. The goal for behaviorally treated participants was to achieve a minimum of 7% weight loss and at least 150 min per week of moderate to vigorous physical activity (e.g., brisk walking; Diabetes Prevention Program Research Group, 2002a). Intensive behavioral counseling proved more successful and more cost-effective than metformin in achieving those outcomes, and it also significantly delayed patients' conversion from prediabetes to diabetes (Diabetes Prevention Program Research Group, 2002b).

The successor Look AHEAD trial involved 5,145 overweight/obese patients with Type 2 diabetes from 16 U.S. locations. Participants were randomized to either diabetes education or an intensive lifestyle intervention involving group treatment, 175 min of physical activity per week, and use of meal replacements. With 8 years of follow-up, Look AHEAD was the longest continuously implemented trial of intensive weight loss intervention. The impressive results showed that 50% of intensively treated participants showed clinically significant (≥5%) weight loss at 8 years (Look AHEAD Research Group, 2014).

Progress has been made in finding delivery channels that expand the public's access to these effective programs. For example, training YMCA wellness instructors to deliver a group-based form of the DPP has made it possible

Table 2
Individual, Sociocultural, and Environmental/Policy Interventions for Cancer Risk Behaviors

Risk behavior	Ecological intervention level		
	Individual	Sociocultural	Environmental and Policy
Smoking	Intensive behavioral counseling, Pharmacotherapy (Fiore et al., 2008)	Multicomponent community programs (Thomas, et al, 2013)	Taxation, incentives, regulation (Thun, 2006); Enforcement (Carson et al., 2011)
Physical activity	Tailored coaching by professionals or peers (CDC, 2011b)	School-based exercise classes, environment, policies (Luepker et al., 1996; Timperio, Salmon, & Ball, 2004); Buddy system (CDC, 2011b; USDHHS, 2008); Dog walking (Pachana et al., 2005)	Point of choice stair signage (Boreham et al., 2000); Increased access to green space or recreational facilities, built environment modification to encourage walking/biking (CDC, 2011b; USDHHS, 2008)
Fruits & vegetables	Intensive counseling (LeFevre, 2014)		Taxes, subsidies, point of purchase/ product labeling (Elbel et al., 2013); Industry partnership (Kraak et al., 2011)
Obesity, Diet	Intensive lifestyle intervention (Diabetes Prevention Program Research Group, 2002b), including meal replacement (Look AHEAD Research Group, 2014)	Family-based obesity treatment for youth (Epstein, Paluch, Roemmich, & Beecher, 2007; Epstein, Valoski, Wing, & McCurley, 1990)	YMCA-led group treatment (Ackermann et al., 2008); Taxes, subsidies, incentives, cafeteria design, access, and vending machine policies
		Peer-led intensive group treatment (Katula et al., 2013)	(Elbel et al., 2013); Access and industry outreach (Elbel et al., 2013)
Alcohol	Contingency management (National Institute on Drug Abuse, 2012); Intensive behavioral counseling (Miller & Rose, 2009); Pharmacotherapy(B. Johnson, 2010); Technology-supported treatment (Rooke et al., 2010)	School, family, and multicomponent youth prevention (Foxcroft & Tsertsvadze, 2011b, 2011c)	Brief primary care counseling (Kaner et al., 2007); Taxes, restricted times of sale, zoning regulation to restrict density of outlets, enforcement of underage drinking laws (CDC, 2011a)
		Mutual support groups (Litt et al., 2009)	
Sun protection	Brief counseling, tailored messaging (Lin et al., 2011); photo-aging information, promotion of sunless tanning (Pagoto et al., 2010)	Informational campaigns challenging the belief that tanning is normative and attractive (Hillhouse, Turrisi, Stapleton, & Robinson, 2008; Mahler, Kulik, Gerrard, & Gibbons, 2010)	Informative signage, increased availability of shade and sunscreen in outdoor areas (Buller, Cokkinides, et al., 2011; Glanz et al., 2002); Legislation imposing age limit ban, maximum exposure, or parental permission (The Free Library, 2014; Pichon et al., 2009)
Risky sexual behavior	Counseling about sexually transmitted infections, communication and skill building to negotiate condom use (Shepherd, Frampton, & Harris 2011); Interactive computer programs about sexual health (Bailey, 2012)	School and community asset/skill development programs that promote delayed first intercourse, limited partners, condom use (CDC, 2013a); Informational campaigns to educate parents about vaccines (Holman et al., 2014)	Government policies facilitating vaccine access (UNICEF, WHO, & UNFPA 2013); Physicians training in parental communication strategies about vaccines (Holman et al., 2014)

to obtain significant weight loss at one fifth of the cost of the original DPP (Ackermann, Finch, Brizendine, Zhou, & Marrero, 2008). The CDC now offers training on this intervention model (Ackermann, Holmes, & Saha, 2013), and similar community-based versions are being delivered cost-effectively by peer counselors (Katula et al., 2013). Another encouraging finding has been that telephone delivery of intensive weight loss treatment by trained coaches has yielded weight loss outcomes comparable with those obtained by in-person treatment (Appel et al., 2011). In sum, these findings encourage optimism that intensive lifestyle intervention can produce sustained weight loss, and that treatment can be delivered via novel channels feasibly and effectively. To date, less intensive intervention has usually proved ineffective (U.S. Preventive Services Task Force, 2014), but stepped care approaches that match treatment intensity to individual patient needs hold promise and warrant further investigation (Jakicic et al., 2012).

Alcohol Intake

Approximately 56% of adults in the United States drank an alcoholic beverage in the past month (Substance Abuse and Mental Health Services Administration, 2012). Of that number, 24.6% reported that they engaged in binge drinking and 7.1% said they drank heavily in the past month. On the days when they drank alcohol, 16% of men in the United Kingdom consumed at least five drinks and 8% of women consumed at least four drinks (Parkin et al., 2011).

Alcohol intake consistently has been found to be associated in a dose-response manner with risk of various cancers, especially colon, breast, and liver cancer (International Agency for Research on Cancer, 2010; Nelson et al., 2013). A number of guidelines advise that alcohol use should be avoided or limited to prevent cancer (USDA, 2010). The public health message is complicated, however, by evidence that low to moderate alcohol intake has cardiovascular benefits and may protect against heart disease (Ronksley, Brien, Turner, Mukamal, & Ghali, 2011). Somewhat surprisingly, given the caloric density of alcoholic beverages, moderate drinking has not been found to be associated with weight gain (CDC, 2014b; Danser & Anand, 2014; Sherwood, Jeffery, French, Hannan, & Murray, 2000), although heavier consumption over time may be.

As for tobacco use, psychologists in experimental psychopharmacology have made major contributions to the fundamental science and treatment of alcohol addiction (Robinson & Berridge, 2000; Tiffany, Carter, & Singleton, 2000). Still, only an estimated 14% to 25% of people who do develop alcohol abuse or dependence ever receive treatment, even though treatments are available (Huebner, & Kantor, 2011). A number of medications are FDA approved for the treatment of alcohol use problems (e.g., disulfiram, naltrexone, acamprosate), and adding behavioral counseling to drug makes treatment more effective (B. Johnson, 2010; O'Malley & O'Connor, 2011). Therapist-guided behavioral treatment for alcohol abuse that incorporates motivational interviewing, goal setting, self-monitoring of drinking, and problem solving shows potential, and contingency contracting (payment for drug-free urine specimens) is considered to be highly effective (Miller & Rose, 2009; National Institute on Drug Abuse, 2012). Technology-supported interventions using either computer, Internet, or mobile phone as a delivery platform are showing good and cost-effective outcomes for abstinence, especially for patients with less severe problems (Gustafson et al., 2014; Rooke, Thorsteinsson, Karpin, Copeland, & Allsop, 2010).

The success of Alcoholics Anonymous (AA) and other 12-step mutual-help support groups organized by those recovering from alcohol use problems is difficult to evaluate because participants' anonymity is carefully preserved. No experimental studies definitively establish the effectiveness of 12-step programs (Ferri, Amato, & Davoli, 2006), but some evidence suggests that long-term abstinence outcomes at least match those of formal treatment (Litt, Kadden, Kabela-Cormier, & Petry, 2009; Moos & Moos, 2005). AA's accessibility and lack of cost make it the most widely used treatment modality for alcohol problems and an excellent example of sociocultural intervention.

A population-level intervention policy with demonstrable effectiveness involves the provision of screening and brief counseling for alcohol use at primary care medical visits (Kaner et al., 2007). Unlike other reactive intervention approaches that reach only treatment-seeking individuals, brief alcohol counseling at medical visits is a proactive approach that engages all comers. Counseling by a physician, nurse, or psychologist takes 5 to 15 min and has been shown to reduce alcohol intake among men (Kaner et al., 2007).

The U.*S. Guide to Community Preventive Services* reports that evidence is sufficient to recommend other policies, including alcohol taxes, restricted days and hours of sale, regulation of the density of alcohol outlets, and vigorous enforcement of underage drinking as ways to prevent or reduce excessive alcohol use (CDC, 2011a). Finally, recent Cochrane systematic reviews report that multicomponent, school-based, and family-based alcohol-misuse prevention programs for youth have yielded promising results (Foxcroft & Tsertsvadze, 2011a, 2011b, 2011c).

Skin Cancer Risk Behaviors

Exposure to ultraviolet radiation (UVR) ordinarily occurs through outdoor activity in the sun, but it can also occur via indoor tanning, involving tanning booths or beds. Only 3 in 10 U.S. adults report routinely using sunscreen and/or sun-protective clothing (Buller, Cokkinides, et al., 2011), and men are less likely than women to use sunscreen consistently (Buller, Cokkinides, et al., 2011). Although the use of sun-protective clothing increases with age (Coups, Manne, & Heckman, 2008), use of sunscreen does not increase. Fewer than half of adults of all ages consistently use sunscreen (Coups et al., 2008).

At least 11% of U.S. adults annually experience sunburn as a consequence of UVR exposure, which increases skin cancer risk (Coups et al., 2008). The carcinogenic

effect of UVR is thought to be mediated by DNA damage, genetic mutations, oxidative stress, inflammation, and immunosuppression (Kanavy & Gerstenblith, 2011). Sun exposure in pursuit of a suntan occurs volitionally for the 59% of adults who report having sunbathed at least once in the past year, and especially for the 25% who report sunbathing 11 or more times (Koh et al., 1997). The 18% of women and 6% of men who report indoor tanning in the past year are at particular risk (Choi et al., 2010). The International Agency for Research on Cancer classifies indoor tanning as a Class 1 carcinogen, joining arsenic, asbestos, and mustard gas (El Ghissassi et al., 2009). Forty hours of indoor tanning (~120 sessions) is associated with a 55% increase in melanoma risk (Lazovich et al., 2004; Veierod et al., 2003).

Because of its level of carcinogenic risk, indoor tanning behavior warrants particular attention. The behavior emerges in adolescence (Stryker et al., 2004), when approximately 15.6% of high school students use an indoor tanning device in any year, and almost half of that number use an indoor tanning device at least 10 times (Guy, Tai, & Richardson, 2011). Indoor tanning co-occurs with several other cancer risk behaviors: smoking, other substance use, and risky drinking (Mosher & Danoff-Burg, 2010). Interestingly, however, indoor tanning is also accompanied by two health protective behaviors: being physically active (Coups et al., 2008) and controlling calorie intake (Demko, Borawski, Debanne, Cooper, & Stange, 2003). The clustering of these appearance-enhancing behaviors suggests an underlying motivation by body image concerns (Stapleton, Turrisi, Todaro, & Robinson, 2009). Indeed, at the extreme, tanning has been described in patients with body dysmorphic disorder, functioning as an attempt to conceal perceived flaws such as pale skin (Hunter-Yates, Dufresne, & Phillips, 2007; Phillips et al., 2006).

The challenges of reminding postal workers to wear hats differ from those of dissuading female college students from using tanning beds. Hence, skin cancer prevention interventions span the ecological model and use targeted messaging, but share the aim of increasing sun protection and decreasing sun exposure. Individual-level interventions that have been tested include the provision of brief counseling, theory-based pamphlets, educational videos, and UV photography, which illuminates sun damage on the skin. Brief counseling and computer-tailored messaging have been found to modestly increase sun protection behavior (Lin et al., 2011), whereas effects on indoor tanning have been inconsistent (Lin et al., 2011). Encouraging the use of behavioral alternatives to UV tanning, including sunless tanning, may be a promising alternative approach to reduce tanning behavior (Hillhouse, Stapleton, & Turrisi, 2005; Pagoto, Schneider, Oleski, Bodenlos, & Ma, 2010). None of the tested approaches is intensive and all are readily scalable.

One sociocultural approach to addressing risky sun exposure involves questioning the assumption that tanned skin is physically attractive—a belief that is strongly associated with tanning behavior. Among college students, challenging the belief that tanning is normative has shown potential to increase use of sun protection and reduce tanning behavior (Hillhouse, Turrisi, Stapleton, & Robinson, 2008; Mahler, Kulik, Butler, Gerrard, & Gibbons, 2008; Mahler, Kulik, Gerrard, & Gibbons, 2010).

Environmental interventions implicitly address norms by targeting public behavior in communities and work sites. For example, the Cool Pool trial randomized 28 swimming pools to an intervention that included staff training, informative signage, interactive activities, and increased availability of shade and sunscreen. Results showed significantly increased use of sun protection and shade (Glanz, Geller, Shigaki, Maddock, & Isnec, 2002). Other successful interventions have targeted environments and individuals that are highly sun exposed, including ski industry employees (Buller, Walkosz, et al., 2011), mail carriers (Mayer et al., 2007), and public beach patrons (Pagoto et al., 2010).

Most policy interventions for skin cancer prevention focus explicitly on restricting the use of indoor tanning facilities. Many states impose age restrictions that exclude or require parental permission from youth under the age of 18, require businesses to limit exposure, and/or impose excise taxes (National Conference of State Legislatures, 2012). A 2009 study found that about 87% of facilities complied with the parental permission requirement, 77% adhered to age limit bans, and less than 11% of facilities followed the maximum exposure requirement (Pichon et al., 2009; The Free Library, 2014).

Risky Sexual Behavior

Risky sexual behavior involves sexual intercourse with a partner without sufficient means of protection (e.g., condoms; mutual sexually transmitted infection [STI] testing, and an agreement to be monogamous) to prevent the acquisition, or transmission, of an STI. Sexual intercourse may involve vaginal, anal, or oral sexual penetration with heterosexual or homosexual contacts, and may be consensual or involve coercion. STI may include human papilloma virus (HPV), including oncogenic forms of HPV, or other STI (e.g., syphilis, chlamydia, gonorrhea, genital herpes, HIV). Oncogenic HPV subtypes have become more prevalent in recent years, and molecular evidence for a causal relationship has been reported with cancers of the vulva, vagina, anus, penis, and oropharynx (Chaturvedi, 2010). STI may also be associated with cervical cancer, pelvic inflammatory disease and associated pain, infertility, and AIDS.

About 70% of U.S. 19-year-olds are coitally active (Abma, Martinez, & Copen, 2010), and levels of risk behavior vary with age. Those in their teens and twenties practice greater risky sexual behavior than older adults, and also contract a disproportionate percentage of STIs (Chin et al., 2012). In the United States, the potential for risky sexual behavior generally extends over many years as individuals transition from sexual debut, through serial monogamies, to a more permanent relationship. Males, low-income, and minority populations are characterized by higher levels of risky behavior (Dariotis, Sifakis, Pleck, Astone, & Sonenstein, 2011).

HPV is predominantly acquired during adolescence (Smith, Melendy, Rana, & Pimenta, 2008): About 50% of U.S. females are infected within 3 years of having their first male partner (Winer et al., 2008). A high prevalence of HPV (44.8%) is found in U.S. women 20 to 24 years old (30% low and 28% high-risk subtypes), compared with 24.5% for U.S. women over the broader age range of 14 to 49 (Dunne et al., 2007). Risk might be even greater for men: 50% prevalence was reported among men 18 to 70 years old (38% low risk and 30% high risk subtypes; Giuliano et al., 2011). There is no treatment for the virus, and although most precancerous cells normalize on their own, some do not and can cause anogenital warts and cervical, vulvar, vaginal, penile, anal, or oropharangeal cancer (CDC, 2013b), as well as psychological and sexual consequences (e.g., anger, anxiety, stigma, lower sexual desire) for the individual and relationship partner(s) (Chaturvedi, 2010).

Most behavioral interventions aim to reduce the risks of transmitting or contracting STIs, including HPV. Individual-level interventions that strongly convey information, motivation, and behavioral skills for risk reduction have been successful in reducing risky sexual behaviors in many segments of the population (Fisher, Fisher, & Shuper, 2009; Shepherd, Frampton, & Harris, 2011; Wisconsin, 2010). In addition to conveying information about STIs, the most effective encourage preventive behavior by training communication skills to negotiate increased use of condoms, sexual abstinence, or other safer sex strategies (Shepherd et al., 2011). A few also have targeted complementary behaviors (e.g., drinking and drug use) that co-occur with risky sex (Fisher et al., 2009; Wisconsin, 2010). Interactive computer-delivered self-help programs about safer sex are proving effective in improving knowledge, self-efficacy, and safer sexual behavior, in some cases even surpassing face-to-face intervention (Bailey et al., 2012).

Some safer-sex interventions performed at the level of the group (e.g., classroom) or community (e.g., entire city) also have proved effective (CDC, 2013a). Whereas individual-level interventions usually target people currently exhibiting risk behaviors, group- and community-level interventions also intervene with those not currently at risk (Coates, Richter, & Caceres, 2008). Two examples of successful school-based programs are those that develop youth assets by teaching communication, future orientation, and problem-solving skills, and those that encourage delaying first intercourse, limiting partners, and encouraging condom use (CDC, 2013a). Importantly, there is no evidence that such programs encourage early sexuality or promiscuity despite addressing condom use. Effective safer-sex behavioral interventions have not been widely disseminated, which, unfortunately, leaves the state of everyday practice far behind the state of the science.

Two vaccines, Gardasil and Cervarix, reduce an individual's odds of contracting HPV. Uptake to date has been disappointing, however (Brabin et al., 2008), and disparities in HPV vaccine uptake may exist (Keenan, Hipwell, & Stepp, 2012). System- and policy-level interventions to increase HPV vaccine uptake warrant study and are undergoing research (Holman et al., 2014; UNICEF, WHO, & UNFPA, 2013).

Multiple Health Behavior Change

Until now, we have discussed each cancer risk behavior as if it were a silo, but only rarely do cancer risk behaviors travel alone. Usually they co-occur with different health-compromising behaviors as well as with other socioenvironmental influences that also heighten cancer risk (Fine et al., 2004; Pampel, Krueger, & Denney, 2010; Spring, Moller, & Coons, 2012). Behaviors that predispose to cancer occur in two main topographies: high-rate health-injurious behaviors whose excess prevalence needs to decrease, and low-rate health-enhancing behaviors whose prevalence needs to increase in order to curtail cancer risk. Cigarette smoking, overeating leading to obesity, and physical inactivity illustrate the former pattern, whereas healthy diet and physical activity illustrate the latter one.

The pervasiveness and clustering among health-compromising behaviors cry out for intervention strategies that can change multiple health behaviors efficiently and effectively. The current track record of intervening successfully upon several behaviors at once does not inspire great confidence, however (Butler, et al., 2013; Ebrahim et al., 2011; Prochaska & Prochaska, 2011). Fundamental questions remain unanswered about how to maximize positive change in multiple health behaviors. Open questions concern (a) the maximal and optimal number of behaviors that can be changed at once, (b) whether it is more effective to try to decrease health-compromising behaviors or increase health-promoting ones, and (c) whether simultaneous or sequential intervention is preferable (Spring, Moller, et al., 2012).

Although positive synergies among covariant behaviors may be attainable, negative trade-offs between behaviors have received greater attention. The classic negative synergy is that between quitting smoking and postcessation weight gain, because withdrawal of nicotine increases the reward value and consumption of hedonically appealing foods (Klesges et al., 1989; Spring, Pagoto, McChargue, Hedeker, & Werth, 2003). Whether positive synergies can be harnessed for health behavior change has received little attention. Two exceptions involve Epstein and colleagues' (2006) application of behavioral choice theory to produce synergistic positive changes in diet and physical activity in children, and Spring, Schneider, and colleagues' (2012)parallel work in adults. Spring and colleagues studied 204 adults who self-reported *all* of four unhealthy diet and activity behaviors: low fruit/vegetable intake (<5), high saturated fat ($>8\%$), low physical activity (<60 min/day), and high sedentary leisure screen time (>120 min/day). The study question was which combination of one diet and one activity behavioral target would maximize improvement across a standardized composite score that reflected improvement in all four behaviors. Results showed that each of the four interventions targeting all possible pairs of diet and activity behaviors improved the targeted behaviors to criterion level while participants were being coached, monitored, and financially incentivized to make behavior changes. The greatest magnitude improvement in composite diet and activity behaviors occurred in the intervention condition that

targeted increased fruits/vegetables and decreased leisure screen time. Moreover, a large (one standard deviation) improvement in composite healthy diet and activity persisted 5 months after the intervention ended. The superior outcome of this treatment condition reflected, in part, a tag-along decrease in saturated fat intake, even though it was untargeted. The decrement in fat intake was associated with the decrease in sedentary leisure screen time, suggesting that it may have reflected reduced snacking while watching TV. The least improvement occurred in the traditional diet intervention that targeted decreasing saturated fat and increasing physical activity. The large differences in the amount of improvement brought about by the varied pairings of diet and activity targets in the study by Spring et al. highlights the important reality that not all health behaviors are the same. In this particular study, a concurrent intervention aiming to increase one low-rate healthy diet behavior while decreasing one high-rate health-compromising behavior yielded a significantly better outcome than alternatives in terms of the magnitude and maintenance of the lifestyle improvement accomplished, partly by virtue of an effortless, synergistic improvement in an untargeted dietary behavior.

Findings remain mixed regarding whether a sequential or a simultaneous multiple behavior change intervention strategies is more successful (Hyman, Pavlik, Taylor, Goodrick, & Moye, 2007; Spring et al., 2004). What remains inescapable, however, is that targeting multiple health-damaging behaviors concurrently is highly efficient, if negative synergies between behavior changes can be avoided. All other things being equal, therefore, concurrently addressing multiple health-compromising behaviors appears to have many strong points. One potential downside needs to be monitored carefully, however. An underappreciated observation is that attrition from treatment usually is greater in simultaneous interventions than in sequential interventions that target the same behaviors (Schulz et al., 2012; Spring et al., 2004). Further, the heightened drop-out associated with simultaneous over sequential intervention increases as a person's number of risk behavior rises. One study found that the relative negative impact of simultaneous versus sequential intervention on retention grew progressively greater as the number of risk behaviors increased from two to four (Schulz et al., 2012). Compounding this problem is the reality that health-damaging behaviors become more numerous as social disadvantage increases (Pampel et al., 2010). As income and education decline, diet, physical activity, and tobacco use behaviors follow the social gradient, explaining up to 75% of the socioeconomic disparity in premature mortality (Stringhini et al., 2011). The important potential harm that needs to be monitored, therefore, is that intervening simultaneously rather than sequentially on multiple unhealthy behaviors risks losing the engagement of precisely those disenfranchised population sectors that are most in need of intervention, because they have the most health-compromising behaviors.

Still further complicating the interface between disparities and multiple behavior change strategy is evidence that the clustering of adverse health behaviors appears to differ among ethnic subgroups. In a study of 30,093 college students surveyed for the Fall 2010 National College Health Assessment, Kang and colleagues (2014) found that diverse ethnic subgroups exhibited different patterns of behavioral clustering. A small subset of students who had only one risk behavior (low fruit/vegetable intake) was found only among Whites. The most prevalent pattern, which appeared in all groups, involved co-occurring low fruit/vegetable intake and physical inactivity. This pattern varied in its prevalence from characterizing 52% of White students and 65% of Hispanics to 74% to 83% of Blacks, Asians, and American Indians. The remaining patterns, containing the most numerous risk behaviors, took somewhat different forms across the different ethnic groups. A behavioral bundle that clustered smoking, binge drinking, physical inactivity, and low fruit/vegetable intake characterized 17% of Asians and 33% to 35% of Whites and Hispanics. A cluster of behaviors that included overweight characterized 17% of Blacks and 26% of American Indians. That pattern included all of the other queried risk behaviors for American Indians, but not binge drinking for Blacks. The important implication is that, by adolescence, the way that health-compromising behaviors tend to cluster apparently varies across ethnic groups. Overweight was uncommon among college student subgroups, except American Indians and Blacks, and was accompanied by binge drinking among American Indians, but not Blacks. These findings make apparent that a cookie-cutter, one-size-fits-all approach to multiple health behavior change is unlikely to be viable. A community-based participatory approach that collaboratively engages that affected group in understanding the problem and implementing solutions may yield more equitable, sustainable improvements in health (O'Mara-Eves et al., 2013).

Conclusions

Specific lifestyle behaviors (i.e., tobacco use, excess energy and alcohol intakes, physical inactivity, risky sexual behaviors, and inadequate sun protection) are established risk factors for developing various types of cancer. Even though these risk behaviors are modifiable, few are diminishing in the population over time. In short, a considerable burden of disease and health care costs can now be considered to result from a failure to modify the modifiable risk behaviors. Psychologists have helped to elucidate biobehavioral mechanisms whereby these risk behaviors are acquired, become habitual, and "get under the skin" to create disease risk. Psychologists also have excelled in developing interventions that successfully reverse or produce large improvements in risk behaviors. Multiple health behavior change interventions that effectively prevent risk factors from developing, reverse them once they have emerged, and foster health protective actions could substantially reduce cancer's prevalence and the burden it places on the public and the health care system.

Despite decades spent unraveling biobehavioral mechanisms whereby risk behaviors become bad habits, and despite having developed many effective protocols to treat them, psychologists are relative newcomers to mainstream delivery channels for health promotion. Until relatively recently, most of psychology's professional involvement in clinical and community settings concerned the delivery of mental health services. In 2001, however, the American Psychological Asso-

ciation (APA) revised its bylaws to include "promoting health" as one of the association's objectives (N. G. Johnson, 2003). The bylaws' revision crystallized psychology's identity as a health science and profession by setting aside an outmoded dualism between mental and physical health. The change recognized psychologists' contributions not only to mental health but also to the understanding, prevention, and treatment of costly, debilitating, chronic illnesses like cancer. In 2009, the APA adopted its first strategic plan, including a mission statement that defined psychology as a health science and a health profession. One of the strategic plan's initiatives is to develop treatment guidelines that promote the translation of psychological science into health interventions. Importantly, the APA's first two treatment guidelines will address one mental health condition (depression) and one physical health condition (obesity, a cancer risk factor), signaling a firm commitment to integrated health.

Translating current understanding of health behaviors to maximal benefit for the public's health requires harnessing teachable moments to help people accomplish multiple healthy lifestyle changes. It also requires effective collaboration with medical, public health, nursing, and social work professionals, as well as community groups and policymakers committed to the same goals. Finally, regardless of whether the context is a clinic, a community center, a school, or an online venue, psychologists addressing cancer risk behaviors will need to cope with what Institute of Medicine President Harvey Fineberg called "the paradox of disease prevention—celebrated in principle, resisted in practice" (Fineberg, 2013). Intervening to prevent or treat risk behaviors or promote health-facilitating ones is primary prevention. If preventive intervention succeeds and keeps cancer from developing to begin with, the result is a future nonevent: absence of the onset of cancer. For-profit sector entities concerned with maximizing return on investment within a short timeline may have difficulty monetizing and valuing the benefits of investing in primary prevention, unless they look beyond immediate medical expenditure savings to consider employee retention, absenteeism, presenteeism, and productivity outcomes (Mattke et al., 2013; Merrill, 2013). Psychologists could make no greater contribution to public health than by generating and educating others to appropriately value multiple chronic disease nonevents that signify the success of primary prevention and a societal commitment to improved quality of life.

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