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AHA Scientific Statement Population Approaches to Improve Diet, Physical Activity, and Smoking Habits A Scientific Statement From the American Heart Association

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Abstract

Background—Poor lifestyle, including suboptimal diet, physical inactivity, and tobacco use are leading causes of preventable diseases globally. Although even modest population shifts in risk substantially alter health outcomes, the optimal population-level approaches to improve lifestyle are not well established.

Methods and Results—For this American Heart Association Scientific Statement, the writing group systematically reviewed and graded the current scientific evidence for effective population approaches to improve dietary habits, increase physical activity, and reduce tobacco use. Strategies were considered in 6 broad domains: (1) media and education campaigns; (2) labeling and consumer information; (3) taxation, subsidies, and other economic incentives; (4) school and workplace approaches; (5) local environmental changes; and (6) direct restrictions and mandates. The writing group also reviewed the potential contributions of healthcare systems and surveillance systems to behavior change efforts. Several specific population interventions that achieved a Class I or IIa recommendation with grade A or B evidence were identified, providing a set of specific evidence-based strategies that deserve close attention and prioritization for wider implementation. Effective interventions included specific approaches in all 6 domains evaluated for improving diet, increasing activity, and reducing tobacco use. The writing group also identified several specific interventions in each of these domains for which current evidence was less robust, as well as other inconsistencies and evidence gaps, informing the need for further rigorous and interdisciplinary approaches to evaluate population programs and policies.

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Conclusions—This systematic review identified and graded the evidence for a range of population-based strategies to promote lifestyle change. The findings provide a framework for policy makers, advocacy groups, researchers, clinicians, communities, and other stakeholders to understand and implement the most effective approaches. New strategic initiatives and partnerships are needed to translate this evidence into action.

Cardiovascular diseases (CVD), type 2 diabetes mellitus, and adiposity produce tremendous burdens of deaths, lost quality of life, and economic disruption globally.[1,2] Most of these conditions and their sequelae are preventable or occur at unnecessarily young ages and largely owe to suboptimal lifestyle habits, in particular, poor diet, physical inactivity, and use of tobacco.[3–13] The resulting burdens on families, communities, and nations are enormous and unsustainable, and the health and economic imperatives of improving lifestyle behaviors are fully evident.[2]

Consequently, the recent United Nations high-level meeting on noncommunicable diseases,[14] the American Heart Association (AHA) 2020 strategic goals,[3] and the multisector US Million Hearts Initiative[15] each highlighted the critical need to improve lifestyle habits to prevent CVD and maximize cardiovascular health. Unfortunately, the optimal approaches to improve lifestyle are not established. Although the most relevant specific lifestyle targets are increasingly evident,[3,4,8–12] the most effective strategies to achieve these changes have been less clear. An AHA Scientific Statement identified several effective individual-level (eg, clinical) interventions for achieving behavior change.[16] However, although individual-based approaches can be effective for some patients, they do not work for all,[16] and the long-term sustainability of such efforts also remains in question.

Population-based strategies are crucial complements to individual-based efforts and also have potential for broad and sustained impact.[17–19] The writing group that prepared this AHA Scientific Statement systematically reviewed and graded the current scientific evidence for effective population approaches to improve dietary habits, increase physical activity, and reduce tobacco use. Population strategies were considered in 6 broad domains: (1) media and education campaigns; (2) labeling and consumer information; (3) taxation, subsidies, and other economic incentives; (4) school and workplace approaches; (5) local environmental changes; and (6) direct restrictions and mandates. The writing group also reviewed how healthcare systems and surveillance systems can contribute to and monitor behavior change efforts. The information presented in this statement is intended to provide a useful framework for policy makers, advocacy groups, researchers, clinicians, communities, and other stakeholders to understand and implement the most effective public health approaches for lifestyle change to improve cardiometabolic health.

The writing group identified several specific interventions that were designated an AHA Class I or IIa recommendation with Level of Evidence A or B, providing a set of specific evidence-based strategies that deserve close attention and prioritization for wider implementation (Table 1). Although much of this evidence was derived from studies in high-income Western regions, for several interventions, concordant evidence was also available from other regions, including high-income non-Western and middle- or low-income regions. Although absolute rates of disease vary across populations, the relative impact of major cardiometabolic risk factors is shared across nations.[20] Likewise, the relative benefits of these different population strategies should help inform policy priorities in different countries. Notably, effective interventions were identified across a range of approaches, including media and education, labeling and consumer information, economic incentives, school and workplace approaches, local environmental changes, and direct restrictions and mandates. This provides some flexibility for policy makers, advocacy groups, and organizations to select from among specific interventions based on what

corresponds best with local priorities and circumstances. These various evidence-based interventions could also be implemented in combinations, either simultaneously or in stages, providing multicomponent approaches to improving diet, increasing physical activity, and reducing tobacco use.

In addition to the approaches outlined in Table 1, the writing group also identified many specific interventions and strategies in these domains for which the current evidence was not as robust. These other interventions and evidence for their effectiveness are summarized in the sections below. Because the numbers of policy champions and funding resources for preventive efforts are often limited, prioritization of different interventions requires knowledge of which strategies have evidence for effectiveness as well as which strategies still require further investigation.

The writing group recognizes that it could not review every possible type of population intervention and that its search strategies may have missed some relevant studies. Nonetheless, this AHA Scientific Statement represents a systematic assessment of several key population approaches for improving lifestyle behaviors, with evaluation of the strength and consistency of evidence; detailed listings of the primary evidence in supplementary material; and consideration of complementary evidence across diet, physical activity, and tobacco use behaviors. Given the number and types of studies identified, it seems unlikely that the addition of any missed studies would dramatically alter most of the conclusions. For the types of interventions reviewed, the writing group also identified inconsistencies and gaps in the evidence, as summarized below. The findings highlight the need for and inform the design of future interdisciplinary efforts, including input from academic experts in evaluation, to establish more systematic and rigorous approaches for the evaluation of such programs and policies.

Poor lifestyle behaviors, including suboptimal diet, physical inactivity, and tobacco use are the leading causes of preventable diseases in nearly all nations. The resultant rates of morbidity and mortality, adverse impact on disparities, and economic costs are staggering. At the population level, even modest shifts in risk behaviors and risk factors substantially alter health outcomes and disease risk. This report identifies a range of evidence-based, population-based strategies that effectively promote lifestyle change. The findings inform potential partnerships and strategies to successfully address suboptimal diet, inactivity, and smoking, which are each a major preventable cause of poor health globally. The information presented herein can help provide a blueprint for public health officials, researchers, communities, advocacy groups, private donors, and other stakeholders to engage in and form alliances around evidence-based population prevention efforts. New strategic initiatives and partnerships are needed to translate this evidence into action.

A NEED FOR EVALUATION OF POPULATION INTERVENTIONS

Lifestyle behaviors are influenced by a myriad of individual, social, economic, regulatory, mass media, and other environmental factors. Population-based interventions can influence many of these factors, with potential for broad and sustained impact.[17–19] The present AHA Scientific Statement broadly refers to population approaches as any strategy that targets organizations (eg, schools, worksites), communities, regions, or countries rather than individuals. For example, such approaches were critical for reducing tobacco use in several developed nations since the 1950s.[21,22] On the basis of this empiric success, a growing number of recent research studies have investigated how population strategies can support behavior change to improve lifestyle habits. Several studies have evaluated both established and novel population approaches for reducing smoking, and an increasing number of studies are reporting on novel population approaches for improving diet and physical activity

behaviors. Recent literature reviews or policy statements have considered subsets of these various strategies.[19,21–36] However, most did not evaluate diet, physical activity, and smoking together in the same report, which could provide complementary evidence on the effectiveness of various population approaches, and many did not systematically review the published literature nor formally grade the strength of evidence.

A range of population, community, and school/workplace intervention strategies are being implemented in the United States and elsewhere but often with limited evaluation. Due to limited funding and other resources for preventive efforts, knowledge and grading of the most evidence-based promising strategies are essential to inform priorities. Academic research centers, especially those with clinical and translational research awards, are also being asked to focus more on translational projects that implement knowledge. Given the wide range of potential population strategies and the rapidly growing evidence base evaluating them, it is essential to systematically review these data to identify (1) which policies work and should be implemented, (2) which policies are promising and deserve further intensive investigation, and (3) what critical research gaps remain.

METHODS

Search Strategies and Data Extraction

The writing group searched for evidence of the effectiveness of different population approaches in changing dietary, physical activity, or tobacco use habits and related health outcomes. The present report does not review which specific behavioral goals should or should not be targeted; these issues have been discussed extensively elsewhere.[3,4,8–12] The report also does not attempt to describe all of the various policy interventions that might be sensible to consider or that have been or are being implemented. Rather, the report attempts to identify and assess the evidence for the effectiveness of such interventions. Population strategies were considered in 6 broad domains: (1) media and education campaigns; (2) labeling and consumer information; (3) taxation, subsidies, and other economic incentives; (4) school and workplace approaches; (5) local environmental changes; and (6) direct restrictions and mandates. Observational or interventional studies were included that evaluated how these strategies relate to or alter knowledge or attitudes toward diet, physical activity, or smoking; changes in these behaviors; changes in related risk factors (eg, blood cholesterol and glucose, blood pressure, obesity levels); or disease end points (eg, coronary heart disease [CHD], stroke, diabetes).

The writing group considered studies evaluating population strategies at organizational (eg, school, workplace), community, regional/state, or national levels. Notably, the report excludes studies focused on individual-based associations or interventions (eg, controlled trials in which the unit of intervention was a person rather than a classroom, worksite, community, or region). The evidence for individual-based approaches for diet and physical activity change was recently reviewed.[16] The writing group also did not evaluate the feasibility of implementation or cost-effectiveness, which was beyond the scope of the present report; the findings in this report can inform such future investigation.

For each category of population intervention, the writing group first performed broad searches of online databases, including PubMed/Medline, EconLit, Agricola, ERIC (Education Resources Information Center), RePORT (National Institutes of Health Research Portfolio Online Reporting Tools), and the Social Science Citation Index. These searches were followed by additional online searches, hand searches of citations, and use of expert contacts to identify systematic or narrative reviews in the scientific literature, as well as policy statements and guidance from the Institute of Medicine (IOM), World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), US Department

of Health and Human Services, and other similar international, national, and local agencies. The evidence from these identified reviews and reports was evaluated as primary data if the reports included sufficient descriptions of the methods for literature searches and the methods and findings of included individual studies to permit inference on the quality and strength of evidence. If the reports did not meet these criteria, the original research studies cited in these reports were obtained and evaluated individually. Finally, to obtain any recent relevant research not identified by these methods, the writing group performed systematic searches of PubMed for all relevant English-language original research articles published since January 1, 2007, using specified key words and MeSH terms for each category of population intervention, together with searches of related articles and hand searches of citations. Full descriptions of these search criteria are available online in the online Data Supplement.

For each category of population intervention, searches were performed and data extracted by teams of 2 to 3 investigators, with studies and data jointly reviewed in regular conference calls, emails, and a shared online website provided by the AHA. For each identified report, data were extracted on study design, population, type and duration of approach or intervention, duration of follow-up, outcomes, covariates, findings, and factors related to quality of design or execution.

The writing group also reviewed the evidence for healthcare systems' strategies for behavior change, although a complete systematic review was beyond the scope of the present report. The writing group also reviewed surveillance and monitoring systems for diet, physical activity, and tobacco behaviors because of the importance of such systems for informing goals and designs of policy programs, understanding and choosing appropriate metrics, monitoring the effects of implemented policies, and elucidating current gaps or barriers in knowledge and methods.

Grading the Evidence for Population Lifestyle Strategies

Population-based strategies are typically implemented as a policy, whether volunteer or mandated and whether at organizational (school, worksite), community, city, or broader levels. Traditional policy evaluation often incorporates the CDC Evaluation Framework,[37] which considers the theory behind policy strategies[38] and process evaluation. This framework principally evaluates the process of creating policy change (eg, assessment of stakeholder engagement, campaigns for public awareness to gain momentum for policy change, recruitment of legislative champions, barriers to success and how these are overcome, media placement, whether the policy actually passes) rather than the effects or impact of the policy on its intended target, such as health-related outcomes. Health impact assessments are increasingly being used as planning tools to foster consideration of health needs in policy and program decisions, including sectors not traditionally focused on health.[39,40]

Evaluation of the effects of population-level strategies on health requires investigation in observational or interventional research. Such evaluation is critical to understand the extent to which specific interventions alter health; determine potential for sustainability; provide accountability to funding partners and stakeholders; improve and enhance future planning efforts; and assess whether there are any unintended consequences.

For the present report, potential metrics of interest included health-related knowledge, behaviors, risk factors, and clinical end points. Although the long-term goals of many policy interventions often include decreasing clinical cardiovascular end points and other lifestyle-related diseases, such effects may require years to become fully evident. Such a timeframe may be impractical or too costly for some types of evaluations. Given the considerable

evidence on the impact of dietary, physical activity, and tobacco habits on risk of cardiometabolic diseases, changes in the behaviors themselves were considered relevant outcomes for assessing the effectiveness of population-level policies. Changes in intermediate risk factors affected by the behaviors—eg, levels of blood pressure, blood cholesterol, and adiposity—are also linked to disease risk and provided additional relevant outcomes for assessing effectiveness. Thus, the writing group evaluated the evidence for the effects of population interventions on each of these relevant end points, including changes in health-related behaviors, risk factors, and disease end points.

For each type of population intervention, the overall evidence was reviewed and summarized, and these data were reviewed by all members of the writing group and graded using the AHA classification (Table 2). The writing group recognizes that evaluation of many population approaches does not lend itself well to typical medical-model controlled trials, in which individuals are randomly assigned to double-blinded, isolated interventions such as drug treatment. By nature, population interventions target groups or communities, not individuals. Additionally, ethical and logistical considerations often preclude the ability to perform randomized trials at the level of discrete populations. Thus, evidence from multiple research paradigms was considered relevant, including results from ecological studies, observational studies, natural experiments, and various interventions, including uncontrolled, quasi-experimental, and cluster-randomized trials. Well-designed quasi-experimental studies were considered a particularly important means of evaluating the effectiveness of population interventions.

Where appropriate, the writing group considered whether population interventions could be evaluated alone or only as part of a multicomponent strategy, the evidence for sustainability of behavior changes, and qualitative evidence for heterogeneity, ie, whether certain strategies were more or less effective depending on other factors such as level of intervention (eg, local, state, federal) or population of interest (eg, children, adults, the elderly, certain ethnic or socioeconomic subgroups). Sufficient data were found to support an inference on the potential heterogeneity of efficacy to be unusual; where relevant, this evidence is presented.

RESULTS

The writing group identified a vast body of literature providing evidence on the potential effectiveness of various population interventions. The writing group found the design, methodology, and findings of each individual study to be highly relevant for considering and grading the evidence as a whole for any specific type of strategy. Thus, although presentation of narrative summaries of each individual investigation in the text was prohibitive, detailed summaries of many of the studies included in our assessment were compiled. These summaries are provided in extensive supplementary tables (Supplementary Tables, available online), which are cited throughout the text.

Media and Education Campaigns

The writing group considered the evidence for the effectiveness of media or education campaigns at national, community, and school levels. A variety of media have been used, including television, radio, print, or billboard advertising; in-store media education; and leaflets mailed or delivered door-to-door. Interventions that simply provided information on or near products, such as food labels, menu labeling, stair signage, or warning labels on tobacco products, were considered separately (section on “Labeling and Consumer Information”).

National, Community, and School-Based Media or Education Campaigns to Improve Diet—Several focused media campaigns have been conducted to increase knowledge about and consumption of specific healthful foods (Supplementary Table 1). These include the US 5-A-Day For Better Health! campaign to increase consumption of fruits and vegetables, initiated by the National Cancer Institute with collaboration from industry and the federal government. Cooperative agreements were established with a nonprofit organization representing farms, commodity groups, and distributors, including in-store and promotional activities such as a licensed 5-A-Day logo. Reports on this campaign, although not always peer reviewed,[41,42] suggest some success. For instance, the national 5-A-Day campaign, launched in 1991, was associated with increased consumption of fruits and vegetables from ≈ 2.8 to 4.3 servings per day between 1988 and 1999.[41] In March 2007, the new Fruits & Veggies—More Matters campaign focused on women born between 1965 and 1979 with children living at home. In a 2010 survey, 18% of these mothers were "definitely" aware of the campaign, and 38% reported being more likely to purchase a product having the campaign logo; data were not reported on actual changes in consumption.[42] Similar focused media campaigns in Australia were associated with increased public awareness and consumption of fruits (from 1.5 to 1.7 servings per day, $P<0.05$) and vegetables (from 2.6 to 3.1 servings per day, $P<0.001$).[43] In Pakistan there were self-reported improvements in dietary habits, such as reduced consumption of meat and increased consumption of fruits and vegetables.[44]

Community- and school-based long-term media and education campaigns have also been effective in improving dietary habits of adults, school-age children, and younger children,[45–48] as well as reducing adiposity and cardiovascular risk factors in adults.[49] Many of these educational campaigns used multiple strategies for communication. Therefore, the independent effects of specific educational strategies, eg, national media advertisements versus concordant supermarket-based activities, is difficult to quantify. On the basis of the Consumer Information Processing model, the supermarket represents a useful venue to provide point-of-purchase nutrition information to promote healthy eating.[50] In 1 intervention,[51] use of in-store public service announcements about the 5-A-Day campaign for 4 weeks, in combination with a take-home audiotape, increased knowledge about the healthfulness of fruits and vegetables, as well as self-reported consumption in the intervention group (6.2 servings per day) compared with both baseline (5.4 servings per day) and shoppers in control stores (5.6 servings per day) ($P<0.05$ for each).

Shorter-term (weeks to months) media campaigns, such as Fighting Fat, Fighting Fit in the United Kingdom and similar programs in the United States and Australia have generally increased knowledge of healthy lifestyle messages, although sometimes less so in lower socioeconomic or minority subgroups and typically with less clear evidence for actual behavior change,[52–54] although there were some exceptions in which behavior change was also demonstrated.[55] Combining shorter-term media campaigns with other means of more direct communication or participation may increase effectiveness. In the Fighting Fat, Fighting Fit campaign, persons who chose to register in a 6-month mail-based educational program increased their consumption of fruits and vegetables by 1.3 servings per day, reduced their intake of fat and snacks, increased their physical activity, and lost an average of 2.3 kg, lowering the prevalence of obesity by 11% ($P<0.001$ for each compared with baseline).[56] In the 5-A-Day campaign, sending newsletters with strategies for improving consumption of fruits and vegetables and goal-setting information increased the frequency and variety of fruit and vegetable consumption.[57]

In an urban district of China's third largest city, Tianjin, an educational intervention to reduce the population's consumption of sodium was implemented between 1989 and 1992.[58] The main activities in the intervention neighborhoods included training of healthcare

personnel about sources and effects of salt sources on blood pressure and on how to provide practical advice to patients, community education by means of door-to-door distribution of leaflets, distribution of posters and stickers to food retailers, and introduction of lower-sodium salt in some retail stores. In the intervention neighborhoods, mean sodium intake decreased by 22 and 11 mmol/d in men and women, respectively, compared with increases of 18 and 4 mmol/d, respectively, in the control neighborhoods ($P<0.001$ for men, $P=0.065$ for women). These changes did not vary by education or occupation. When compared with control neighborhoods, systolic blood pressure decreased in the intervention neighborhoods by 5 mm Hg in men ($P=0.065$) and 6 mm Hg in women ($P=0.008$). In North Karelia, Finland, a media- and education-based community intervention successfully reduced consumption of butter, whole-fat dairy, nonlean meats, and salt and increased consumption of vegetable-oil margarine and vegetable oils, low-fat dairy, lean meats, vegetables, berries, and fruit.[59,60] Targeted dietary habits improved substantially, with associated declines in population blood cholesterol and blood pressure levels and rates of CHD.[59,60]

Three community-based health education programs were evaluated in the 1980s in the United States, with a major focus on media and education to improve multiple cardiovascular risk factors simultaneously. The Stanford Five-City Project tested a 5-year community-based program that incorporated behavior change theory (social learning theory, a communication-behavior change model), community organization principles, and social marketing methods. After 3 to 5 years of intervention, compared with controls, the intervention communities saw improvements in several cardiovascular risk factors, including lower blood cholesterol, blood pressure, resting heart rate, weight gain, and smoking prevalence.[49] In contrast, similar media and education strategies in the Minnesota Heart Health Program and the Pawtucket Heart Health Program did not lead to significant improvements in cardiovascular risk factors or events when compared with control communities.[61–63] In the latter studies, secular improvements in risk factors were also seen in the control communities, perhaps in response to similar national campaigns targeting these risk factors; these trends may have limited detection of any added effects of the community-level interventions.

These US community programs did not have a strong emphasis on complementary population strategies, such as those related to taxation, subsidies, direct restrictions, or mandates. In comparison, community and national programs in Finland, Singapore, and Mauritius used media and education campaigns as central elements of larger multicomponent interventions that leveraged other strategies, such as alterations in physical environments and changes in taxation and subsidies, to support a healthful lifestyle.[60,64,65] For example, after 1977, when the North Karelia project was extended nationally, the original media- and education-focused approach was supplemented with substantial focus on changing the food environment by means of voluntary agreements with industry, changes in food subsidies and taxation, and governments-supported programs to increase local production and consumption of fruits and vegetables (“Taxation and Subsidies” and “Direct Restrictions and Mandates” sections).[60] Targeted dietary habits improved substantially, with associated substantial declines in population blood cholesterol and blood pressure levels and rates of CHD.[59,60]

In the nation of Mauritius, a national prevention program was launched to reduce major risk factors by promoting healthier diets, increased exercise, smoking cessation, and reduced alcohol intake.[65] Media and education efforts were major components, including extensive use of mass media and widespread community, school, and workplace education activities. Legislative restrictions and mandates were also introduced to improve cooking oils. From 1987 to 1992, moderate leisure-time physical activity increased from 16.9% to 22.1% in men and from 1.3% to 2.7% in women. Cigarette smoking decreased from 58.2% to 47.2%

in men and from 6.9% to 3.7% in women. Heavy alcohol use also declined substantially, from 38.2% to 14.4% and 2.6% to 0.6%, respectively. The effects of legislative measures on cooking oils are discussed in the section “Direct Restrictions and Mandates.” In this 5-year period, the prevalence of hypertension was reduced from 15.0% to 12.1% in men and 12.4% to 10.9% in women. Mean population serum total cholesterol fell by 15%, from 5.5 to 4.7 mmol/L ($P<0.001$).

Singapore instituted a sustained multicomponent intervention in 1992 that combined extensive media/education approaches with school, workplace, and environmental strategies and collaboration with food industry to produce healthier food choices.[64] An evaluation of national trends between 1998 and 2004 demonstrated significant declines in the prevalence of smoking, hypertension, hypercholesterolemia, and type 2 diabetes and significant increases in regular exercise. No relevant comparison or control groups were available. However, another community-based, multicomponent intervention that included education of multiple stakeholders as well as changes in school and community environments demonstrated reductions in age-adjusted body mass index (BMI) of children in the intervention community, compared with control communities.[66]

In sum, the evidence from ecological studies, quasi-experimental studies, and cluster-randomized trials indicates that focused national, community, and school-based media and education campaigns are effective in increasing knowledge and consumption of specific healthful foods, with some evidence from several studies for associated reductions in adiposity and other cardiovascular risk factors (Table 3). Some of these studies had follow-ups of many years to decades, suggesting that behavioral changes are sustainable when the media and education campaigns are continued. Such campaigns appear to be most effective when they are focused on specific foods, implemented for many years, use multiple modes for communication and education, and, if shorter term, incorporate other means of more direct communication to or involvement by the public. Broad community-based media and education programs that target multiple cardiovascular risk factors and behaviors simultaneously have been less successful, suggesting the importance of focused messages for the target audience. This is a major premise of social marketing, which uses a consumer orientation to behavior change: incorporation of research from the target population, testing of different strategies and channels of delivery, and integration of marketing principles (eg, product, place, promotion) into the intervention.[67] Media and education have also been part of successful multicomponent approaches at national and community levels, although their relative contribution to the overall success is difficult to separate in such multicomponent interventions.

National, Community, and School-Based Media or Education Campaigns to Increase Physical Activity—Several media and education campaigns have been used to promote physical activity. Examples in the United States include VERB, a national social marketing campaign coordinated by the CDC to increase and maintain physical activity among 9- to 13-year-olds[68]; the Play 60 Challenge, a partnership between the AHA and the National Football League to encourage children to perform 60 minutes of daily physical activity; and the AARP’s Active for Life: Increasing Physical Activity Levels in Adults 50 and Older campaign, a social marketing campaign to increase moderate physical activity among older adults.[69] Statewide and community-level campaigns have also been developed, typically mass media strategies involving multiple mediums such as television, radio, newspaper, billboard, or transit ads.[53,70,71] In quasi-experimental (pre/post) evaluations, such campaigns generally improved self-reported measures such as awareness of the campaign, changes in attitudes toward activity, and, in a few studies, self-reported general activity levels.[72,73] For example, in an evaluation of the national VERB campaign, 6 communities received more intensive advertising and marketing due to increased funding

and donated media time.[74] Compared with a control community receiving the usual national campaign, children in the intervention communities reported higher levels of awareness and understanding of VERB and greater free-time physical activity at 2 years. The effectiveness of such programs for more rigorously or objectively measured physical activity or related risk factors has generally not been assessed. A review of such media campaigns by the US Task Force on Community Preventive Services concluded that there was "insufficient evidence to determine the effectiveness of mass media campaigns, when used alone, to increase physical activity or improve fitness because of a small number of studies with inconsistent findings and methodological limitations."[75]

As described above, several intensive community-level media and education interventions have also attempted to alter physical activity as 1 part of a more comprehensive set of health factors and behaviors.[49,61,62] These interventions produced mixed results, with benefits on risk factors seen in 1 study[49] but without clear benefits in the other 2 studies, as compared with secular trends.[61,62] Multicomponent community-level interventions that combine media and education with other approaches, such as environmental changes, to encourage healthier diets and more physical activity have led to reductions in adiposity in children,[66] but the effectiveness of the media/education component on physical activity as such is less clear.

In sum, the findings from these studies indicate that focused media and education strategies improve awareness and attitudes about physical activity and, in at least some quasi-experimental studies, self-reported physical activity (Table 3). Media and education campaigns may be less effective when multiple health behaviors are targeted simultaneously. Conversely, the combination of a focused media and education strategy with other approaches, such as environmental changes, may hold the most promise; further investigation of these combinations in multiple target populations is needed.

National, Community, and School-Based Media or Education Campaigns to Reduce Tobacco Use—Several comprehensive reviews and other recent reports have evaluated the evidence for the effects of anti-tobacco media and education campaigns (Supplementary Table 2).[76–85] All of these reviews have concluded that such campaigns can increase negative attitudes about smoking, reduce initiation of smoking among youth, and promote smoking cessation among active smokers. The impact can be substantial. For example, the CDC reviewed the effects of several state programs.[77] California's targeted anti-tobacco media education program was associated with large reductions in smoking across several racial/ethnic groups between 1990 and 2005, including declines from 20% to 15% in Asian men, from 22% to 16% in Hispanic men, and from 28% to 21% in black men. In Florida, a youth tobacco prevention program that included a major mass media component led to significant declines in just 1 year, including absolute declines in current cigarette use of 3.5% in middle school students and 2.2% in high school students.

Such campaigns are most effective when combined with other community, school, and healthcare system—based strategies (Table 3). As part of such combined strategies, media and education components have generally been estimated to account for at least 20% of declines in tobacco use. Factors that increase effectiveness include greater duration and dose of exposure to the media campaign and use of strong negative messages about health. To maximize success, the CDC estimated that such approaches must have sufficient reach, frequency, and duration to reach 75% to 85% of the target audience each quarter and run at least 6 months to increase awareness, 12 to 18 months to have an impact on attitudes, and 18 to 24 months to influence behavior.[77]

Sustained campaigns appear to be important. From 2000 to 2003, Minnesota implemented a high-profile media campaign that successfully reduced smoking among youth. However, when the program was discontinued, youth's awareness of the message declined and likelihood of youth initiating smoking increased from 43% to 53% within 6 months.[77] Similar findings have been seen when several other anti-tobacco media campaigns were discontinued.[86]

In sum, there is strong evidence that anti-tobacco media and education campaigns are effective for fostering negative attitudes about smoking, reducing smoking initiation among youth, and promoting smoking cessation among active smokers, especially when combined with other population-level strategies.

Labeling and Consumer Information

Labeling/Information and Diet—Several labeling and information approaches have been used to improve food purchasing choices. Strategies have included providing the content of selected nutrients on food labels, use of front-of-pack product labels or icons to highlight specific nutrients or provide overall summaries of healthiness, and listing of calories or specific nutrients on restaurant menus. For instance, the US Nutrition Labeling and Education Act of 1990 mandated the use of nutrition labels in the form of a standardized "Nutrition Facts" panel on most food packages. In 2005–2006, about 60% of US adults reported using the nutrient data on the Nutrition Facts panel, and about half reported looking at the ingredient list and serving size information.[87]

Although industry has done extensive research on the impact of labeling and marketing in store environments, these data are not publically available for evaluation. Research has also been done by academic investigators. Several observational cross-sectional studies and limited longitudinal studies have evaluated factors associated with the use of nutrition labels and whether their use relates to dietary habits (Supplementary Table 3).[87–94] Generally, women; persons with greater education, existing chronic disease, or greater awareness of diet-disease relations; and persons counseled by their physician to change their diet were more likely to report using nutrition labels to help make decisions about foods. Greater reported use of food labels was inconsistently associated with certain dietary habits, such as lower consumption of added sugars, total fat, and total calories and higher consumption of fruits, vegetables, and dietary fiber. In many cases, these differences were observed for use of specific nutrient information on the food label; for example, only use of sugar information on the label, rather than general use of the food label, was associated with lower consumption of added sugar. Some studies did not show any association between reported awareness or use of the food label and many or all dietary habits. Additionally, aspects of the food label were demonstrated to be confusing to consumers, for example, relations between sodium content and salt content.

In part because of the disappointing evidence on the effects of food labels on dietary behaviors, a growing number of initiatives are attempting to provide more focused and clear information in the form of front-of-pack labels or icons. For example, since 1995 the AHA has operated a national labeling program that allows industry to add a "Heart Check" package icon to products that meet specific AHA nutritional guidelines. In a national survey among 1004 grocery shoppers conducted in February 2009, 83% reported that this label aided in their awareness of the healthfulness of products; 63% reported trusting this more than any other label or icon; and 41% reported looking for this label before purchasing foods (D. Milne, AHA quantitative consumer research). In 2006, the UK Food Standards Agency recommended that UK food retailers and manufacturers place front-of-pack "traffic light" icons on products in a range of categories. Other examples include the mandating of front-of-pack labeling in the Netherlands (Choices International Foundation,

www.choicesprogramme.org/en),[95] Sweden (the Swedish Keyhole),[96] and New Zealand (Pick the Tick).[97] Sodexo, the largest caterer in Europe, has voluntarily adopted the "international choices" logo, a front-of-pack stamp based on food-category specific criteria on saturated fat, *trans* fat, sodium, added sugar, and dietary fiber content, as well as total calories.[98] India, Poland, and Israel are working to adopt a local variant of the Choices International system, and the Mexican government is also creating a front-of-pack label to mark healthier choices. A recent government-sponsored scientific panel in Australia also reviewed the general rationale, principles, and practical aspects of food labeling, although not the evidence for effects on consumer behavior.[99] In the United States, the IOM is reviewing front-of-pack nutrition rating systems, considering the purpose and merits of the different programs and the nutrition criteria that underlie them.[100,101] The next phase report will assess which icons are most effective, develop conclusions about systems and icons that best promote health and how to optimize their use, and consider potential benefits of a single, standardized front-of-pack food guidance system regulated by the US Food and Drug Administration.[100,101]

Limited studies have evaluated the impact of focused front-of-pack labels on consumer behavior (Supplementary Table 3). Several cross-sectional observational studies have been performed on correlates of reported and observed use of food labels and front-of-pack logos[102]; consumer recognition[103]; and purchasing behavior in supermarkets[104] related to front-of-pack logo. Generally, these observational studies have found that people who report greater attention to health concerns are more likely to report using the logo and purchasing products with the logo. Causation cannot be assessed in such cross-sectional studies; ie, shoppers predisposed to purchasing a healthier food may report using the logo rather than the logo influencing the purchase.

Simplified front-of-pack or point-of-purchase labels or icons have also been evaluated in interventional studies. In a quasi-experimental intervention in the United Kingdom, a front-of-pack icon label for healthfulness had no effects on sales of specific products in supermarkets in the 4 weeks before versus after introduction of the icons.[105] A similar uncontrolled study in New England supermarkets demonstrated statistically significant but small changes in food purchasing at 1 and 2 years after implementation of an in-store, on-shelf version of a front-of-pack icon system.[106] One controlled acute (single meal) intervention demonstrated that food labels reduced total calories consumed at a buffet lunch, but this was a small study (N=47) among motivated volunteers.[107] A larger (N=420) acute (single meal) controlled intervention demonstrated that front-of-pack food labels resulted in improved recognition of more versus less healthful foods but did not alter which foods were selected by subjects.[108] Two longer-term (3 to 4 weeks) controlled interventions found no effects on sales of labeling low-fat food choices in a vending machine located in a teachers' lounge[109] or placing front-of-pack logos on foods in worksite cafeterias.[110] In a 12-month controlled intervention, adding a low-fat label (with or without promotional signage) to snacks in vending machines located in high schools and worksites had minimal effects on sales.[111]

A limited number of quasi-experimental studies suggest that labeling in combination with additional environmental changes may be effective. A combined environmental and labeling intervention, both adding healthier options while also labeling calories, energy density, and macronutrients on all foods sold in a worksite cafeteria, led to a reduction in total calories consumed at lunch.[112] In a quasi-experimental study at a large US hospital, foods and beverages were labeled with simple color codes (red, yellow, green) based on US Department of Agriculture (USDA) food pyramid guidelines.[113] After 3 months, sales of "red" products decreased by 9.2%, including 23.1% lower sales of sugar-sweetened beverages, and sales of "green" products increased by 4.5% ($P<0.001$ each). Total sales at

the cafeteria did not change, and no changes were seen in sales of these different foods at 2 smaller comparison cafeterias that did not institute labeling.

Many foods, such as those sold in cafeterias and restaurants, are promoted on menus rather than in a package or setting conducive to a label or logo. In the United States, more than half of all food dollars are spent on such foods prepared away from home, including at restaurants, fast-food chains, cafeterias, and other public places.[5] Such foods were exempted from the US Nutrition Labeling and Education Act of 1990. As a result of the new US healthcare reform law, retail food establishments with ≥20 locations, including chain restaurants, coffee shops, grocery stores, bakeries, and vending machines, will be required to post calories on menus and have available other nutritional information by 2012.

Both observational and quasi-experimental studies have evaluated the impact of point-of-purchase information, such as menu or menu board information on calories and/or nutrients, on food-purchasing behavior (Supplementary Table 4). In observational analyses, customers who report seeing and using posted calorie information purchase fewer total calories than other customers,[114,115] although such findings can be limited by reverse causation (ie, calorie-conscious customers may pay more attention to menu postings rather than the postings themselves altering calorie consciousness). Interventional studies have also been performed. In 1 review of earlier interventional studies published through 2003, the authors concluded that the design and reporting of many of these studies were suboptimal.[116] In a study among college students, posting the caloric content of entrees in a college cafeteria for a 14-day period led to selection of entrees with lower kilocalories without reducing overall sales revenue.[117] Similarly, a comparison of meals purchased at full-service restaurants in Washington state found that adding caloric and nutrient information to menus was associated with selection of entrees that were lower in calories, fat, and sodium during the next month.[118] In contrast to these results, showing adolescents restaurant menus with and without caloric information produced relatively small theoretical changes in behavior, with only 1 in 5 adolescents selecting a lower-calorie or lower-fat alternative when menus had posted information.[119] Similarly, posting of caloric information for foods and beverages on menu boards of New York City fast-food restaurants was associated with increased self-reported awareness of calorie information[115] but did not affect average calorie consumption by patrons of these restaurants in low-income areas of New York City when compared with either pre-menu labeling or control areas in Newark, New Jersey.[120] In a controlled trial, adding caloric information to a fast-food menu also did not alter food selection or consumption at a single meal in adolescents and adults who were regular patrons of fast-food restaurants.[32] In a systematic review of randomized controlled trials (RCTs) evaluating workplace interventions to improve lifestyle and health,[121] 2 trials that provided fat and/or fiber information on foods in worksite vending machines or cafeterias demonstrated small increases in consumption of fiber or fruits and vegetables. A 1-year controlled trial found no effects of listing caloric information on foods at the worksite cafeteria on dietary consumption or adiposity.[122,123] The writing group did not identify any other studies investigating the effects of menu labeling on other risk factors such as adiposity or metabolic risk factors.

Some evidence from natural experiments suggests that front-of-pack icons and nutrient labels may influence industry behavior by leading to product reformulations. For example, after the launch of a voluntary industry program for a simple “healthy choice” front-of-pack logo in the Netherlands, existing foods were reformulated and new products were launched to alter several nutrients.[124] For example, sodium was reduced in processed meats, sandwiches, and soups; dietary fiber was increased in fruit juices, processed meats, dairy products, sandwiches, and soups; and saturated fat and added sugar were reduced in dairy products.[124] Contemporaneous with mandates to add *trans* fat content to food labels in

Canada and the United States, many products were reformulated by industry to reduce or eliminate *trans* fat.[125,126] The impact of the labeling per se, versus increased consumer and media attention surrounding the policy change or other factors, cannot be differentiated; for example, in both of these studies, many food products served at restaurants that did not require labeling were also reformulated.[125,126]

In sum, there is limited evidence that labeling and information approaches, including nutrient facts labels, simplified or summary front-of-pack product labels/icons, or point-of-purchase (eg, menu) listing of calories or specific nutrients have meaningful effects on dietary behaviors of consumers (Table 4). Indeed, for nutrition facts panels, there is reasonable evidence for little to no effects on diet or even contribution to confusion. Although from 20% to 80% of adults in various studies report using food label nutrition or ingredient information, front-of-pack icons, or menu labeling to make food choices, with differences by gender, education, and underlying disease status (Supplementary Table 3), there is limited objective evidence that these labels or icons produce dietary change or alter other diet-related risk factors, especially over the long term. Efficacy may be limited by the little time that many people spend when selecting foods for purchase and by a limited understanding of food labels or icons and point-of-purchase information among some subgroups, such as the elderly, men, and those with lower education or literacy. Simple point-of-purchase icons in cafeterias appear promising when combined with additional environmental changes to alter diet; further investigation is needed in different settings and with longer follow-up. Interestingly, labeling and information approaches may be effective for influencing industry to reformulate their products, which can improve dietary habits by altering the characteristics and availability of different foods and beverages.

Labeling/Information and Physical Activity—Few studies of labeling/information and physical activity were identified. The use of signage to increase use of stairs as a part of overall physical activity has produced small changes in this behavior, for example, at worksites or shopping centers. Displaying signs with either health or weight-control messages for 1 month increased the percentage of people who used the stairs: persons <40 years of age increased their use of stairs from 4.6% at baseline to ≈6.0%, and those >40 years of age increased their use of stairs from 5.1% to ≈8.4%.[127] In another intervention, motivational posters or banners encouraging use of stairs, when posted next to escalators adjacent to stairs, increased stair use from 2.4% at baseline to 4% for posters and to 6.7% for banners; this increase was sustained at 10 weeks after signage was removed.[128,129] Incorporation of motivating messages was found to increase use of stairs from 8.1% to 18.3% over a 6-week intervention.[130] In a nonrandomized intervention in a predominantly Hispanic US-Mexico border community, posters at open-area staircases in various community sites (eg, airport, bank, library, office) produced small increases in stair use among women (absolute increases of ≈1% to 6%), with mixed results (both increases and decreases) among men.[131] In another trial, use of labeling (eg, posters, bulletin boards) to encourage use of stairs at a worksite did not significantly increase physical activity compared with controls.[121] In sum, these studies indicate that motivating signage can increase use of stairs, but the effects appear modest, and relatively few controlled or long-term studies have been performed (Table 4).

Labeling/Information and Smoking

Warning Labels on Cigarette Packs: Observational, quasi-experimental, and short-term controlled studies have been performed to evaluate the effectiveness of warning labels on cigarette packs (Supplementary Table 5). These studies demonstrate that warning labels are most effective in countering the attractiveness and persuasiveness of cigarettes when they are visually noticeable,[132,133] avoid the use of chemical names or ingredients,[134] are specific

rather than general,[135] include pictorial and especially graphic[136] warnings, are attributed to a specific source (eg, "medical studies," "the Ministry of Health") rather than unattributed,[137] and are provided at appropriate literacy levels.[138] Smokers with greater education are more likely to recall printed warnings on cigarette packages.[139]

Observational evidence suggests that warning labels are effective for increasing awareness of health risks and reducing smoking. An international survey including adult smokers from the United States, United Kingdom, Canada, and Australia demonstrated that smokers who notice the warnings were more likely to endorse health risks and that knowledge of health risks was greater in countries with more mandated government warnings.[140] As new warnings have been added and updated, smokers have reported that the warnings increased their motivation to quit, reduced their likelihood of purchasing cigarettes, and made them smoke less overall.[141] Smokers who report noticing warning labels also report greater intentions to quit[141] and higher stages of change and self-efficacy.[142] Quasi-experimental evidence supports these findings.[133,143] Notably, industry and trade documents indicate that the reverse tactic, the promotion and labeling of "light" or "low-tar" cigarettes by cigarette companies, has been highly successful in increasing the use of such cigarettes by consumers.[144]

In sum, there is limited long-term evidence from natural experiments or interventions on the effectiveness of labeling alone in reducing smoking, perhaps because different population approaches to reducing smoking (eg, education, labeling, taxation) have often been adopted in combination. However, the evidence indicates that warning labels are effective at increasing awareness of health risks, countering attractiveness of cigarette advertisements and packages, and reducing amounts of smoking (Table 4). Awareness of warning labels is also linked to intentions and readiness for cessation, although the directionality of this latter association has not been established.

Taxation, Subsidies, and Other Economic Incentives

There is considerable interest in potential economic approaches to improve diet, physical activity, and tobacco-related behaviors.[145–148]

Food Pricing: Direct Taxes or Subsidies—Conventional wisdom often holds that healthier foods are more expensive than less healthy foods, supported by analyses of costs on a per-calorie basis.[149,150] However, less healthful foods often contain more calories and are more energy-dense than some healthful foods such as fruits or vegetables, leading to somewhat circular conclusions on a per-calorie basis. Some investigations based on types of foods and overall eating plans rather than costs per calorie also support higher average prices for healthier foods.[151,152] Conversely, several other investigations have not found consistent price differences between more versus less healthy foods.[153–156] Additionally, research evaluating a variety of predictors suggests that prices of similar foods vary substantially due to other factors, in particular, the type of store in which they are sold.[157–159] Prices also vary substantially by whether food is from a supermarket or preprepared, with less healthy foods from fast-food outlets costing more, even on a per-calorie basis, than healthy foods from local supermarkets.[160] Perceptions are also relevant. In a study among adults of lower socioeconomic status, perceptions of lower availability and higher price of healthier foods, rather than actual availability or price, were associated with fewer healthful food purchases.[161]

Given these considerations, there has been growing interest in the potential role of taxes or subsidies to decrease intake of less healthy foods/beverages or increase intake of healthier foods/beverages. As described below, pricing policy has been central to tobacco control. In the United States, taxes on less healthy foods or beverages already exist: 17 states have

specific taxes on soft drinks and syrups, fruit drinks, candy, and/or gum.[162] The primary goals of these taxes were to generate state income, often traced to War Revenue Acts during World War I, rather than to improve health. Amounts have been generally small, ranging from pennies per gallon of soft drinks to several percentage points in sales taxes. Nonetheless, total annual revenue from such taxes can be high, for example, up to $200 million per year in Texas.[162] Effects of these taxes on consumption have not been systematically assessed.

Economists have evaluated how price influences choices (price elasticity) in the food sector for decades, often to assist producers or consumers rather than because of health considerations.[163] Ideally, full demand systems should be used for such analyses, which evaluate not only the effects of a price change on consumption of the corresponding food/beverage but also the effects on all other categories of foods/beverages.[164] For instance, a single price change could affect consumption of the food or beverage itself (eg, coffee), its complements (eg, cream or sugar), and its substitutes (eg, tea).[163,165] Unfortunately, such full-demand evaluation has been infrequently done for dietary factors.

A systematic review of 160 studies assessed the observational relations of food prices with demand and consumption behavior in major food categories in the United States. Consumption of foods eaten away from home, soft drinks, juice, and meats had the strongest associations with price differences across regions (r=±0.7–0.8).[166] All of these were cross-sectional studies, and only a few examined both direct and cross-price elasticity or effects on total energy intake.

Reviews of cross-sectional analyses have concluded that small taxes would minimally alter consumption of less healthy foods or beverages or related risk factors.[31] For example, 1 simulation approach estimated that at lower tax rates (eg, 1 cent per kilogram or 1% of value), the effects of ad valorem taxes on salty snack foods would have small effects on sales.[167] Conversely, the authors calculated that such taxes would generate up to $100 million in annual tax revenues that could be used for prevention programs. Larger price increases appear to be more effective at altering consumption. On the basis of data from the systematic review described above, the authors estimated that a 10% increase in the price of sugar-sweetened beverages would decrease consumption by 8% to 10%.[166] Similarly, on the basis of longitudinal analyses evaluating price increases and decreases and dietary changes in a cohort of young adults >20 years of age, an 18% tax on sugar-sweetened beverages (the amount proposed in New York City) was estimated to significantly lower consumption and result in 0.99 kg less weight gained each year.[168] Consistent with these observational studies, in a multiphase interventional study in a hospital cafeteria, a 35% price increase for sugar-sweetened beverages reduced sales by 26% compared with both baseline and a comparison cafeteria.[169]

To translate into health improvements, such reductions in consumption must not be replaced, at least not fully, with other price-constant similar foods or beverages. In a cross-sectional analysis among adolescents, the price of a fast-food meal was linked to both eating habits and adiposity: a 10% greater price for a fast-food meal was associated with a 3% higher probability of fruit and vegetable consumption, a 0.4 lower BMI, and a 5.9% lower probability of being overweight.[170] In a longitudinal study among young adults, price increases and decreases and multiple cross-elasticities and their substitutions were evaluated over 20 years of follow-up.[168] Increases in prices of sugar-sweetened beverages and foods consumed away from home were associated not only with decreases in consumption but also lower total energy intake, body weight, and insulin resistance. On the basis of this analysis, an 18% tax on sugar-sweetened beverages, as proposed by New York state, would be estimated to produce an average annual relative weight loss of 0.99 kg over 20 years. These

findings suggest that price-related reductions in consumption of higher taxed items were not fully compensated for by increased consumption of other similar beverages or foods.

In addition to taxation of foods to decrease consumption, there is interest in lowering prices of more healthful foods to increase consumption. In observational analyses, lower prices of fruits and vegetables were associated with greater intake of these foods,[171] as well as with lower BMI,[170,172] including in prospective studies.[173] One analysis estimated that a 10% price subsidy would encourage low-income US consumers to increase their intake of both fruits and vegetables by ≈2% to 5%, at a cost of about $310 million for fruits and $270 million for vegetables.[174] On the basis of food consumption data and demand elasticity in the United Kingdom, the combination of taxing less healthy foods and using this revenue to subsidize the price of fruits and vegetables was estimated to sufficiently alter consumption to prevent >6000 deaths from CVD and cancer annually.[175]

Several interventional studies have evaluated whether lowering the prices of healthier food options increases their consumption by consumers. In a small quasi-experimental study in a worksite cafeteria, compared with environmental changes (adding healthy options, food labels), the further addition of small pricing incentives and nutrition education did not further alter food purchases.[112] Another quasi-experimental worksite cafeteria intervention demonstrated that more substantial subsidies on healthier foods and dishes, which lowered prices by 20%, led to significant increases in purchases of these foods while decreasing purchases of unsubsidized, less healthy foods.[176] A controlled trial evaluated the effects of larger price subsidies on food sales from vending machines in 24 secondary schools and worksites in Minnesota.[111] In randomized 4-week intervention periods, price reductions of 10%, 25%, and 50% on low-fat snacks were associated with significant increases in sales of these products of 9%, 39%, and 93%, respectively. Promotional signage alone to recommend low-fat options had relatively small effects on sales. An 18-month controlled trial in metropolitan vending machines demonstrated that the combination of lower relative prices (a reduction of ≈31%) and increased relative availability (≈55%) of healthier foods more than doubled their sales.[177] In another intervention, a 50% reduction in the price of fresh fruit and baby carrots in secondary school cafeterias produced a 4-fold and 2-fold increase in the sales of these foods, respectively, compared with the usual prices.[178] In a controlled trial among 602 postpartum women enrolled in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC), women assigned to intervention groups received a subsidy ($10 per week in farmers' market or supermarket food vouchers) to purchase fruits and vegetables; women in the control group received a similar voucher for diapers.[179] The subsidy was given for 6 months, after which participants were monitored for another 6 months to evaluate sustainability. At 6 months, consumption of fruits and vegetables was significantly higher in both intervention groups versus controls (overall, 7.8 versus 4.8 servings per day, $P<0.001$). Six additional months after the intervention, this increase was sustained (7.5 versus 4.9 servings per day, $P<0.001$).

Interestingly, at least 2 of these interventions suggested that the effects of food subsidies might be sustained, at least weeks to months, after subsidies were removed.[176,179] This suggests that changes in preferences for healthy foods, once established, may be at least partly sustainable.

In addition to observational studies and shorter-term interventions, national interventions and natural experiments suggest that changes in food pricing can substantially alter risk of clinical events over relatively short time periods. For example, several Eastern European countries experienced dramatically divergent increases or decreases in cardiovascular mortality in the years after the fall of the Soviet Union.[180] The best predictor of these changes was the degree of increased consumption of vegetable oils, in particular, those

containing plant-derived omega-3 fats, in place of animal fats. These differences in consumption were related to differences between countries in changes in subsidies and pricing of fats and oils.[180] As described above, coordinated changes in agricultural, subsidy, and taxation policies in Finland led to decreased consumption of animal fats and increased consumption of vegetable oils and berries, with substantial and sustained reductions in population CVD risk factors and incidence.[59,60]

External factors can influence price elasticities of dietary choices. For example, economic downturns or other pressures might impact purchasing behavior to make consumers more sensitive to price differences or, alternatively, to make less expensive, processed, calorie-dense foods more appealing to some consumers. Changes in social and cultural norms, for example, through education, are also important to maximize the long-term impact of price changes on consumer behavior.[181]

In sum, the evidence indicates that changes in prices of certain foods and beverages alter their consumption, with additional supportive evidence from observational studies and natural experiments for corresponding changes in diet-related risk factors and clinical events (Table 5). In some, but not all, studies, vulnerable populations, such as youth and people of lower socioeconomic status, appear most sensitive to prices. The effects are proportional to price differences, with relatively larger changes being linked to more meaningful differences in consumption. In addition to the health impact of taxation resulting from decreased consumption of less healthy foods and beverages, the additional health impact of the revenue for funding prevention programs and/or subsidizing increased consumption of healthier foods must also be considered.

Agricultural Policy—A great deal of research over the past century has focused on US and European agricultural policy.[148] Several foods traditionally supported by agricultural policy, such as wheat, corn, dairy, and beef, are typically more energy-dense and less nutrient-dense, served in larger portion sizes, and, in some cases, less expensive on a per-calorie basis than foods less supported by agricultural policy such as fresh fruits and vegetables, whole grains, nuts, and fish.[148,182,183] Many subsidized crops have also historically been diverted for use as inexpensive feed for meat production. Soy has also been subsidized; vegetable oils in moderation are, of course, healthy.[8]

Some scholars have concluded that simply removing agricultural subsidies from foods or commodities would significantly shift prices and limit their presence in the food supply.[182] This work has generally been based on analyses of current pricing and recent price trends, together with observed links between limited social and economic resources and disparities in access to healthier foods without consideration of the complex history of agricultural subsidies and the current types of subsidies and groups who benefit from the current subsidies.

Several economists have explored the role of agricultural policy in the price, availability, and portion sizes of foods.[148,184–187] In general, analyses focusing on recent US policy have concluded that over the past 2 decades, agricultural subsidies alone have not distorted the relative costs of fruits and vegetables and other foods relative to animal products, sugars, and edible oils.[184–187] Rather, a major effect of these agricultural subsidies is income transfer to farmers. According to the Organization for Economic Cooperation and Development, 29% of income of farmers in Western countries comes from government subsidies, trade interventions, or direct income transfers.[188] These analyses suggest that simple removal of current subsidies from unhealthier commodities would not have any major impact on food prices at least over several years.

In contrast to these relatively focused effects of subsidies, an array of other long-term US agricultural and related policies and investments over the last century have created an entire framework of production, distribution, marketing, and demand that facilitates lower cost of less healthful, processed foods relative to healthful foods such as fruits, vegetables, nuts, and legumes.[148,185–187,189,190] Examples of such investments include grain elevators, marketing assistance, favorable tax policies, and credit and commodity programs. Adjusted to 1992 dollars, total US public investment in agriculture rose from $500 billion in 1940 to $2.5 trillion in 1990, with very little of this spent on direct agricultural subsidies.[189]

These historical trends suggest that comprehensive and sustained changes in multicomponent agricultural policies have a large impact. This is supported by experiences in Finland, in which the national extension of a community-based media and education campaign to improve diet was accompanied by modifications of several existing agricultural, subsidy, and taxation laws over time to support the production of healthier foods.[60] For instance, taxation policies that favored dairy products and subsidies that supported butter (eg, direct subsidies to bakeries) and dairy fat were modified to support mixed vegetable oil and light spreads and greater production of lean meats and protein. Also, the national Berry and Vegetable Project was developed to increase the feasibility of growing local berries.[59] The Ministries of Agriculture and Commerce financed a major collaborative project including berry farmers, industry, various commercial sectors, and health authorities. In addition to media and education to increase consumption, this project supported sales campaigns, the development of new berry products, and related relevant activities. Over the period of the Project, many Finnish farmers switched from dairy to berry production, and berry production and consumption rose nationally from initially very low levels. These changes in the food supply, together with related media and education campaigns, were associated with substantial reductions in population CVD risk factors and rates of CVD events.[59,60] Additional government budget policies were developed in the 2000s to support domestic vegetable consumption and other health-related food innovations[60]; the specific impact of these new policies has not yet been reported.

In sum, the present evidence suggests that changes in current US agricultural subsidies alone will produce marginal changes in food availability, prices, or population dietary habits (Table 5). In contrast, experience over the last century suggests that sustained efforts over several decades, which alter both agricultural and other related policies to create an infrastructure that facilitates production, transportation, and marketing of healthier foods, would have greater long-term impact.

Financial Incentives or Disincentives to Reduce Adiposity—There is growing interest in direct incentives for overweight or obese people to reduce their body weight, for example, by directly taxing BMI or by providing rewards for weight loss. Although this is being done increasingly in a range of industry insurance and wellness programs (“Workplace-Based Economic Incentives for Employees” section), it has not been implemented in any free-living population outside of such programs. Until such strategies are developed and tested outside the workplace, the impact of such approaches remains undetermined (Table 5).

Financial Incentives to Influence Locations of Supermarkets or Grocery Stores—The evidence for the influence of the local food environment, including locations and availability of different types of stores and restaurants, on dietary habits and related risk factors is reviewed in the section “Local Environmental Change for Diet (Community Settings).”

Economic Incentives/Subsidies to Promote Physical Activity—In modern societies, there is often a real or perceived time cost to performing physical activity.[191] Because people must perceive value to create this time, it is possible that economic incentives could be used to help promote physical activity and recreation.

Incentives to purchase exercise equipment, for example, have been proposed as a means to increase physical activity.[192] However, there are no data to determine if tax incentives for purchase of this equipment have a behavioral or health impact.[193,194] The price of gasoline has also been proposed as a key factor that could influence individuals' transportation choices, including modes of transit such as walking and biking. Gasoline consumption is responsive to price changes,[195–197] and thus increasing gas price could theoretically reduce driving and possibly increase modes of active commuting.[198–200] One cross-sectional observational analysis in Europe found a significant inverse association between gasoline price and prevalence of obesity.[201] Another analysis evaluated pooled data from the Behavioral Risk Factor Surveillance System (BRFSS) surveys from 1990 to 2001 to assess the cross-sectional relations between gasoline prices, urban sprawl, and bicycling.[202] Each US $1 increase in gasoline price was associated with absolute increases of 0.4% (from 4.3% to 4.7%) and 0.6% (from 2.9% to 3.5%) in prevalence of bicycling among men and women, respectively.[202] A longitudinal study using clinic-based US data from 1992 to 2001 found that increases in inflation-adjusted gasoline price were associated with increased total physical activity, roughly equivalent to 20 minutes of additional walking per week for each 25-cent increase per gallon.[203] Similarly, a recent study using US surveillance data from 1979 to 2004 found that each additional $1 in gas prices was associated with additional walking.[204]

In sum, some evidence suggests that changes in gasoline prices could influence physical activity, but more research is needed due to the limited number of studies and their typically cross-sectional designs (Table 5). Otherwise, relatively little evidence exists to evaluate the effectiveness of tax incentives or subsidies to promote physical activity or minimize sedentary behaviors. Evidence for economic incentives for physical activity in the workplace setting is reviewed elsewhere ("Workplace Economic Incentives for Individuals" section).

Taxes to Reduce Tobacco Use—In the United States, the cigarette tax increased by 62 cents to a total of $1.01 per pack on April 1, 2009.[205] Federal tax rates also increased on other tobacco products such as smokeless products, roll-your-own tobacco, and cigars. Many states also impose tobacco excise taxes, with a current nationwide average of $1.45 per pack as of July 2010. New York state raised its cigarette tax by $1.60 in June 2010, giving it the highest US rate at $4.35 per pack. Tax rates are much lower in most developing countries. In 2006, the average price per pack was $4.30 in high-income, $1.50 in middle-income, and $1.10 or less in lower middle– and low-income countries.[206]

Global trends in cigarette affordability (price relative to per capita income) were investigated in 70 countries (28 high-income developed countries and 42 developing countries) between 1990 and 2001.[207] Cigarettes were more expensive but also relatively more affordable in developed countries, due to the higher per capita income. An update of this analysis in 77 countries through 2006 found that in high-income countries, cigarettes became less affordable beginning in 1990, whereas among low-income and middle-income countries, cigarettes became more affordable, with an increasingly rapid rate since 2000.[206] For example, affordability of cigarettes increased greatly in the Philippines, Mexico, Vietnam, China, and Russia. In 33 of 34 countries in which cigarette affordability decreased, real price increased. In 20 of 37 countries in which affordability increased, real price decreased.

A robust literature has examined the impact of increases in cigarette tax on prevalence of smoking, especially in youth. The majority of studies have found that higher taxes reduce consumption, including reducing the prevalence of active smoking and increasing cessation rates, especially in young smokers.[208–210] When affordability elasticities of demand were evaluated in 70 countries between 1990 and 2001, each 1% increase in the relative income price (the inverse of cigarette affordability) was estimated to decrease cigarette consumption by between 0.49% and 0.57%.[207] In the United States, modeling techniques have estimated that a 40% increase in cigarette prices due to taxes would reduce smoking prevalence from 21% in 2004 to 15.2% in 2025, producing large gains in cumulative life-years (7 million) and quality-adjusted life-years (13 million) and a total cost savings of $682 billion.[211]

In sum, there is strong evidence that higher tobacco taxes reduce consumption, both overall and in particular among youth (Table 5). Industry documents demonstrate that tobacco companies understand the impact of tax increases on consumption and have developed pricing strategies that could partly counter these effects, such as development of lower-cost generics and price-related marketing efforts such as multipack discounts and couponing.[212] For maximum impact, tobacco tax policies will need to adapt to these industry strategies.

Workplace Economic Incentives for Individuals—In March 2010, the Patient Protection and Affordable Care Act codified an existing statute that allows employers to charge employees a differential health insurance premium based on meeting certain health status factors such as BMI, tobacco use, or physical fitness or activity levels within the context of a worksite wellness program.[213] The maximum differential was increased from 20% to 30%, with discretion for the Secretaries of Health and Human Services and Treasury to increase the differential to 50% if deemed appropriate. Consequently, employers can charge deductibles that are up to 30% higher for employees who are obese or who use tobacco, whereas nonobese employees, nonsmokers, or those who are physically fit can pay lower deductibles. This could translate to increased annual health insurance expenditures of $965 to $2412 for individuals and $2675 to $6688 for families for those not meeting these health metrics.[214] A recent survey indicated that because of rising healthcare costs and the new allowance under the federal law, 62% of employers plan on switching from incentives for participation to incentives for improvements in health metrics, shifting costs from healthy employees to their less healthy counterparts.[215] The premise is that these financial incentives/disincentives will motivate employees to take personal responsibility for their own health and improve their behaviors and health status over the short and long term.

Experiments testing financial incentives to improve health behaviors have generally been individual- randomized trials rather than population-level interventions, for example, at the workplace or community level. These studies demonstrate that financial incentives can improve health behaviors in the short term, especially when financial incentives are larger.[216–219] Examples of incentives in these studies included compensation ranging from $100 to $400 for completion of smoking cessation programs with biochemical verification of quitting or incentives for weight loss ranging from $7 to $14 for each percentage point of weight lost. Generally, incentives led to greater participation and completion rates, successful cessation in smoking cessation programs at 3 months, and greater weight loss ranging from 0.9 to 2.25 kg at 3 months. However, these differences generally did not persist at longer follow-up (eg, 6 months) after completion of the incentive programs.

One review identified 9 individual-level RCTs with a follow-up of at least 1 year that used traditional pay-for-performance incentives for weight loss among overweight or obese adults.[220] Intervention durations were typically from 8 to 16 weeks, although in some trials the interventions lasted throughout follow-up. A pooled analysis found no significant effect of use of financial incentives on weight loss or maintenance at 12, 18, or 30 months.

Secondary analyses suggested that effects might be greater when incentives were larger (eg, >1.2% of personal disposable income), when rewards were given for behavior change rather than for weight change, and when rewards were based on group performance rather than for individual performance, but none of these differences were statistically significant. Another review identified 14 studies that tested workplace interventions including incentives or competitions to reduce tobacco use.[221] In pooled analysis, a significant reduction in self-reported tobacco cessation was seen. However, because nearly all interventions were multicomponent, the specific contribution of the incentives alone could not be evaluated. Additionally, because rewards are generally short term, long-term sustainability is not established.[222]

A review of economic incentives relating to a larger spectrum of preventive behaviors, including for example, seat belt use, examined 111 individual-level RCTs and included 47 studies published from 1966 to 2002 that met the authors' criteria.[223] The researchers found that economic incentives worked much (73%) of the time, especially for short-term and simple preventive care with distinct and well-defined behavioral outcomes, such as immunizations and health screenings, but worked less well for more complex and long-term changes related to diet or weight loss.[223] These studies did not provide sufficient data to determine the size of the incentive required to maintain a sustained effect, due to the wide range of incentives offered, including coupons, free bus tokens, cash prizes, promotional items, merchandise, and free day care. Also, some of the incentives were confounded with additional lottery or competition intervention components, and many of these studies were limited by small numbers of participants, cross-sectional designs, and/or very modest awards.[224]

In sum, individual financial incentives appear to produce improvements in health behaviors, but gains are lost when the incentives are no longer offered (Table 5). The potential long-term effects of sustained incentive/disincentive systems, such as related to health insurance premiums or deductibles, need to be further assessed. The CDC will release a report by 2013 based on employer data that will analyze the effectiveness of premium-based and cost-sharing incentives in changing health behavior and the effectiveness of different types of rewards on the impact of incentives within employer-based worksite wellness programs. Sparse data are available on the effectiveness of other workplace-based incentives for improving physical activity, although many such programs exist, for example, subsidizing gym memberships or annual purchases of fitness equipment. These findings imply a need for further research on long-term incentive programs and policies for sustained behavior changes.

Workplace Economic Incentives for Businesses—Economic incentives can also be provided to businesses to promote healthful behaviors. For example, the Patient Protection and Affordable Care Act authorizes a grant program to small businesses to provide worksite wellness programs. This grant program has not been fully implemented, and thus its effectiveness cannot be evaluated. Other proposed legislation has included tax incentives to businesses for offering robust worksite wellness programming. Until these programs are implemented or legislation regarding tax incentives passes, insufficient data exist to evaluate the impact of these types of incentives on wellness programming or health behaviors (Table 5).

School and Workplace Approaches

School-Based Approaches to Improve Both Diet and Physical Activity—Many school-based approaches have been tested that target both dietary and physical activity habits in a combined intervention (Supplementary Table 6).[36,225–228] In such studies, the

primary outcome is typically adiposity as measured by an age- and sex-appropriate BMI (BMI *z* score), rather than changes in diet or physical activity in themselves that would have independent health benefits.

One systematic review identified 20 such RCTs with interventions of at least 12 weeks' duration, conducted in ages ranging from kindergarten through high school.[225] Overall, about half (9 of 20) studies demonstrated significant improvements in BMI *z* score following a school-based program targeting both dietary and physical activity behaviors. A WHO review of 55 intervention studies, mostly from North America, concluded that multicomponent school-based interventions can effectively improve knowledge and attitudes about diet and physical activity, diet and physical activity behaviors, and related clinical outcomes.[36] On the basis of this review, specific components of such interventions with evidence for effectiveness included (1) curriculum on diet and/or physical activity taught by trained teachers, (2) supportive school environment and policies, (3) a parental or family component, (4) a formal physical activity program (for interventions targeting physical activity), and (5) serving of healthy food options in school cafeterias and vending machines. More recent trials, including 3- to 4-year interventions from Europe and China, generally support these conclusions, although sometimes only in certain subgroups or for certain outcomes.[227–231]

In sum, the evidence supports the effectiveness of such comprehensive multicomponent school-based interventions that target both diet and physical activity (Table 6). Emerging literature suggests that the effectiveness of such interventions may be further augmented by additional intensive community involvement based on the principles of community-based participatory research.[232]

School-Based Approaches to Improve Diet—Several studies have evaluated various school-based strategies to improve diet (Supplementary Table 6).[225,233] Outcomes have included knowledge and attitudes toward and consumption of specific foods, such as fruits and vegetables and sugar-sweetened beverages, and related risk factors such as high BMI. Multicomponent interventions targeting both diet and physical activity are described above.

One strategy that has been tested is garden-based education programs. Effects have been evaluated in at least 10 controlled trials and quasi-experimental studies in schools, with an additional 3 studies evaluating community-based garden programs for children.[233–235] The latter programs typically included weekly 1-hour nutrition and gardening classes, plus hands-on time in the garden several times per month. Overall, the garden-based programs significantly increased preferences for fruits and vegetables in 4 of 8 studies, willingness to try new fruits and vegetables in 4 of 5 studies, and levels of consumption of fruits and vegetables in 4 of 5 studies.[233–235]

Two studies evaluated the effects of a fresh fruit and vegetable program, in which intervention schools received free fresh fruits and vegetables for snacks during the school day.[237,239] Greater familiarity with and preferences for fruits and vegetables were demonstrated in at least some age groups in 1 study,[239] and both studies demonstrated significant increases in fruit consumption. In 1 trial, the proportion of students eating fruit or drinking 100% fruit juice at least once a day was significantly increased in the intervention versus control schools (59% versus 41%); the proportion eating fruit or drinking 100% fruit juice at least twice a day was also increased (39% versus 27%).[237] In the other study, average fruit consumption increased by 0.34 servings per day; interestingly, fruit consumption outside of school also increased by an additional 0.27 servings per day.[239] Vegetable consumption did not increase in either intervention, which in 1 study was attributed by the authors to the fewer choices of vegetables offered to students (carrots and

celery) versus fruits (apples, oranges, pears, plums, pineapple, and kiwi), but that could also be related to taste preferences.

Two trials using school-based nutrition education alone without any additional components demonstrated improvements in knowledge, preferences, and attitudes toward consumption of fruits and vegetables, but findings were mixed for changes in actual consumption.[234,240] In a systematic review of school-based randomized policy interventions to reduce adiposity, 2 of 3 trials evaluating dietary policies demonstrated stabilization of BMI *z* score or overweight/obesity in the intervention groups compared with continued increases in these measures in controls.[225] The 2 successful trials used low-intensity policy interventions focused on (1) reducing intake of sugar-sweetened beverages and (2) increasing regular consumption of breakfast. The third trial used a board game to improve nutrition knowledge, failing to show any effects on adiposity. Another cluster-randomized trial in 10 US schools evaluated a comprehensive educational initiative that included school self-assessment, nutrition education, nutrition policy, social marketing, and parent outreach.[238] After 2 years, the intervention lowered the incidence of overweight by 50% (7.5% versus 14.9%).

Several intervention studies have evaluated the effects of providing cold filtered water at school. One RCT demonstrated that installation of school water fountains and provision of plastic water bottles, together with education and goal-setting components, increased water consumption by 1.1 glasses per day and also reduced the odds of overweight by 31% in German elementary school children at 1 year.[241] Two small, nonrandomized pilot studies showed that similar interventions increased water intake by students but did not reduce intake of other beverages such as soda, sports drinks, or juice[242,243]; changes in weight were not assessed in these short-term (<3 months) studies.

Several cross-sectional observational studies have evaluated how school vending machines relate to dietary habits (Supplementary Table 7). Factors predicting greater use of school vending machines included either very high or low parental limits on intake of sugar-sweetened beverages at home[244] and the absence of school restrictions on times of use of vending machines.[245] The presence of beverage vending machines at school was associated with a nearly 3-fold higher likelihood of students consuming snacks or beverages or both in place of lunch and a greater likelihood of their choosing less healthy options, even though many healthy foods and beverages were available.[246] Students who frequently used school vending machines (≥3 times per week) were 3 times more likely to buy sugar-sweetened beverages and candy more than once daily.[245] The writing group did not identify any RCTs that tested the effects of changes in school vending machines (availability, restrictions, prices, or types of foods) on dietary habits or related risk factors in children. One trial evaluated the effects of labeling low-fat choices in vending machines in teachers' lounges,[109] and another evaluated the effects of increasing the proportions of lower saturated fat, nonconfectionery choices in vending machines in hospitals.[247] Labeling demonstrated generally small to no effects on purchasing, whereas altering the types of foods available in the machines correspondingly altered the proportions of those types of foods sold.

In sum, several school-based approaches appear to be effective for improving diet, including garden-based education programs, fresh fruit and vegetable programs, environmental changes or standards that increase healthy food options in cafeterias and vending machines, and comprehensive multicomponent interventions focused on both diet and physical activity (Table 6). There is currently less robust evidence for other approaches, such as school-based education alone, restrictions on accessibility of school vending machines, or promotion of use of water.

School-Based Approaches to Improve Physical Activity—Improving physical activity has been a major focus of many school-based studies (Supplementary Table 6). In a prospective observational analysis among US children monitored from first to fifth grade, meeting the recommended time for recess was associated with lower BMI *z* scores, and meeting the recommended time for physical education (PE) was associated with lower BMI *z* scores in boys but not girls.[248] Potential strategies to foster physical activity have included increased availability and types of playground equipment; adding regularly scheduled classroom activity breaks during academic lessons; increasing time and intensity in and using trained teachers for PE classes or, for younger children, in recess and play time; or increasing active commuting to school. Multicomponent strategies that target both diet and physical activity are discussed in the section "School-Based Approaches to Improve Both Diet and Physical Activity."

In cross-sectional observational studies, the availability and types of school playground equipment were associated with extent and types of physical activity behaviors. In 1 analysis, when compared with schools not having these factors, greater moderate daily physical activity was seen in schools with fixed playground equipment, such as slides or monkey bars, and visible playground markings, and greater vigorous physical activity was seen in schools with loose equipment (eg, balls, bats) and playground supervision.[249] A second study found that the number of different permanent play facilities at schools (swings, courts, sandpits, monkey bars, slides, etc) was positively associated with physical activity assessed by accelerometers.[250] For each additional play facility (range, 14 to 35), average accelerometer counts were 3.8% higher at school ($P<0.001$) and 2.7% higher overall ($P<0.001$), and time spent in vigorous physical activity was 9 minutes (3.4%) higher each day. The presence of each additional 5 play facilities was associated with 15% to 20% higher overall activity levels in children. Consistent with these observational studies, a controlled intervention among 26 elementary schools in the United Kingdom demonstrated that the addition of playground markings, sports and playground equipment, and greater supervision increased vigorous physical activity during recess.[251]

Four intervention studies have assessed the potential effectiveness of classroom activity breaks—short physical activity breaks throughout the day during academic lessons.[252–255] In 3 studies assessing changes in physical activity over intervention periods of 12 weeks to 3 years, students in the intervention classrooms increased their physical activity during school, whether assessed by questionnaire, pedometer, or accelerometer.[253–255] A fourth 1-year study found improvements in objectively assessed strength but not in flexibility or cardiorespiratory fitness.[256] Three of these studies assessed change in BMI: 1 study found reduced BMI in girls but not boys,[254] 1 study found no significant difference in intervention versus control schools,[255] and another found significantly increased BMI in the intervention group.[256] Differences in adiposity versus lean muscle mass were not assessed in these studies. Classroom breaks have also been used as part of successful multicomponent school-based interventions targeting physical activity.[227,257,258]

A large number of studies have focused on improving PE in schools, typically by updating PE curricula, adding more PE classes, and training teachers, and often with additional educational or home-based components (Supplementary Table 6).[225,257,259–261] In controlled trials, such multicomponent interventions often increase the amount and/or intensity of physical activity during school hours. Findings have been more mixed for objectively measured total physical activity, fitness, and inactivity-related risk factors. A systematic review by Harris et al found that only 5 of 18 school-based physical activity interventions used objective measures of physical activity.[259] Three studies using the SOFIT (System for Observing Fitness Instruction Time) instrument found more physical activity in the intervention group; 2 studies using accelerometers found no differences in physical

activity between intervention and control groups. Another more recent 1-year multicomponent school-based physical activity intervention found improvements in accelerometer-assessed moderate to vigorous physical activity as well as in body composition.[257]

Among activity-related risk factors, adiposity has been evaluated most frequently in school-based physical activity interventions. In a recent systematic review, only 5 of 15 controlled trials showed improvements in BMI.[225] Across individual studies, effects tended to be stronger in girls than in boys and during the first several months of the intervention (eg, up to 6 months), with declining success thereafter. For example, in 1 trial, an additional 2 hours per week of usual PE class reduced BMI *z* score at 6 months, but this improvement was not sustained over longer periods. In these trials, the overall duration of the intervention phase (ranging from 12 weeks to 1 school year) did not appear to be related to success. Another systematic review and meta-analysis found no significant pooled effect on BMI of 18 school-based physical activity trials including a total of >18,000 children and with durations ranging from 6 months to 3 years.[259] Because BMI could be an imperfect end point for physical activity interventions due to changes in lean muscle mass, many of these trials also evaluated other body composition metrics, including waist circumference, waist-to-hip ratio, triceps skin-fold thickness, subscapular skin-fold thickness, percentage of body fat, total lean mass, total fat mass, and skin-fold sum. In 10 trials, only 3 of 18 measures demonstrated significant improvements after the physical activity intervention, 1 measure demonstrated deterioration, and 14 measures did not show any significant change.[259] More recent multicomponent school-based PE/physical activity interventions in Europe demonstrated improvements over 1 academic year in aerobic fitness, skin-fold thickness, and/or BMI *z* score overall or in certain subgroups.[257,261]

Overall, the findings for school-based physical activity programs are mixed, with promising results for physical activity but generally a null finding for adiposity (Table 6). Several but not all school-based interventions that focused on improving PE curriculum, often in combination with other school or home-based physical activity components, showed improvements in objectively measured school-based and total physical activity. Conversely, the majority of these trials found no evidence for reductions in adiposity, including no effects in overall pooled analyses. The writing group's review of the different approaches, populations, and outcomes in these various school-based physical activity interventions did not provide any clear explanation for the heterogeneous effects on adiposity or other metabolic outcomes. Many of these trials tested multiple components in combination (eg, restructuring PE curricula, increasing number of classes or time spent in PE or recess, adding trained PE teachers, use of novel activities such as dance classes), limiting the ability to draw conclusions about the relative effectiveness of any one of these specific components. Additional ongoing cluster RCTs will provide important additional evidence on the efficacy of overall school-based programs to improve physical activity and reduce adiposity.[262,263]

In addition to targeting activity during school, there is interest in increasing physical activity during commuting to school. In cross-sectional observational analyses, as compared with passive commuters (eg, bus, car), children who actively commute (eg, walking, bicycling) have higher total physical activity levels, although not lower BMI/adiposity.[264] Only 2 studies, both nonrandomized interventions, were identified that evaluated specific approaches to increase active commuting. These each evaluated "walking school bus" programs, in which children walked to school with set stops along the way, accompanied by walking adult chaperones.[265,266] In both studies, compared with control schools, the program increased the proportion of children who reported that they were walking to school. For instance, after 2 years in 1 trial, 36% of children in the intervention reported active

(walking or bicycling) commuting on at least 50% of school days versus 26% of controls.[265] In a subset of children who received objective physical activity measurements, these proportions were 71% and 25%, respectively. However, although active commuting was increased, there were no significant differences in BMI or percentage of body fat between groups, even after 2 years. This raises the possibility that increased commuting activity could be partly offset by unrecognized decreases in activity elsewhere or that statistical power or intervention intensity were insufficient. Children who were frequent walkers had a significantly lower BMI (−0.77 kg/m^2) and percentage of body fat (−4.0%)[265]; such observational, non–intention-to-treat analyses should be interpreted cautiously. Thus, walking school bus programs appear potentially promising but, given the limited number of studies, require further investigation to confirm the effects on total physical activity and inactivity-related risk factors.

In sum, effective school-based approaches to improve physical activity include increasing the availability and types of playground spaces and equipment and instituting comprehensive multicomponent interventions focused on both diet and physical activity (Table 6). Interventions focused on PE alone also increase physical activity but with inconsistent effects on adiposity. Regular classroom activity breaks also appear to increase activity, but relatively few studies have evaluated this approach. Strategies to increase activity by commuting, such as walking school bus programs, appear promising but require further investigation.

School-Based Approaches to Reduce Tobacco Use—School-based population strategies to reduce tobacco use among children include reducing the density of tobacco advertising and retail outlets around schools; restrictions on school campuses, including colleges and universities, and increased enforcement of anti-tobacco restrictions around schools. The evidence for altering the density of retail outlets is discussed in the section “Local Environmental Change”; the evidence for smoking restrictions on campus and increased enforcement of existing restrictions is discussed in “Restrictions and Mandates.”

Workplace-Based Approaches to Improve Diet—Several systematic reviews[121,267,268] evaluated controlled trials of workplace interventions to improve diet, physical activity, and other health indicators (Supplementary Table 8). Among these, many tested measures to improve diet, generally either based on food labeling or expanding availability of healthier options in cafeterias and vending machines (findings from these and similar, more recent studies are described in “Labeling and Consumer Information”). Overall, these studies suggested that use of worksite cafeteria or vending machine labels or icons alone had little effect on improving diet, consistent with findings for labeling and consumer information approaches in other settings (Table 4). In contrast, the combination of such labeling or other prompts together with additional environmental changes, such as types and locations of foods and beverages served, positively affected purchasing behaviors at worksites. Such worksite dietary and/or physical activity interventions also demonstrated improvements in adiposity measures,[267,268] eg, pooled reductions in weight of 1.26 kg (95% confidence interval [CI], −4.6, −1.0) and in BMI of 0.5 kg/m^2 (95% CI, −0.8, −0.2) in 1 meta-analysis. The evidence for effects on other clinical risk factors was mixed.[268]

A WHO report recently reviewed the evidence for religious congregation–based interventions to improve diet.[36] These were generally individual-focused interventions that were housed in religious congregations rather than environmental or population interventions per se. Most were based in black congregations in disadvantaged US communities. The WHO report concluded that the number of such studies was small, but that the evidence was relatively consistent for positive psychosocial, behavioral, and/or risk factor changes. The report concluded that using the existing social structure of a religious

community might facilitate adoption of changes towards a healthy lifestyle, especially in disadvantaged communities.

In sum, the evidence suggests that worksite food or beverage labeling or information alone may not be effective, but that such labeling or other prompts combined with environmental changes in available foods and beverages can improve dietary habits (Table 6). Although these worksite interventions appear promising, their interpretation may be limited by weaknesses in methodology and reporting; eg, outcome measures were often self-reported, randomization processes were not described, or interventions were nonrandomized.[121,268]

Workplace-Based Approaches to Improve Physical Activity—Reviews of controlled trials that predominantly used informational and behavioral approaches to improve diet and physical activity interventions are described above.[121,267,268] Several other studies have focused on the workplace physical environment (Supplementary Table 8).

In an observational study, men more often used stairs in a worksite with visible staircases compared with one with concealed stairs; no differences were seen for women.[269] In 1 natural experiment, the combination of "skip-stop" elevators (stopping at every third floor, requiring employees to take the stairs to other floors) with changes to nearby stairs to make them open and appealing resulted in a 33-fold increased use of stairs compared with a traditional elevator core and fire exit stairs on the other side of the building.[270] Initially, about one third of employees were satisfied with the skip-stop system, one third were neutral, and one third were dissatisfied. Two years later, about half were satisfied, one fourth neutral, and one fourth dissatisfied. The evidence for effects of worksite signs or prompts to encourage stair use is reviewed in the section "Labeling and Information."

There is also interest in worksite fitness centers to improve physical activity. In 1 cross-sectional observational analysis, the presence of exercise facilities, lockers, and exercise programs at the workplace were each associated with greater walking/steps taken per day.[271] In another observational analysis, perceived low quality of exercise facilities at the worksite fitness center was associated with lower likelihood of membership.[272] Consistent with these observational findings, in a randomized intervention, adding a new worksite fitness center or upgrading existing worksite fitness centers was associated with increased physical activity among employees.[121] In contrast, in another controlled trial, adding a worksite walking track did not significantly improve CVD risk factors.[121]

Worksite physical activity may also be increased without fitness centers. In a 1-year intervention that provided 1 hour per week at work for either resistance training or other general activity (largely walking), self-reported physical activity was unchanged, but both interventions improved percent body fat and systolic blood pressure compared with controls.[273] A 10-week worksite intervention that encouraged walking by means of education and weekly email prompts increased walking by ≈1800 steps per day compared with controls.[274]

In sum, the evidence suggests that certain workplace-based interventions can increase physical activity, but the numbers and types of studies that have assessed this topic in a rigorous fashion are relatively limited (Table 6).

Workplace-Based Approaches to Reduce Tobacco Use—See "Direct Restrictions and Mandates."

Workplace-Based Economic Incentives for Employees and Businesses—See "Taxation, Subsidies, and Other Economic Incentives."

Comprehensive Worksite Wellness Programs—The priorities for design of worksite wellness programs were recently reviewed.[146] Such programs should include tobacco cessation and prevention, nutrition education and promotion, regular physical activity, stress management/reduction, early detection and screening programs, weight management, disease management, CVD education, and changes in the worksite environment to encourage healthy behaviors and promote occupational safety and health.[146] Cultural sensitivity and targeting of higher-risk employees are also important. Several quasi-experimental studies and some randomized trials have evaluated the effectiveness of comprehensive worksite wellness programs (Supplementary Table 8).[275–282]

In sum, these studies provide relatively consistent evidence that such programs improve health behaviors and related clinical risk factors (Table 6). Examples of findings include improved diet (increased consumption of fruits and vegetables, reduced consumption of saturated fat and fatty meats), increased daily activity and walking, reduced smoking (14% reduction), reduced systolic blood pressure (≈7 mm Hg reduction) and body fat (9% reduction), and lower estimated global CVD risk (≈13% reduction). Interventions targeting higher-risk employees appear especially effective. However, limitations were noted, including inconsistent methodology across trials, often relatively small sizes (N<400), and short durations of follow-up (typically <6 months, with a few studies having a follow-up of 12 to 18 months). Under the Patient Protection and Affordable Care Act, by 2013 the CDC will release a report based on employer data that will analyze the effectiveness of worksite wellness programs.

Local Environmental Changes (Community Settings)

In addition to school and workplace environments, increasing attention is being devoted to how the local community environment may influence behaviors. The local environment has been variably defined, including as a small area immediate and unique to individuals (eg, based on a maximum linear or travel distance); as a larger area shared by many individuals, typically administrative units; or as a "residential environment" or "neighborhood" without specifying a definitive boundary. In addition to generally improving population behaviors, changes in community or neighborhood environments could also be relevant for reducing disparities, given the often less favorable local environments near homes and schools of disadvantaged subgroups.

Local Environmental Change for Diet (Community Settings)—Research on the local food environment has generally focused on accessibility to food outlets, including supermarkets, grocery stores, convenience stores, fast-food restaurants, and full-service restaurants (Supplementary Table 9). Some studies have also assessed in-store availability of foods and participation in farmers' markets or community gardens.

All identified studies of local accessibility to types of food outlets were observational. Some studies were broadly regional and did not assess neighborhood-specific associations.[283] Most studies typically evaluated 1 or more neighborhood-level characteristics of food outlets, including presence (yes/no), number, density per capita, and distance from home. Analyses typically adjusted for both individual-level and other neighborhood-level characteristics to minimize the potential effects of confounding. Nearly all studies were cross-sectional, with only a few longitudinal analyses.

Four larger cross-sectional studies found that greater accessibility to neighborhood supermarkets (presence, number, or distance) was associated with more healthful dietary habits[284–287]; 1 small cross-sectional study[288] and the only large longitudinal study[289] did not. Seven cross-sectional studies in both adults and children found that greater accessibility to neighborhood supermarkets (presence, number, or distance) was associated with lower

prevalence of adiposity[290–297]; 1 county-level (ecological) study did not.[298] In 2 of these studies,[284,292] relationships were stronger in blacks than in whites. One small longitudinal study (n=353) found no significant relation between neighborhood supermarkets and 3-year risk of overweight/obesity or change in BMI *z* score in young girls.[299]

Fewer studies have evaluated associations for neighborhood grocery stores or convenience stores. Among studies evaluating accessibility to grocery stores, 1 small study found no associations with fruit or vegetable consumption,[288] and 5 of 6 studies, including 1 longitudinal study, found no associations with adiposity.[173,290,292,293, 298,300] In 2 smaller studies, living closer to a neighborhood convenience store was associated with more healthful dietary habits among women[285] but less healthful dietary habits among adolescent boys.[288] Four of 6 studies, including 1 longitudinal study, found that greater accessibility to a neighborhood convenience store was associated with more adiposity or diabetes.[173,290,292,293,298,299] In an analysis in Japan, a greater local density of mixed types of stores (supermarkets, grocery, bakeries, etc) having different types of foods was positively associated with consumption of confectioneries and bread but not meats, fish, fruits and vegetables, or rice.[301]

A few cross-sectional studies have assessed the relation of neighborhood fast-food restaurants to dietary habits, with generally null results.[284,288,302] In 1 longitudinal analysis, the number of neighborhood fast-food restaurants per capita was associated with fast-food consumption only among low-income younger adults.[289] Many more studies have evaluated how accessibility to fast-food restaurants relates to adiposity. Most did not find any significant relation between neighborhood accessibility (number, distance, or density) to fast-food restaurants and prevalence of adiposity in either adults or children.[173,291,293, 294,299,303–305] Exceptions include analyses using the BRFSS, in which higher per capita density of fast-food restaurants was associated with higher BMI and prevalence of obesity[306] or diabetes[298] in adults. In a US study among pregnant women from 3 states, the presence of a fast-food restaurant close to home (within 0.8 km) was associated with greater weight gain,[307] and in a regional Canadian survey, a higher ratio of fast-food restaurants and convenience stores to grocery stores was associated with a higher prevalence of obesity in adults.[308] In Portland, Oregon, adults who lived in neighborhoods with a high density of fast-food restaurants and visited these restaurants regularly (at least once per week) had a higher prevalence of obesity[309] and weight gain over time[310]; the inference for built-environment effects is limited by the latter condition of regular visits. A regional analysis in Canada found that higher per capita density of fast-food restaurants was associated with higher total mortality and admissions for acute coronary syndromes.[311]

A small number of cross-sectional studies in children have evaluated the accessibility of school (rather than home) to fast-food restaurants and adiposity.[307,312] These studies found that the presence of a fast-food restaurant near school (≤0.8 km) was associated with a higher BMI and prevalence of overweight/obesity.

Less is known about the relation of non–fast-food restaurants with diet-related behaviors. Some cross-sectional studies have assessed the relation of neighborhood full-service restaurants with dietary habits, with generally null results.[284,288] In 2 separate cross-sectional analyses using 2006–2007 BRFSS data, a higher per capita density of full-service restaurants was associated with a lower BMI and lower prevalence of obesity[298,306] and diabetes.[298]

Only a few identified cross-sectional studies evaluated whether neighborhood in-store availability of foods, typically assessed by shelf space, is related to dietary habits or adiposity. Among 4 studies, positive correlations were generally seen only in unadjusted

(crude) analyses for self-reported consumption of various foods and corresponding shelf space in supermarkets.[313–316] In 2 studies evaluating metabolic risk markers, after multivariable adjustment including for race/ethnicity, neighborhood availability of healthier foods was not significantly associated with insulin resistance or adiposity; greater shelf space for energy-dense snack foods was positively associated with BMI.[317,318]

Several studies have considered local farmers' markets in relation to consumption of fruits and vegetables (Supplementary Table 9). Most did not evaluate built-environment accessibility but rather participation in voucher or coupon programs to purchase produce at these markets, most often as part of the Farmers' Market Nutrition Program for women enrolled in WIC or similar seniors' farmers' market programs.[319,320] A handful of cross-sectional and quasi-experimental studies found that WIC participants receiving such vouchers because of enrollment in the Farmers' Market Nutrition Program reported eating more fruits and vegetables. A small, uncontrolled community intervention found that implementation of summer farmers' markets that included vouchers to community members and direct youth participation and education led to positive attitudes toward such markets as both a learning opportunity and exposure to fresh foods for children.[321] Overall, these studies provide some limited evidence that initiatives that provide vouchers for purchasing fruits and vegetables at farmers' markets increase consumption of fruits and vegetables. These findings provide additional support for the effectiveness of subsidies for more healthful foods ("Food Pricing: Direct Taxes or Subsidies" section) but not on the potential impact of local environmental changes.

Two cross-sectional ecological analyses used the USDA Food Environment Atlas, an online mapping tool of various food outlets in US counties, to assess the per capita density of farmers' markets in relation to the prevalence of adult obesity and/or diabetes across US counties.[297,298] Neither analysis found significant independent relation between the density of farmers' markets and prevalent obesity; 1 analysis observed a significant inverse association with prevalent diabetes.[298] A small longitudinal study among young girls in Northern California found mixed results for neighborhood farmers' markets and 3-year risk of adiposity.[299] Availability of farmers' markets within 0.4 km of home was not associated with risk of overweight/obesity or change in BMI *z* score; availability within 1.6 km of home was inversely associated with overweight/obesity (odds ratio [OR]=0.22; 95% CI, 0.05, 1.06) but not with a change in BMI *z* score.

A few cross-sectional studies or small pre/post studies have found that participation in a community garden program is associated with higher self-reported consumption of fruits and vegetables.[322–324] These studies compared individuals who were or were not participating in these gardens within each community rather than neighborhood or community availability of such gardens, and thus the findings do not inform relevance for local environmental change.

Overall, nearly all of these environmental studies, including those for supermarkets, were cross-sectional, limiting inference about the direction of the associations: ie, whether food outlet accessibility influenced the health-related behavior or vice versa. Currently, there is still minimal prospective observational or quasi-experimental evidence that altering locations of food outlets will make an impact on the purchase of healthy foods. In the United Kingdom, for example, randomized controlled studies on placement of supermarkets in low-income food deserts altered where shopping was done but did not affect food purchasing patterns.[325,326] Further research, including more rigorous study designs, is needed to evaluate the effects of the neighborhood food environment, around both home and school, on dietary behaviors.

Nonetheless, public policy has moved rapidly, and several initiatives provide financial incentives to encourage building of new supermarkets in impoverished areas. For instance, the New York City Food Retail Expansion to Support Health (FRESH) program provides both zoning and financial incentives to encourage grocery stores to locate in some of the most underserved neighborhoods with primarily pedestrian-oriented local shopping districts. In Pennsylvania, the Fresh Food Financing Initiative funded a program of grants and loans to increase the number of supermarkets or grocery stores in underserved state communities. The impact of these and similar programs on consumer behavior, health outcomes, and economic indexes is not yet known; a limited set of evaluations is currently ongoing. The Obama administration has prioritized this initiative to address food deserts, and the Treasury Department announced a $25 million “Notice of Funds Availability” for the Healthy Food Financing Initiative to take this program nationwide. Rigorous evaluation of the impact of such programs on food purchasing and eating habits is needed.

In sum, our understanding of the impact of local store availability on food selection and diet, including among populations with limited resources, is at an early stage (Table 7). Recent IOM and USDA reports concluded that the availability of local supermarkets was cross-sectionally associated with healthier choices and fewer CVD risk factors, but that causal inference was limited, without strong evidence that placement of a new food outlet that offers healthy choices will improve the diet of people in these communities.[325,327–329] Similarly, the most consistent evidence for associations of community environment with diet was found for accessibility to supermarkets, with greater access cross-sectionally linked to more healthful habits and less adiposity in both adults and children. Findings for grocery stores or convenience stores were mixed. For neighborhood fast-food restaurants, little evidence was identified for associations with dietary habits, and studies of adiposity were quite mixed, with the majority showing no associations. A limited number of studies that evaluated school- (rather than home-) related fast-food restaurants found positive associations with students’ adiposity. Local supermarket shelf space for various foods was generally not associated with consumption of these foods or with metabolic risk markers in a handful of studies. Evidence for the effects of neighborhood farmers’ markets or community gardens on diet or diet-related risk factors was quite limited.

Local Food Environment and Disparities: Local food environments are related to disparities. For example, using Sanitation Department and geographical information systems (GIS) data, in 2001, Block et al mapped all fast-food restaurants in New Orleans, Louisiana.[330] After adjustment for other neighborhood characteristics, each 10% higher density of fast-food restaurants was associated with 4.8% lower neighborhood income and 3.7% higher proportion of black residents. Predominantly black neighborhoods had 1 additional fast-food restaurant per every square kilometer, compared with predominantly white neighborhoods. Similar findings were seen in St Louis, Missouri,[331] and South Los Angeles, California,[332] in which fast-food restaurants were more densely located in lower-income urban neighborhoods. In the latter analysis, more affluent areas also had significantly greater availability of healthier restaurant options both in terms of preparation methods and menu choices.

In a review of 54 US studies published between 1985 and 2008 on neighborhood differences in access to food, residents of low-income, minority, and rural neighborhoods generally had less access to supermarkets and healthful foods.[30] For example, in a national study of >28,000 US ZIP codes, Powell et al found that low-income neighborhoods had fewer chain supermarkets than middle-income neighborhoods, although they also had more nonchain supermarkets and grocery stores.[333] After adjustment for income and other covariates, predominantly black communities had about half (52%, $P<0.01$) as many chain

supermarkets as predominantly white communities, and predominantly Latino communities had approximately one third (32%, $P<0.01$) as many as did largely non-Latino communities.

A systematic review evaluated 45 observational studies published between January 1995 and January 2009 that assessed various built-environmental factors and obesity in disadvantaged individuals or areas in the United States.[334] The authors concluded that access to supermarkets, rather than only grocery or convenience stores, was 1 of 3 neighborhood factors with the strongest evidence for inverse associations with adiposity and related lifestyle behaviors in disadvantaged populations (the others were availability of places to exercise and safety). The authors also concluded that disadvantaged populations were more likely to live in neighborhoods with suboptimal availability of food stores, places to exercise, aesthetic characteristics, and traffic or crime-related safety.

Fewer studies have been performed outside the United States. In an analysis in Glasgow, Scotland, the mean densities of restaurants, fast-food restaurants, cafes, and takeaway outlets were significantly lower in both the most and least affluent neighborhoods compared with more average neighborhoods.[335] In a much broader analysis across the United Kingdom, neighborhood deprivation as defined by a compound measure of income, employment, health, education, and housing was positively associated with per capita density of McDonald's outlets in both Scotland and England ($P<0.001$).[336]

In sum, local food environments appear related to neighborhood socioeconomic status in a variety of populations. The effects of interventions on disparities in these food environments or whether neighborhood disparities or socioeconomic status modify the efficacy of such interventions are still unknown.

Local Environmental Change for Physical Activity (Community Settings)—A growing number of studies have evaluated the potential impact of the community environment on physical activity and activity-related risk factors, including in urban and rural settings and among children, adolescents, and adults (Supplementary Table 10a-f). The writing group identified many recent systematic or narrative reviews of these topics, generally composed of cross-sectional observational studies with few longitudinal studies included. Given the array of smaller cross-sectional observational studies that were already captured in the identified reviews, in additional systematic searches for original articles published after 2007, the writing group focused on additional studies that were randomized trials, quasi-experimental studies, longitudinal studies, or large (N>5000) cross-sectional studies.

In evaluating neighborhood environment and physical activity, metrics of interest have included accessibility of recreation or exercise spaces and facilities; land-use design (eg, integration of residential, work, retail, and public spaces; interrelationships of destinations such as homes, worksites, schools, and shopping areas); sidewalks and street design; crime and safety; and aesthetic conditions such as greenness or cleanliness. Several studies also evaluated composite variables, such as walkability, to incorporate several of these metrics simultaneously. These various characteristics have been assessed based on individual perception (self-report), direct observation (eg, from community audits), or existing databases in combination with GIS. Outcomes in these studies have included leisure-time recreation and exercise, utilitarian transport or travel, occupation-related physical activity, and adiposity.

Accessibility of Recreation or Exercise Spaces and Facilities: Many studies have evaluated accessibility to recreation or exercise spaces and facilities such as parks, playgrounds, bikeways, and sports facilities (Supplementary Table 10a). Among adults,

greater accessibility was generally, although not always, associated with more physical activity.[28,337–342] Examples of characteristics linked to physical activity included access to local parks and bicycle paths, the presence of facilities on frequently traveled routes, and neighborhood density of public and private facilities.[339] In 1 meta-analysis, after adjustment for age, income, and education, the presence of physical activity facilities was positively associated with physical activity assessed as a binary factor, eg, any walking, sufficient walking, sufficient leisure-time activity (OR=1.20; 95% CI, 1.06, 1.34).[340] In a review of 13 cross-sectional studies among children, greater accessibility was positively associated with physical activity in 9 of 13 studies, at least in some subgroups, particularly among girls. [343] Interestingly, all studies assessed the neighborhood availability of facilities, not whether children or parents actually used these facilities.[343] In contrast to these findings, a review of studies published through 2004 concluded that availability or accessibility of physical activity equipment, facilities, and programs was unrelated to physical activity levels in youth.[344] Cross-sectional and longitudinal analyses from the National Longitudinal Study of Adolescent Health suggest some positive associations between green space coverage or availability of physical activity facilities and physical activity among US adolescents but with somewhat varying findings, depending on the environment measure, the physical activity outcome, and sex.[345–348]

Adiposity has also been evaluated as an outcome.[342,349,350] In a review of cross-sectional studies that directly measured body weight in adults or children, 2 of 3 studies in adults observed that shorter distance to or greater density of fitness facilities was associated with lower BMI, prevalence of overweight, and calculated 10-year risk of CHD.[349] In a cross-sectional analysis in a multiethnic US cohort, perceived availability of neighborhood facilities and spaces for exercise was independently associated with lower insulin resistance.[317] Among youth, 2 studies found inverse associations between the number of facilities and risk of overweight; 2 studies evaluating distance found no relation to overweight.[349] In a systematic review, children's own (but not their parents') reported accessibility to physical activity facilities and bike/walking trails was inversely associated with adiposity outcomes in several studies.[350]

A systematic review of 45 US studies on built-environmental factors and obesity in disadvantaged populations concluded that availability of places to exercise was 1 of 3 neighborhood factors with strong evidence for inverse associations with risk of adiposity and related lifestyle behaviors.[334] The 2009 IOM report *Local Government Actions to Prevent Childhood Obesity* recommended that neighborhood accessibility to parks, playgrounds, and public and private recreational facilities be increased.[147] Suggested interventions included building and maintaining parks and playgrounds close to residential areas; improving access to public and private recreational facilities through increased operating hours and development of culturally appropriate activities; and establishing joint use of facilities agreements to allow school playing fields, playgrounds, and recreation centers to be used by the community when schools are closed.

In sum, greater access to recreation and exercise spaces and facilities is relatively consistently linked to greater physical activity and lower adiposity or other metabolic risk factors (Table 7). However, nearly all the evidence is cross-sectional, limiting inference about causality, and additional prospective, quasi-experimental, and cluster-randomized studies are needed.

Land-Use Mix/Locations and Accessibility of Destinations: The evidence for how land-use design might influence physical activity or adiposity is summarized in Supplementary Table 10b. Several recent systematic reviews evaluated how land-use mix might influence physical activity in children.[147,334,350–355] Each of these reviews identified only a handful of

observational studies, all cross-sectional. Most studies evaluated overall land-use mix, quantified based on varying metrics incorporating the types, variety, and physical interrelationships of land use (eg, residential, school, entertainment, retail, office) near home. A few studies evaluated more simple metrics, such as distance to school from home, in relation to children's active commuting (walking or biking to school). Across all these systematic reviews, 5 of 6 studies found a positive relation between overall land-use mix and children's physical activity; in 5 of 8 studies, between overall land-use mix and children's active commuting; and in 3 of 3 studies, between distance from home to school and children's active commuting. After adjustment for confounders, magnitudes of these relationships often remained quite large (eg, OR 2- to 3-fold or higher associations), especially for active commuting. Four recent systematic reviews evaluated the evidence for associations between land-use mix and childhood adiposity.[350,351,355,356] Only 3 unique studies were identified by these reviews, all cross-sectional observational analyses, including 2 studies in southern California (N=799, N=98) and 1 study in Canada (n=501). None observed significant relations between land-use mix and BMI or overweight/obesity in children. One longitudinal analysis among US adolescents found no significant relation between land-cover diversity and moderate to vigorous physical activity.[346] The writing group did not identify any additional recent randomized trials, quasi-experimental studies, longitudinal studies, or large (N>5000) cross-sectional studies of these relationships among youth published after 2007.

Several recent systematic reviews evaluated the relation between land-use mix and physical activity in adults.[334,337,338,340,351,352,357–359] These reviews collectively identified 18 original investigations, all cross-sectional observational studies; our further searches identified a few more recent large cross-sectional studies.[271] Nearly all found significant positive associations, often with substantial magnitudes of associations (eg, OR in the 2- to 3-fold range or higher). Only 1 small longitudinal investigation was identified, evaluating walking in 32 low-income women who, based on a housing program, moved to either a suburban neighborhood or a neotraditional neighborhood (ie, small lots, modest setback distances, front porches, sidewalks, etc).[360] Among multiple land-use metrics evaluated, an increase in the population density of service-related jobs following the move was associated with fewer steps walked; changes in other land-use metrics were not significantly associated with walking. Cross-sectional studies of land-use mix and adiposity in adults are consistent with the findings for physical activity. Of 6 original investigations identified across multiple systematic reviews,[334,337,351,352] 4 investigations observed independent inverse relations between land-use mix and BMI or overweight/obesity, and 2 investigations observed nonsignificant trends toward such inverse associations.

In sum, multiple cross-sectional studies in different population groups observe relatively consistent and robust relationships between more diverse land-use mix, ie, the presence of greater number and diversity of destinations near the home and physical activity in both children and adults (Table 7). The magnitude of many of these associations makes it less likely that residual confounding could fully explain the relations. However, although a cross-sectional relation is clearly present, the design of these studies precludes inference about the direction of the association: eg, families who prefer to walk and be active could be selecting neighborhoods with more diverse land use rather than land-use mix altering physical activity. In adults, studies of land-use mix and adiposity are consistent with physical activity findings; similar studies in children did not find relations with adiposity but were limited in number and sample size.

Sidewalks and Street Design: There is growing interest in how the design of sidewalks and streets may influence physical activity. Characteristics of interest have included availability and quality (eg, the presence of shoulders) of sidewalks and walking paths and street

connectivity, a measure of ease of travel and provision of alternate routes for active commuting. Studies of these factors and physical activity or adiposity are summarized in Supplementary Table 10c.

The writing group identified multiple recent systematic reviews of sidewalk or street design and active commuting to school and/or general physical activity in children.[147,334,338,343,353,354,361] Collectively, these reviews included 8 cross-sectional studies that evaluated the presence of sidewalks or biking paths: 5 of 6 of these studies observed positive relations with active commuting to school, but only 1 of 3 studies observed positive relations with general physical activity. These reviews also identified 5 cross-sectional studies that evaluated street connectivity: 1 of 2 studies found positive relations with active commuting to school and 2 of 3 studies with general physical activity. Another recent large cross-sectional study among US adolescents found some relation between intersection density and physical activity, with but some variation by urbanicity and by sex.[348]

The writing group also identified 1 additional cross-sectional study and prospective study from 1 large US cohort of adolescents[346,348] and 2 additional prospective studies from 1 relatively small (N<500) cohort of children (8 to 9 years of age) and adolescents (13 to 15 years of age) in Melbourne, Australia.[362,363] In the US cohort, street connectivity was positively related to moderate to vigorous physical activity in cross-sectional analyses, with variation by urbanicity and by sex,[348] but was unrelated to moderate to vigorous physical activity in longitudinal analyses.[346] In the Australian cohort, the extent of sidewalks and walking paths near home was positively correlated with changes in active commuting over time in both age groups in girls but not in boys[362]; however, these findings were not adjusted for covariates. Intersection density, a measure of better street connectivity, was positively correlated with changes in active commuting over time in adolescent boys but not in younger boys or in girls. In adjusted analyses in this cohort, parental perceptions of better pedestrian crossings were associated with a 2.5-fold greater increase in overall active commuting to school over 2 years of follow-up.[363] Only 1 quasi-experimental analysis was identified, which found that California children whose route included a Safe Routes to School project increased both active commuting to school and general walking compared with children whose route did not have a Safe Routes to School project. Two recent systematic reviews[349,356] identified only 2 cross-sectional studies of street connectivity and childhood obesity; neither found a significant association. No additional randomized trials, quasi-experimental studies, longitudinal studies, or large (N>5000) cross-sectional studies published after 2007 were found of these relationships in children.

The writing group evaluated multiple recent reports that systematically reviewed the literature for sidewalk and street design and physical activity in adults.[334,337,338,340,351,357,359,361] In addition to evaluating original investigations, several reports also included multiple earlier reviews.[338,351,359] Some studies focused on rural populations[337] and others on minority subgroups.[357] All investigations identified by these reviews were cross-sectional observational studies. End points included walking (overall, for commuting, and for recreation), exercise, and overall physical activity. Although virtually all of the reviews concluded that the presence or quality of sidewalks and street connectivity was positively linked to physical activity in adults, findings from the original investigations were much more mixed (Supplementary Table 10c). Overall, less than half of the original studies found significant associations between sidewalks or street connectivity and various physical activity outcomes, and in studies reporting positive associations, these were sometimes only seen for certain characteristics of sidewalks or street connectivity, certain types of activity, or certain subgroups of the population, without any clear pattern across studies.

The writing group identified 2 prospective studies and 1 quasi-experimental study published after 2007. Among 357 women in Melbourne, Australia, sidewalk availability was not significantly related to walking for leisure or transport over 2 years' follow-up.[364] Among 5115 US young adults, neighborhood street density was positively associated with walking, bicycling, and jogging in low-urbanicity areas but not in middle- or high-urbanicity areas.[365] In Knoxville, Tennessee, neighborhood physical activity and active commuting to school were directly observed before and after construction of an urban greenway/trail in 1 neighborhood and in 2 control neighborhoods that did not receive a trail.[366] Total neighborhood physical activity significantly increased in the intervention neighborhood and decreased in control neighborhoods ($P<0.001$); active commuting did not change.

Recent systematic reviews identified 4 cross-sectional studies of sidewalk availability and adiposity in adults.[334,337,349,367] Findings were mixed, with no significant associations among adults in the rural southern United States or Hispanic adults in Texas, and inverse associations among urban US adults and Australian adults. Only 1 cross-sectional study of street connectivity and adiposity was included, finding no significant associations with obesity in a large study of US adults. The writing group did not identify additional randomized trials, quasi-experimental studies, longitudinal studies, or large (N>5000) cross-sectional studies of these relationships in adults published after 2007.

In sum, there is mixed evidence for a relation between sidewalks or street design and physical activity or adiposity in adults, with several studies finding associations, but many others, not and nearly all findings coming from cross-sectional studies (Table 7). Among children, the presence and greater quality of sidewalks or biking paths were more consistently linked to increased active commuting to school in cross-sectional studies, supported at least in part by 1 prospective study and 1 quasi-experimental analysis. Relatively few studies in children have evaluated sidewalks and general physical activity, street design and active commuting or general physical activity, or sidewalks or street design and adiposity, limiting conclusions about these relations.

Neighborhood Safety and Crime: Many observational studies have evaluated whether safety or crime in a community environment is linked to physical activity (Supplementary Table 10d). Several recent narrative or systematic reviews have assessed this topic for children's physical activity, with many of these reviews identifying the same overlapping sets of original individual studies.[147,343,344,353–355,368–371] Nearly all studies identified in these reviews were cross-sectional; a handful were longitudinal. In the great majority of studies, parental perceptions of overall neighborhood safety were positively associated with children's physical activity. When different aspects of safety were evaluated, most studies evaluating traffic safety (eg, related to aspects of road or pedestrian crossings) observed positive relationships with children's physical activity. Relatively fewer studies in these reviews evaluated neighborhood crime or perceived personal danger (eg, from strangers). For self-reported measures of crime or personal danger, findings were often mixed and nonsignificant. In 2 studies using objective measures of neighborhood crime, significant inverse associations with children's physical activity were seen. Fewer studies in these reviews evaluated traffic safety or crime and active commuting to school by children, with most studies finding no significant association.[353] Two recent systematic reviews evaluated the relation between neighborhood safety and various measures of childhood adiposity.[355,356] Findings were mixed, and most studies did not find significant associations.

In searches for additional experimental studies, longitudinal studies, or large (N>5000) cross-sectional studies published after 2007, several prospective studies were identified, including studies based on data from the Australian Children Living in Active Neighborhoods Study[362,363,372] and the US National Longitudinal Study of Adolescent

Health[346] (Supplementary Table 10d). In the Australian studies, various parentally perceived and objectively measured neighborhood traffic safety characteristics were assessed in relation to 2- to 5-year changes in parentally reported or self-reported physical activity and active commuting, in physical activity assessed by accelerometer, and in BMI *z* score. In some analyses, associations were seen for certain neighborhood-activity relationships, at least in some age- and/or sex-specific groups. For example, the number of traffic/pedestrian lights and total length of walking paths were positively associated with changes in active commuting among girls 8 to 9 years of age, and parental perception of no traffic lights or pedestrian crossings was associated with a lower frequency of increased active commuting to school. However, these and other parental perceptions, as well as other evaluated metrics, such as total length of busy versus local roads or number of intersections, were not associated with increased physical activity or commuting in other sex or age groups or with objectively measured 5-year changes in physical activity or BMI *z* score. In the US study, neighborhood crime safety (rates) were found to be inversely related to bouts of moderate to vigorous physical activity in both males and females.[346]

Four systematic reviews evaluated how neighborhood safety relates to physical activity in adults (Supplementary Table 10d).[337,359,373,374]_ENREF_267_ENREF_268_ENREF_269 The identified studies were generally cross-sectional and observational. The large majority of studies in these reviews found that perceived or objective measures of safety were positively associated with physical activity, including among women and men, and with use of parks and park activities. Among studies that evaluated only walking, rather than overall physical activity, a minority found significant associations with attributes of neighborhood safety.[359] A systematic review of 45 observational studies on various built-environmental factors and obesity in disadvantaged US populations concluded that neighborhood safety was 1 of 3 factors with the strongest evidence for inverse associations with risk of adiposity and related lifestyle behaviors.[334]

In sum, the evidence indicates that parental perceptions of overall neighborhood safety are cross-sectionally linked to children's physical activity, with greater evidence for safety issues related to traffic and road conditions than to crime, except in a few studies using objective measures of the latter (Table 7). Although the writing group's review found mixed evidence for the relation of neighborhood crime to physical activity or adiposity in children, a 2009 IOM report recommended community policing strategies to improve the safety and security of streets and parks, especially in higher-crime neighborhoods, to reduce the risk of childhood obesity.[147] This report also recommended several interventions to improve traffic safety, including the Safe Routes to School programs, to allow more children to safely walk or ride a bicycle to school; traffic enforcement programs to improve safety for bicyclists; and retrofitting streets to reduce vehicle speeds, accommodate bicyclists, and improve the walking environment. In adults, the writing group found perceived or objective measures of neighborhood safety to be consistently associated with physical activity and use of parks. A handful of longitudinal studies provide some limited support for these findings, although the heterogeneity of observed results does not allow strong conclusions in this regard. No interventional or quasi-experimental studies were identified.

Aesthetic Conditions: Several observational studies have evaluated whether neighborhood aesthetics such as vegetation or green space, enjoyable scenery, and physical disorder (eg, garbage, broken glass) relate to physical activity or adiposity (Supplementary Table 10e). Recent systematic reviews collectively evaluated about 20 cross-sectional studies, about half in children and half in adults.[334,337,339,354,356] In children, recent findings have been relatively limited and mixed. For example, among 6 cross-sectional studies published since 2006, different neighborhood characteristics, including greenness, physical disorder, and enjoyable scenery, were evaluated by no more than 3 studies each; outcomes varied,

including active commuting, overall physical activity, or adiposity. Only approximately half of the investigated relationships were significant, without clear patterns across different types of neighborhood characteristics or outcomes. In a prospective analysis by Bell and colleagues among nearly 4000 children in Indiana, objectively quantified neighborhood greenness was inversely associated with BMI *z* score over 2 years' follow-up.[356]

In adults, few studies evaluated greenness or physical disorder and with mixed results. In contrast, many cross-sectional studies evaluated general aesthetics or enjoyable scenery, and nearly all found relations with more favorable physical activity or adiposity measures (Supplementary Table 10e). Other reviews evaluating either original studies or reviews published before 2006 concluded that cross-sectional studies demonstrate associations between various metrics of neighborhood aesthetics and physical activity or walking.[28,338,359]

In sum, better general aesthetics of neighborhoods appear positively related to physical activity among adults, with less consistent findings among children (Table 7). However, nearly all of the studies have been cross-sectional, limiting inference about causality. Additional prospective, quasi-experimental, and cluster-randomized studies are needed.

Walkability: Walkability represents a composite indicator of various local neighborhood characteristics, such as land-use mix, street connectivity, pedestrian infrastructure, aesthetics, and traffic and/or crime safety. As with other local environmental factors reviewed in this report, nearly all evidence for relation with physical activity or adiposity is derived from cross-sectional observational studies (Supplementary Table 10f). Although the numbers of studies were relatively limited, nearly all found either self-reported or GIS-assessed indexes of walkability to be positively associated with physical activity, including objective measures of physical activity.[28,334,338,351,352,359] Few studies evaluated walkability and adiposity in either children or adults, with a minority of these observing positive findings.[349–352,355,358,359]

In sum, cross-sectional observational studies identify consistent positive associations between walkability and physical activity in children and adults (Table 7). Studies of walkability and adiposity are few and inconsistent.

Local Environmental Change to Reduce Smoking (Community Settings)—

Community strategies to alter the environment to reduce smoking have most commonly involved smoking restrictions. The evidence for effectiveness of smoking restrictions or better enforcement of existing restrictions in schools, workplaces, or other public places is discussed in "Direct Restrictions and Mandates."

Density of Tobacco Retail Outlets: Several studies have evaluated the relation between density of tobacco retail outlets around homes or schools and smoking behaviors (Supplementary Table 11). Several cross-sectional observational studies in both youth and adults have demonstrated positive associations between density of and/or distance to neighborhood tobacco retail outlets and prevalence of smoking.[375–379] Similar findings have been observed for tobacco retailers around schools.[380,381] For example, among 24,875 students from 135 randomly selected California high schools, the absolute prevalence of current smoking was 3.2% higher at schools in neighborhoods with the highest tobacco outlet density (≥5 outlets within 0.8 km) compared with neighborhoods with no tobacco outlets.[381] In this cohort, the density of retail cigarette advertising in school neighborhoods was also associated with higher school smoking prevalence.

In sum, the density of tobacco retail outlets around both homes and schools is consistently associated with greater smoking (Table 7). Only cross-sectional studies were identified rather than longitudinal or interventional (eg, quasi-experimental) studies of these relationships.

Community Telephone Quit Lines: Additional community strategies could include development of services to assist with smoking cessation, such as telephone counseling (Supplementary Table 11). Such interventions have generally been evaluated in individual-randomized trials rather than as a community-wide intervention per se.[382] For example, in individual-level trials, smokers randomly assigned to receive greater telephone support had higher cessation rates at 6 months (but not 18 months) in 1 study and at 12 months in another.[383,384]_ENREF_241 One randomized trial tested the effects of telephone hotlines at the community level.[385] Compared with providing smokers with detailed self-help cessation packets, the addition of telephone hotlines to assist with cessation increased cessation rates, including cotinine-validated cessation, at up to 18 months' follow-up and also reduced relapse rates.

In sum, the success of individual-based telephone cessation-support interventions, together with 1 supportive trial at the community level, suggest that such an approach at the community level would be effective for reducing tobacco use (Table 7). This evidence has led the US Task Force on Community Preventive Services to recommend the development of community telephone hotlines for counseling and support services for tobacco cessation.[386]

Direct Restrictions and Mandates

The evidence for effects of direct restrictions and mandates on diet, physical activity, and tobacco use is summarized in Table 8.

Direct Restrictions and Mandates: Diet

Restrictions on Advertising to Children: The scope and effects of food and beverage marketing on consumer behavior are well documented, particularly among children. In 2006, the largest food and beverage companies spent $1.6 billion in the United States alone to market their products to children and adolescents, with 46% of all youth-marketing expenditures devoted to television.[387] In 2006, the IOM Committee on Food Marketing and the Diets of Children and Youth reported a systematic review of the available research and concluded that there is moderate to strong evidence that television advertising influences food and beverage preferences, purchase requests, beliefs, and dietary intake. Similar reports[388] and more recent studies support these findings (Supplementary Table 12).[389]

The IOM committee as well as other recent analyses also concluded that food and beverage marketing practices geared to children and youth are out of balance with recommended healthful diets and contribute to an environment that puts their health at risk.[387–391] For example, in a review of ≈98,000 food-product advertisements on top-rated US children's television shows, 98% and 89% of the advertised foods seen by viewers 2 to 11 years of age and 12 to 17 years of age, respectively, were packaged or processed foods that were high in fat, sugar, or sodium. About half of all calories among the advertised products came from sugar.[390] In another review of 1600 hours of children's programming, most food advertisements were for candy and snacks (34%), sugared cereals (28%), and fast foods (10%); none of the 8854 ads were for fruits or vegetables.[391]

In a nationally representative longitudinal study of US children, Chou et al estimated the potential impact of television marketing restrictions on adiposity in children and

adolescents.[392] On the basis of the relation between the number of hours of television advertisements for fast-food restaurants seen per week and observed risk of overweight, it was estimated that a ban on these advertisements would reduce the prevalence of overweight by 18% among US children 3 to 11 years of age and by 14% among US adolescents 12 to 18 years of age.[392] Similarly, in an analysis using 2003–2004 National Health and Nutrition Examination Survey (NHANES) data and evidence for relation of television advertising to dietary consumption, it was estimated that eliminating television food advertisements to children 6 to 12 years of age would reduce the prevalence of obesity by 14.6%.[393]

On the basis of evidence for the influence of advertising as well as the types of foods and beverages currently marketed, the 2009 IOM report *Local Government Actions to Prevent Childhood Obesity* recommended several strategies for restricting such marketing to children and adolescents.[147] These included the development of regulations that account for the full spectrum of advertising and marketing practices across all media, the banning of fast-food and restaurant advertisements on television, and the banning of advertising and marketing of less healthful foods and beverages near school grounds and public places frequently visited by youth.

Restrictions on marketing to youth currently exist in many countries. A WHO report found that among 73 countries reviewed, 85% had regulations on television advertising that specifically refer to children.[394] For example, Australia bans food advertisements aimed at children 13 years of age and younger; The Netherlands bans advertising of sweets to children 12 years of age and younger; and the United Kingdom bans advertising in or around television programs aimed at or likely to appeal to children 15 years of age and younger. Sweden, Norway, and Quebec each ban all television advertising aimed at children, regardless of the product involved. The United States does not have any restrictions on marketing or advertising of foods and beverages to children, although the Interagency Work Group of the Federal Trade Commission, the Food and Drug Administration, the CDC, and the USDA have developed a set of proposed voluntary principles that would guide industry in marketing food to children.

In sum, there is consistent evidence that television advertising to children influences food and beverage preferences, purchases, and consumption, and that the majority of such advertising is for products suboptimal for health. On the basis of this evidence, restrictions on such advertising would be effective at improving dietary behaviors in children (Table 8). Television advertising has been studied most; somewhat less evidence exists for other types of advertising and marketing.

Restrictions on Specific Dietary Factors: A growing number of city, regional, or national policies aim to restrict levels in the food supply of certain dietary factors with adverse health effects (Supplementary Table 12). For example, several nations, regions, and cities have placed restrictions on the content of industrially produced *trans* fat in cooking oils or foods.[23,395] Analyses of foods before and after implementation of these restrictions have demonstrated widespread compliance, with little evidence for adverse effects on food availability, price, or quality.[23,395] The effects of these relatively recent interventions on clinical outcomes have not yet been assessed.

In Finland, a national multicomponent strategy to improve dietary habits was initiated in 1977, incorporating legislative restrictions on the maximum salt content of certain foods in the 1990s and percentage of milk fat in whole and low-fat milk in the 1980s and 1990s.[59,60] Other intervention components included media and education, voluntary agreements with industry, modifications to taxation and subsidy policies for several foods, and government-supported programs to increase production and consumption of fruits (see the corresponding

relevant sections of this report for further details on these other interventions). The direct restrictions on salt and milk-fat content were successfully implemented with good compliance. From the 1970s to the late 1990s, mean daily salt consumption in Finland declined from about 14 to 15 g in men (unknown in women) to about 11 g in men and 7 g in women; mean diastolic blood pressure declined by 5% in men and 13% in women; and mean total blood cholesterol declined by almost 20%. Age-adjusted CHD mortality decreased by 65%, with about three quarters of this decrease estimated to be related to improvements in population risk factors rather than medical treatments.[59,60] Given the sustained multicomponent nature of the overall intervention, the health effects of the direct restrictions on salt and milk fat were not separately assessed.

In Mauritius, a national multicomponent intervention program was instituted in 1987 to improve population lifestyle-related risk factors.[396] This program included a regulatory policy for general cooking oil to limit the content of palm oil and replace it with soybean oil. On the basis of serial cross-sectional surveys, this policy is estimated to have reduced consumption of saturated fat by about 3.5% energy and increased consumption of polyunsaturated fat by about 5.5% energy by 1992. In those 5 years, mean population total cholesterol concentrations fell by 0.79 mmol/L in men and 0.82 mmol/L in women ($P<0.001$ each). The cooking oil–related decrease in saturated fat and increase in polyunsaturated fat explained about half of this decline in both men and women.

In sum, these quasi-experimental experiences demonstrate that regulatory policies to reduce particular nutrients in foods are highly effective for improving population dietary habits (Table 8).

Mandates on Specific Dietary Factors: In addition to restrictions on consumption of less healthful foods, policies and legislation can be implemented to mandate increased availability of healthier dietary options. For example, the Mauritius policy intervention included not only limits on palm oil but also increases in soybean oil as its replacement.[396] The resulting increases in healthful polyunsaturated fat contributed to the substantial population improvements in blood cholesterol levels.[396]

Otherwise relatively limited evidence was identified on policy or legislative mandates to increase the production or availability of more healthful foods. As described in the section “Agricultural Policy,” the modification of Finnish taxation policies successfully encouraged production of mixed vegetable-oil and light spreads and greater production of lean meats and protein. The national Berry and Vegetable Project successfully increased local healthy crops.[59,60] However, these interventions were not direct mandates but changes in taxation, subsidies, and agricultural policies to support and encourage dietary changes.

In sum, the use of mandates to increase consumption of healthful foods appears to be a potentially promising strategy, but further research and evidence are required (Table 8).

Direct Restrictions and Mandates: Physical Activity—Regulation of physical activity through legislation offers a unique challenge, especially when contrasted with that of smoking. Smoking, a negative health behavior, is susceptible to direct regulatory approaches, whereas physical inactivity, which is the lack of a healthy behavior, renders legislative approaches much more challenging. It is hard to enforce individuals’ participation in a positive health behavior. Therefore, most direct regulatory approaches to encouraging physical activity operate through changes in the built environment, worksite wellness programs, financial incentives, or transportation policies.[397,398] These various approaches are addressed in other sections of this report and have been summarized in other reviews.[36,399] Multiple population strategies are often employed simultaneously and in

settings in which randomized controlled experiments are not practical; thus, quantifying the independent effects of different approaches is challenging. For all of these reasons, there is little evidence for the effectiveness of direct restrictions or mandates to increase physical activity. Evidence is just now being developed at some state and local levels.[400]

The promulgation by any country of specific national guidelines for physical activity modes and amounts does not mandate physical activity but could still be considered a policy intervention if such guidelines were subsequently referenced and addressed in other legislative initiatives that affect physical activity, such as legislation dealing with schools and workplaces, transportation funding, the built environment, and regulation of public lands, among others. For example, the US Dietary Guidelines for Americans directly inform the nutrition standards for foods and beverages served at schools, jails, and government workplaces. Consequently, the development of the first Physical Activity Guidelines for Americans in 2008[9] may represent the beginning of incorporation of physical activity guidelines into US federal policy. School-based mandates, such as requiring minimum time in PE classes or, for younger children, recess and play time, are discussed in the section "School and Workplace Approaches."

In sum, consensus opinion from the writing group and others suggests that specific national guidelines can improve population physical activity by influencing subsequent policy and legislation, but further research and evidence are required (Table 8).

Direct Restrictions and Mandates: Smoking

Community Restrictions on Smoking in Public Places: Community smoking restrictions prohibit smoking in some or all public places in a geographic locality, with 1 specific aim being to reduce exposure to secondhand smoke among nonsmokers. Several quasi-experimental studies have evaluated the health effects of such bans, comparing community rates of relevant disease rates or hospitalizations in time periods before versus after the ban and/or parallel assessments of disease rates in a nearby locality without a smoking ban (Supplementary Table 13). Most studies were ecological, evaluating overall rates of exposure and events in the population rather than how individual exposures are related to particular coronary events. Durations of follow-up from implementation of the ban to assessment of post-ban end points varied across studies from 0.2 to 3.0 years.

A 2009 IOM review of community smoking bans found consistent and substantial reductions in markers of tobacco-generated air pollution and particulate matter in places in which smoking was banned.[401] The IOM report also found substantial evidence that smoking bans were effective in reducing coronary events, based on critical reviews of 11 quasi-experimental studies that examined smoking bans and changes in acute coronary events.[402–412] All studies demonstrated reductions in coronary event rates, with decreases ranging from ≈6% to 47%. Additionally, in 1 locality in which the ban was revoked, a subsequent increase in coronary events was seen. In studies that evaluated coronary rates separately for smokers versus nonsmokers, reductions were demonstrated in both groups, consistent with the benefits of reduced exposure to secondhand smoke among nonsmokers.

In 2 separate meta-analyses of these studies, the pooled relative reduction in acute coronary events was 17% (95% CI, 8%, 25%).[413,414] The largest relative risk reductions were seen among younger persons and nonsmokers. Meta-regression suggested that benefits increased over time, with larger reductions in coronary events seen with longer durations of follow-up after the smoking ban was instituted.[413]

Since these reviews, 4 new reports of the effects of smoking bans on cardiovascular and respiratory conditions have been published, all demonstrating reductions in cardiovascular

and/or respiratory events following smoking bans.[415–418] Herman et al studied Arizona's May 2007 statewide smoking ban, which prohibited smoking in most enclosed public places and places of employment, in relation to rate of hospital admissions from January 2004 to May 2008, stratified by the county-specific presence or absence of preexisting smoking bans to separate the effects of the ban from temporal trends.[415] When counties with no prior bans were compared with those with prior bans, Herman found that those with no prior bans experienced significant reductions in hospital admissions for conditions directly affected by secondhand smoke, including acute myocardial infarction (MI) (13%), angina (33%), stroke (14%), and asthma (22%). No significant differences were seen for control conditions such as appendicitis, kidney stones, acute cholecystitis, and ulcers, each of which were not expected to be affected by the smoking ban. Trachsel et al found a 22% lower rate of incident acute MI in the year following the March 1, 2008, smoking ban in public buildings in the Swiss canton of Graubünden, compared with the prior 2 years.[416] Graubünden had a stable population of ≈100,000 in these years but also had a large transient tourist population. Rates in both residents and nonresidents were lower, suggesting a short-term benefit of the smoking ban.

Naiman et al evaluated hospital admission rates for multiple smoking-related conditions, including acute MI, angina, stroke, asthma, chronic obstructive pulmonary disease, and pneumonia/bronchitis, from January 1996, 3 years before initial implementation of a smoking ban in restaurants and related settings in Toronto, Ontario, Canada, to March 2006, 2 years after the last phase was implemented.[417] Rates of cardiovascular conditions decreased by 39% and admissions for respiratory conditions decreased by 33%; no changes were observed in control cities or control end points. The reductions in disease end points occurred during the ban period related to restaurant settings. Dove et al evaluated rates of fatal MI before and after implementation of a comprehensive smoke-free workplace law in Massachusetts in July 2004, stratified by cities/towns with and without previous local smoking bans from 1999 through 2006.[418] MI mortality rates decreased by 9.2% after implementation of the law in cities and towns with no prior local smoking ban, with a smaller, not statistically significant decrease in localities that did have a prior ban. The effect of the statewide ban on MI mortality was larger (–18.6%; $P<0.001$) after the first year of implementation.

Interestingly, in several studies, variability in the extent of reductions in coronary events was explained by different levels of preexisting partial bans. Before the total public ban, different localities in these areas had particular configurations of prior legislation, including preexisting less-restrictive bans, different venues covered by the bans (such as offices, other workplaces, restaurants, or bars), and varying levels of compliance with and enforcement of the bans. These preexisting partial bans would attenuate the full effects of reduced smoking exposure due to community bans.

In all these studies, factors associated with the indoor smoking ban, such as related media reports or outreach efforts, were difficult or impossible to separate from the impact of the ban itself.[401,412,413] The effects of smoking bans may also influence or be synergistic with other cessation efforts. For example, Italian smokers who attempted cessation through group counseling or use of bupropion were more successful after a community smoking ban was instituted than their counterparts who participated in such cessation efforts before the ban.[419] A smoking ban may also encourage other health-promoting actions, such as persons initiating an indoor smoking ban at home or quitting smoking. The combination of such effects may contribute to the full benefits of a smoking ban, such as reduced hospitalizations for childhood asthma[420] and reduced occurrence of disease conditions in younger and more recent smokers.[421] Considerations of the best methods for modeling the different causal pathways that influence the total effects of smoking bans are ongoing.[401,422]

Economic arguments against smoking restrictions, ie, that such bans hurt certain businesses that cater to smokers, are not well substantiated in prospective studies. In 1 analysis, although some businesses did have to change their business plans, overall bar and restaurant revenue was not reduced and may even have increased after a smoking ban was implemented.[423] Such findings may be intuitive given that in many countries the majority of people do not smoke. Smoking bans also reduce cleaning costs and employee medical costs,[11] providing further economic incentives to businesses to support such bans.

In sum, the studies reviewed in the IOM report[401] and recent meta-analyses,[412,413] in combination with several other more recent studies, provide convincing evidence that community smoking bans reduce rates of cardiovascular and smoking-related respiratory events, at least partly through lower exposure to secondhand smoke and possibly other concomitant effects (Table 8). The pooled analysis suggests a substantial overall pooled effect that increases over time.[413]

Workplace-Based Restrictions on Smoking: Several studies have evaluated the effects of workplace-specific smoking restrictions (Supplementary Table 13). In a systematic review and meta-analysis including 26 quasi-experimental studies, the implementation of a smoke-free workplace policy was associated with pooled reductions in absolute smoking prevalence of 3.8% (95% CI, 2.8%, 4.7%) and in cigarette consumption among smokers of 3.1 cigarettes per day (2.4, 3.8).[424] Overall, smoke-free workplace policies were associated with a 29% reduction (11%, 53%) in total cigarettes smoked. Studies with either self-reported (N=3) or biochemical (N=3) measures of exposure to secondhand smoke all found significant reductions in environmental tobacco smoke after implementation of a smoke-free policy. A more recent systematic review that included 37 studies, including 13 quasi-experimental studies, demonstrated similar results, with smoke-free workplace (majority of studies) or smoke-free community (some studies) policies linked to reduced prevalence of active smoking, more attempts to quit and higher quit rates, and fewer overall cigarettes smoked per day.[425] Some limited evidence suggests that the effects of smoke-free workplace policies may be larger in men than in women and among persons with greater education, but favorable effects were generally seen in all groups studied.[426–432]

Similarly, in a prospective analysis of employees at worksites in 20 US and Canadian cities between 1993 and 2001, people who worked in places that changed to or maintained smoke-free policies were 1.9 times more likely to quit (OR=1.92; 95% CI, 1.11, 3.32), and continuing smokers decreased their average daily consumption by 2.57 cigarettes per day compared with people whose worksites did not have a smoke-free policy.[433] These associations were strongest in worksites that had smoke-free policies in place in both 1993 and 2001. Similar findings were seen in analyses of smoking cessation rates in US hospitals that instituted smoke-free policies, compared with rates before the ban[434] or with workplaces without smoke-free policies in the same communities.[435] In cross-sectional analyses in Japan, the United States, and Switzerland, employees at sites with more restrictive smoke-free policies were less likely to be current smokers and, when assessed, smoked fewer cigarettes per day if they were still active smokers.[436–438] Similar findings have been seen in cross-sectional studies among teenage workers in worksites.[439]

Smoke-free workplace policies have also been associated with lower exposure to secondhand smoke. Among worksites that are not fully smoke-free, the designation of specific smoking areas is associated with fewer cigarettes smoked by smokers and less exposure to secondhand smoke among nonsmokers. For instance, in the prospective analysis of US and Canadian worksites, in those that were not smoke-free but had designated smoking areas, employees consumed 2.22 fewer cigarettes per day, compared with employees in worksites with no smoking restrictions.[433] In a cross-sectional study in

Massachusetts, compared with employees in smoke-free worksites, those in worksites with designated smoking areas had a 2.9-fold higher odds (95% CI, 2.4, 3.5) of being exposed to secondhand smoke and were exposed 1.7 times longer (95% CI, 1.4, 2.2); employees in worksites where smoking was permitted had a 10.3-fold higher odds (95% CI, 6.7, 15.9) of being exposed to secondhand smoke and were exposed 6.34 times longer (95% CI, 4.37, 9.21).[440] Lower exposure to secondhand smoke was also reported by employees of worksites with smoke-free policies in US, Swiss, and Chinese studies, compared with worksites without such policies.[434,438,441]

As seen with community-level smoking restrictions, worksite-based restrictions can be synergistic with other cessation efforts. Following the extension of a smoke-free indoor policy to include outdoor spaces at 1 worksite, participants who enrolled in smoking cessation programs had higher 6-month quit rates after the extension (52.4%) than before (43.0%); post-ban participants were 80% less likely to relapse than pre-ban participants, and nonquitters decreased their consumption by 6.6 cigarettes per day, a 39% decrease.[442]

In sum, full smoke-free policies at the workplace are consistently linked with increased smoking cessation, fewer cigarettes consumed among those who continue to smoke, and decreased exposure to secondhand smoke (Table 8). Partial policies, such as designated smoking areas, are consistently linked with fewer cigarettes smoked by active smokers and less exposure to secondhand smoke among nonsmokers. A 2009 AHA policy statement supports these conclusions and advocates for comprehensive smoke-free laws for all workplaces and public environments.[443]

School-Based Restrictions on Smoking: Several studies have evaluated the potential influence of campus smoking restrictions as well as enforcement of such restrictions on smoking among students (Supplementary Table 13). In some, but not other, cross-sectional observational studies, students at schools with stronger policies restricting tobacco use were less likely to be current smokers.[210,444–449] A limited number of quasi-experimental evaluations with only short-term (1 to 4 months) follow-up demonstrated mixed findings, with no consistent evidence for the effects of campus smoking restrictions on active smoking or cessation.[450,451]

In contrast to studies assessing the presence of anti-tobacco policies, cross-sectional observational studies evaluating the level of enforcement of these policies more consistently found links between stronger enforcement and lower rates of smoking among students.[210,452–458] Interestingly, in some studies, teachers' smoking behaviors on school grounds were also strongly linked (2- to 5-fold relation) to students' smoking.[446,447]

In sum, there is mixed evidence for the effectiveness of school-based smoking restrictions on reducing smoking, and further investigation is required (Table 8).

Residence-Based Restrictions on Smoking: In recent systematic reviews of multiple cross-sectional as well as longitudinal studies, residence smoking restrictions were strongly and consistently linked to lower smoking prevalence, lower average cigarette consumption among smokers, higher rates of cessation attempts, and lower rates of relapse in adults; less smoking and progression to experimentation in children; and less exposure to secondhand smoke in children[459–461] (Supplementary Table 13). The magnitude of the relation observed was often very large, including >2-fold differences in many of these associations. The results of most individual studies support the findings of these systematic reviews.[439,452,462–469] In addition to detached homes, multiunit housing may be a reasonable target for smoking restrictions to reduce secondhand smoke exposure,[470–473] but the writing group did not identify studies evaluating the effectiveness of such interventions.

In sum, the evidence supports the effectiveness of residence-based smoking restrictions for reducing smoking (Table 8).

Restrictions on Advertising and Promotion: The powerful effects of tobacco advertising and promotion on consumer behavior are well documented, particularly among children and adolescents.[22,474–478] In longitudinal studies, exposure to tobacco marketing is consistently related to positive attitudes and beliefs about tobacco use, experimenting with cigarettes, and becoming a smoker, with a dose-response relation between extent of exposure to marketing and risk. These effects are seen with both traditional marketing approaches and other exposures, such as point-of-sale promotion (which represents a substantial proportion of tobacco industries' marketing budgets in many localities), as well as pro-tobacco depictions in films, television shows, and gaming videos. Similar findings are seen across a range of cultural and socioeconomic backgrounds.

On the basis of these well-established relationships, restrictions on advertising and marketing of tobacco products to youth have been a mainstay of anti-tobacco efforts.[477] In general, such restrictions have been implemented as part of multicomponent strategies to reduce smoking, so that the independent magnitude of their effects is difficult to quantify directly. Overall, the clear impact of advertising on tobacco-related attitudes and behaviors[22,474–478] provides robust evidence that the absence or limitation of such influences reduces their pro-tobacco effects in youth. Because the tobacco industry has become highly skilled at exploiting multiple potential traditional and nontraditional avenues for marketing, more complete advertising and promotional bans are more successful than partial restrictions in both developed and developing countries.[479,480] On the basis of this body of convincing evidence, the Framework Convention on Tobacco Control has called for comprehensive bans on tobacco advertising in all nations.[480] A review of internal industry documents, trade publications, published research, and government reports indicates that cigarette packs themselves would remain a key promotional vehicle following such advertising bans, and the mandating of plain packaging of all tobacco products has been recommended.[481]

In sum, there is consistent evidence to support the effectiveness of restrictions on advertising and marketing of tobacco products for reducing tobacco use (Table 8).

Healthcare Systems Approaches

Although a complete systematic review of healthcare systems interventions to improve lifestyle was beyond the scope of this report, the writing group reviewed key evidence for potential effective strategies. A 2010 AHA Scientific Statement provides a strong evidence base for effective behavioral change strategies at the healthcare level.[16] Several approaches have been effective, including (1) individual-oriented sessions to assess readiness for behavior change, collaboratively identify goals, and develop plans to achieve these goals; (2) a focus on specific, proximal goals for targeted behaviors; (3) self-monitoring with oral, written, and/or electronic feedback; (4) group sessions for peer support, group problem solving, and skill development for behavior change; and (5) trained motivational interviewing when persons are ambivalent about change.[36,413] Focused behavior change goals are most effective.[16,36] Thus, clinical providers should work with patients to help prioritize a limited set of relevant food and activity habits and, for smokers, tobacco reduction and cessation goals.[3,4,8,482] The use of multiple educational techniques, including live and media presentations, can improve healthcare provider knowledge about and use of behavioral change.[483] Helpful supplementary approaches for patients include long-term support from family, peers, or community programs, particularly after the initial months, when adherence can wane, and use of electronic feedback.[413,484,485]

Several aspects of healthcare systems can influence and foster these evidence-based behavior change strategies. First, medical training across all levels should incorporate and prioritize education for care providers in these strategies. Healthcare systems should also develop and promote efficient telephone or electronic approaches to monitor diet quality, physical activity, adiposity, and smoking; to schedule and track regular individual or group visits for education and behavioral support; and to provide individualized feedback to patients on their efforts to change behaviors.[486–488] Importantly, healthcare systems should also restructure quality benchmarks and reimbursement guidelines to include specific focus on health behaviors, including dietary quality and physical activity.[486–488]

Whereas relatively few healthcare systems changes have focused on diet or physical activity, several approaches are being initiated for tobacco and obesity control. For instance, many electronic medical records systems have fields for tobacco use and body weight, although consistency and accuracy of their use remains variable. In addition, in 2003, the US Centers for Medicare and Medicaid Services guidelines for pneumonia, heart failure, and MI admissions began to require smoking cessation counseling as a performance measure for reimbursement.[489] The Joint Commission on Accreditation of Healthcare Organizations then added smoking cessation counseling as a criterion for excellence, and the combined quality measure went into effect in January 2005. These measures were successful in increasing counseling,[490] although the effects on tobacco use have not been well studied. One retrospective analysis of 889 consecutive smokers treated for acute MI at 19 US hospitals in 2003–2004 did not find higher smoking cessation rates at 1 year in patients who met the Centers for Medicare and Medicaid Services documentation requirement for counseling compared with those without this documentation.[491] Recently, the Joint Commission announced plans for a requirement to assess smoking and offer cessation counseling to all hospitalized patients.[492]

In sum, specific changes in healthcare systems can be a crucial complement to other population behavior change approaches. These include changes in systems for medical training, electronic medical records, structuring of individual and group visits, patient and provider feedback, quality benchmarks, and reimbursement guidelines.

Surveillance and Monitoring Systems for Informing and Evaluating Population Strategies

Several national and subnational surveillance systems currently exist for monitoring lifestyle habits and related health outcomes in the United States (Supplementary Table 14). Many are coordinated and led by the CDC, for which public health surveillance is a key role; other federal and state agencies also perform surveillance. Examples of different surveillance methodologies for lifestyle factors include telephone-based surveys of adults (eg, the BRFSS, the American Time Use Survey), household studies conducted with questionnaires or face-to-face interviews (eg, the National Health Interview Study), and many that try to reach children and are often conducted in schools (eg, the National Youth Tobacco Survey, the School Health Policies and Programs Study). Some surveillance methods, such as NHANES or the Canadian Health Measures Survey, also capture extensive clinical and laboratory data. NHANES, for example, measures levels of cotinine, a biomarker of nicotine exposure, in a nationally representative sample of smokers, including oversampling of blacks and Mexican Americans. Cotinine measurements made in successive years are used to assess longitudinal trends in both intensity of smoking and exposure to secondhand smoke. International surveillance methods of behavioral data are slowly growing, typically based on cooperation between government agencies in different countries or coordinated by international agencies such as the WHO. Examples include the Global Youth Tobacco Surveillance system and the WHO STEPwise approach to Surveillance surveys (www.who.int/chp/steps/en/). Effective behavioral surveillance systems should include at least the following characteristics:

- Standardized, validated metrics and surrogate markers that include prevalence, incidence, marketing/countermarketing strategies, clinical practice guidelines, and/or environmental changes relating to dietary habits, physical activity, and tobacco use
- Repeated longitudinal assessments conducted at regular intervals with consistent methods
- Assessment of trends in both the overall population and certain subgroups, especially at-risk populations
- Data collection at national, state, and local levels as appropriate
- Methods to minimize unnecessary duplication with other ongoing surveillance efforts

Overall, adequate surveillance and monitoring systems are essential to understand and select appropriate metrics of health behaviors to follow over time; to inform the design of population-level programs to improve these behaviors; to monitor the effects of implemented policies; and to elucidate gaps and barriers in our knowledge and methods. Quantifying the current distributions of behaviors, risk factors, diseases, and their correlates and determinants in the overall population and in more vulnerable subpopulations is necessary for informed selection of specific targets for intervention and for reducing disparities. Quantifying changes and trends over time is necessary to evaluate the impact of interventions on behaviors and related health outcomes.

Gaps in Current Diet, Physical Activity, and Tobacco Surveillance—For most lifestyle behaviors, surveillance is generally self-reported. There are limitations to such data, including under- or overreporting, gaps in memory or recall, or self-bias. More objective measures, such as biomarkers of some dietary habits; pedometer or accelerometer data for physical activity; or plasma, saliva, or urine cotinine levels for smoking are helpful and should be added whenever possible to provide more precise estimations of these behaviors. Conversely, even self-reported dietary activity, physical activity, and tobacco use data are consistently linked to disease risk in numerous studies, and thus self-reported data obtained via standardized, validated questionnaires are a useful mainstay for simple, effective, and cost-efficient surveillance methods.

Tobacco use surveillance methods have improved over time and can be relatively comprehensive, including monitoring of tobacco-related behaviors, prevalence, biomarkers of exposure, attitudes, health outcomes, and policies, as well as marketing and its impact on consumer behavior. Some approaches also capture exposure to secondhand tobacco smoke, existing school curriculum and policies, worksite smoking policies and practices, local community ordinances related to tobacco use and indoor air quality, and prevention policies to advise smokers to quit in the healthcare setting. In the United States, improvements in tobacco surveillance have informed and driven successful, comprehensive tobacco control and prevention policy in recent decades.

In comparison, current methods for monitoring dietary and physical activity habits and related policies, marketing, and practices are relatively crude.[493] Several national health surveys capture no diet or physical activity measures (Supplementary Table 14).[494] Even for those that do, the diversity of exposures makes both dietary and physical activity surveillance more challenging than for tobacco. In the United States, for example, labeled food products comprise up to 600,000 unique UPCs (universal product codes), even after excluding products purchased in small amounts.[495] This complexity is increased by continual reformulation of products by the food industry, which reformulates foods more

frequently (eg, ≈75,000 products every 2 years) than they are measured.[495] The number and diversity of restaurant and other prepared foods add further to the challenge. Many metrics of dietary quality are also not standardized, including, for example, carbohydrate quality (eg, what is the best metric to assess if a product is "whole grain") or added sugars (eg, ≈11% of all US foods/beverages contain fruit juice concentrate as a sweetener, but this is not measured as an "added sugar"). Other limitations of current diet surveillance methods are an inability to link consumption choices systematically with food programs, environmental determinants such as food access, policy changes such as shifts in the Supplemental Nutrition Assistance Program, or economic factors such as income and types of employment.[493,496] More systematic data are also needed on prices and yield of key foods, such as fruits and vegetables, to provide robust data for guiding agricultural policy. Similarly, many surveillance systems capture only certain types of physical activity, such as leisure-time activity and exercise. Other relevant activities are often not assessed, including commuting activity, work activity, total activity (ie, all movements incorporated into activities of daily living), and sedentary activity (eg, TV viewing; other screen time; time spent sitting at work, school, or home).

Innovative methods for incorporating diet, physical activity, and related policy metrics into existing survey systems should also be considered. For example, the USDA collects a national farmers' market manager survey that could include more surveillance data related to both policies and health. Similarly, economic development projects that support supermarkets or grocery stores could include collection of health-related metrics in stores and communities. As recently reviewed by the AHA, several states are implementing new methods for BMI surveillance in children, such as through school immunization records or during wellness visits to the doctor.[443] Such programs can implement BMI surveillance (more widely accepted) or BMI assessment and reporting, ie, identification of children who are overweight or obese, followed by notification of their parents (more controversial). To increase impact, such surveillance should be reported in an aggregate manner to the state Department of Health so that progress can be tracked and ideally passed on to a national database.

A major gap in surveillance is the absence of systematic collation, monitoring, and evaluation of behavior change policies themselves. Such surveillance should occur at local, regional, and national levels and include proposed programs, enactment, implementation, costs, sustainability, reach over time, and, of course, effectiveness.

Recommendations for Use of Current Surveillance Programs—Despite these limitations, current surveillance systems can provide useful information to evaluate the impact of population-level strategies on behavior change, risk factors, and chronic disease, and whether policies have a similar or different impact on particularly vulnerable populations. In the United States, for example, prevalence data from the BRFSS and the National Youth Tobacco Survey have been helpful for determining the impact of raising tobacco excise taxes on tobacco use, especially in youth. NHANES has documented progress in reducing population exposure to secondhand smoke. Local NHANES data could be used to measure urinary sodium levels to assess the impact of sodium reduction in the food supply. The AHA is using NHANES data to monitor progress toward dietary, physical activity, and tobacco goals for achieving cardiovascular health.[3,5] Globally, the WHO STEP data have been important for estimating the impact of low fruit and vegetable consumption on mortality in both developed and developing nations.[13] On the other hand, national-, state-, or even county-level surveillance data may not indicate the effectiveness of some community-based efforts, such as in cities, communities, schools, or workplaces. Local data collection will be crucial in such circumstances. As population strategies increasingly focus on diet, physical activity, and tobacco use, it will be important to identify how current

surveillance systems can inform the effectiveness of such policies and, importantly, refine these surveillance systems over time to help prioritize population approaches and maximize their impact.

RESEARCH GAPS

Several key research gaps were identified. Several particular multicomponent strategies appear promising but require further investigation to confirm effectiveness, such as combining sustained, focused media/education campaigns with local-environment changes to improve physical activity; and combining simple labels/icons with local-environment changes (eg, changes in availability) to improve diet. Results of worksite-based interventions to increase physical activity (eg, by altering the physical environment for use of stairs, setting aside work time for exercise, encouraging walking, or adding a worksite fitness center) are also encouraging but based on a small number of studies.

Additional research is also needed on the effects of several financial and economic strategies. The effects of long-term individual financial incentives and penalties (eg, based on insurance rates) require further study with more robust designs that assess discrete levels and types of incentives, minimize confounding intervention components, and are of sufficient duration to assess sustainability. Similarly, the effects of financial and regulatory requirements on healthcare systems to promote healthy behaviors need more rigorous study. The long-term effects of both small and larger changes in food and beverage pricing on dietary behavior also warrant further investigation, including the potential for unintended consequences on consumption of substitutes and complements for these foods/beverages.

The writing group found a large and rapidly growing number of studies assessing how altering the local community environment may influence diet and physical activity. Several facets of the environment appear promising for interventions, but wide variations in definitions and methods for assessment of environmental exposure, behavioral outcome, and potential confounding variables, as well as in analysis methods, limit the ability to pool or compare results across studies. Better standardization of these methods is needed. Additionally, nearly all of these studies were cross-sectional, limiting inference about the direction of the association: for example, rather than the environment affecting behavior, people may choose to live in neighborhoods having or not having certain characteristics based on their own behavior preferences, or the average preferences of residents in a neighborhood may influence the environment (eg, the types of stores that open and are successful). Thus, more longitudinal and quasi-experimental studies of the local environment and lifestyle are essential.

Major gaps have been identified in the strength of evidence for the effectiveness of several types of interventions and policies that are currently being implemented to improve lifestyle or related health outcomes. These included, for example, the use of front-of-pack labels or icons on packaged foods or menu labeling in restaurants; sustained individual financial disincentives, such as differences in insurance rates, for poor lifestyle; business tax incentives for comprehensive worksite wellness programs; and mandating of an increased number of PE classes led by trained PE teachers at schools. The implementation of policy-level strategies does not always require perfect evidence: risks versus benefits and associated costs and alternative approaches may warrant implementation even without strong evidence. Nonetheless, these findings highlight the need for integrated rigorous evaluation of the impact of these policies on targeted behaviors and health outcomes as they are implemented in practice.

For many interventions, there was limited and/or inconsistent evidence to evaluate the potential heterogeneity of effects, eg, depending on the population (children, adults, specific

vulnerable subgroups, etc) or level of intervention (local, state, federal). For some strategies, such as media and education campaigns or labeling and information approaches, a few studies suggested less effectiveness or awareness in lower education or minority subgroups, but others did not. In contrast, for other strategies, such as taxation or subsidies, more consistent evidence suggested stronger effects in youth, lower income, or disadvantaged populations. Similarly, local environmental strategies appeared to hold particular promise in disadvantaged subgroups, largely based on greater potential for improving the environment in such neighborhoods; however, nearly all studies were cross-sectional, limiting inference about the effectiveness of such approaches in any population. Direct restrictions and mandates appear especially promising for influencing the entire population and even reducing disparities, given that their targets (eg, excess intake of unhealthy foods, insufficient intake of healthy foods, tobacco use) are often concentrated in disadvantaged subgroups. Further investigation of the potential heterogeneity for each of these strategies is needed, in particular because identified heterogeneity could be useful, for example, to select interventions with stronger effects in vulnerable subpopulations.

For some approaches, such as labeling/information and school and workplace strategies, the long-term sustainability of consequent behavior changes was not well-established. The effectiveness of many individual-based (eg, clinical) behavior change strategies are known to wane over time when the intervention ceases.[16] This also appeared to be true for many types of population-based interventions, such as media or education approaches, for which sustained population responses required ongoing educational efforts. On the other hand, an advantage of many of the identified population-based strategies was their potential for inherent sustainability, for example by altering the physical environment, pricing or availability of products, or legal or social acceptance of specific products or behaviors.

Finally, although much can be done with current national and international surveillance systems, the writing group identified the need for further improvements, especially for dietary, physical activity, and sedentary behaviors, to better capture these lifestyle factors and also their relevant determinants, such as policies, environmental correlates, and industry practices.

CONCLUSIONS

This systematic review identified and graded a range of evidence-based population-based strategies to effectively promote lifestyle change. The findings inform potential partnerships and strategies to successfully address suboptimal diet, inactivity, and smoking, which are each major preventable causes of poor health globally. New strategic initiatives and partnerships are needed to translate this evidence into action.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Summary of Evidence-Based Population Approaches for Improving Diet, Increasing Physical Activity, and Reducing Tobacco Use.*

Diet	
Media and education	• Sustained, focused media and education campaigns, using multiple modes, for increasing consumption of specific healthful foods or reducing consumption of specific less healthful foods or beverages, either alone (IIa B) or as part of multicomponent strategies (I B)†‡§
	• On-site supermarket and grocery store educational programs to support the purchase of healthier foods (IIa B)†
Labeling and information	• Mandated nutrition facts panels or front-of-pack labels/icons as a means to influence industry behavior and product formulations (IIa B)†
Economic incentives	• Subsidy strategies to lower prices of more healthful foods and beverages (I A)†
	• Tax strategies to increase prices of less healthful foods and beverages (IIa B)†
	• Changes in both agricultural subsidies as well as other related policies to create an infrastructure that facilitates production, transportation, and marketing of healthier foods, sustained over several decades (IIa B)†
Schools	• Multicomponent interventions focused on improving both diet and physical activity, including specialized educational curricula, trained teachers, supportive school policies, a formal PE program, healthy food and beverage options, and a parental/family component (I A)†
	• School garden programs, including nutrition and gardening education and hands-on gardening experiences (IIa A)†
	• Fresh fruit and vegetable programs that provide free fruits and vegetables to students during the school day (IIa A)†
Workplaces	• Comprehensive worksite wellness programs with nutrition, physical activity, and tobacco cessation/prevention components (IIa A)†
	• Increased availability of healthier food/beverage options and/or strong nutrition standards for foods and beverages served, in combination with vending machine prompts, labels, or icons to make healthier choices (IIa B)†
Local environment	• Increased availability of supermarkets near homes (IIa B‖)†‡
Restrictions and mandates	• Restrictions on television advertisements for less healthful foods or beverages advertised to children (I B)†
	• Restrictions on advertising and marketing of less healthful foods or beverages near schools and public places frequented by youths (IIa B)†
	• General nutrition standards for foods and beverages marketed and advertised to children in any fashion, including on-package promotion (IIa B)†
	• Regulatory policies to reduce specific nutrients in foods (eg, *trans* fats, salt, certain fats) (I B)†§
Physical activity	
Media and education	• Sustained, focused media and education campaigns, using multiple modes, to promote physical activity (IIa B)†

Labeling and information	• Point-of-decision prompts to encourage use of stairs (IIa A)[†]
Economic incentives	• Increased gasoline taxes to increase active transport/commuting (IIa B)[†]
Schools	• Multicomponent interventions focused on improving both diet and physical activity, including specialized educational curricula, trained teachers, supportive school policies, a formal PE program, serving of healthy food and beverage options, and a parental/family component (IIa A)[†] • Increased availability and types of school playground spaces and equipment (I B)[†] • Increased number of PE classes, revised PE curricula to increase time in at least moderate activity, and trained PE teachers at schools (IIa A/IIb A[¶])[†] • Regular classroom physical activity breaks during academic lessons (IIa A)[†§]
Workplaces	• Comprehensive worksite wellness programs with nutrition, physical activity, and tobacco cessation/prevention components (IIa A)[†] • Structured worksite programs that encourage activity and also provide a set time for physical activity during work hours (IIa B)[†] • Improving stairway access and appeal, potentially in combination with “skip-stop” elevators that skip some floors (IIa B)[†] • Adding new or updating worksite fitness centers (IIa B)[†]
Local environment	• Improved accessibility of recreation and exercise spaces and facilities (eg, building of parks and playgrounds, increasing operating hours, use of school facilities during nonschool hours) (IIa B)[†] • Improved land-use design (eg, integration and interrelationships of residential, school, work, retail, and public spaces) (IIa B)[†] • Improved sidewalk and street design to increase active commuting (walking or bicycling) to school by children (IIa B)[†] • Improved traffic safety (IIa B)[†] • Improved neighborhood aesthetics (to increase activity in adults) (IIa B)[†] • Improved walkability, a composite indicator that incorporates aspects of land-use mix, street connectivity, pedestrian infrastructure, aesthetics, traffic safety, and/or crime safety (IIa B)[†]
Smoking	
Media and education	• Sustained, focused media and education campaigns to reduce smoking, either alone (IIa B) or as part of larger multicomponent population-level strategies (I A)[†]
Labeling and information	• Cigarette package warnings, especially those that are graphic and health related (I B)[†‡§]
Economic incentives	• Higher taxes on tobacco products to reduce use and fund tobacco control programs (I A)[†‡§]
Schools and workplaces	• Comprehensive worksite wellness programs with nutrition, physical activity, and tobacco cessation/prevention components (IIa A)[†]
Local environment	• Reduced density of retail tobacco outlets around homes and schools (I B)[†]

	• Development of community telephone lines for cessation counseling and support services (I A)[†]
Restrictions and mandates	• Community (city, state, or federal) restrictions on smoking in public places (I A)[†] • Local workplace-specific restrictions on smoking (I A)[†‡§] • Stronger enforcement of local school-specific restrictions on smoking (IIa B)[†] • Local residence-specific restrictions on smoking (IIa B)[†§] • Partial or complete restrictions on advertising and promotion of tobacco products (I B)[†]

PE indicates physical education.

[*] The specific population interventions listed here are either a Class I or IIa recommendation with an evidence grade of either A or B. The AHA evidence grading system for class of recommendation and level of evidence is summarized in Table 2. Because implementation of population-level strategies does not require perfect evidence but rather consideration of risks versus benefits, associated costs, and alternate approaches, the absence of any specific strategy herein does not mean it should not also be considered for implementation.

[†] At least some evidence from studies conducted in high-income Western regions and countries (eg, North America, Europe, Australia, New Zealand).

[‡] At least some evidence from studies conducted in high-income non-Western regions and countries (eg, Japan, Hong Kong, South Korea, Singapore).

[§] At least some evidence from studies conducted in low- or middle-income regions and countries (eg, Africa, China, Pakistan, India).

[||] Based on cross-sectional studies only; only 2 longitudinal studies have been performed, with no significant relations seen.

[¶] Evidence IIa A for improving physical activity; evidence IIb B for reducing adiposity.

Table 2

Classification of Recommendations and Level of Evidence for Population-Level Interventions

- The recommendation for any particular intervention is classified as follows*:

Class I. There is evidence for and/or general agreement that the intervention is beneficial, useful, and effective. The intervention should be performed.

Class II. There is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of the intervention.

Class IIa. Weight of evidence/opinion is in favor of usefulness/efficacy. It is reasonable to perform the intervention.

Class IIb. Usefulness/efficacy is less well established by evidence/opinion. The intervention may be considered.

Class III. There is evidence and/or general agreement that the intervention is not useful/effective and in some cases may be harmful.

- In addition, the weight of evidence in support of the recommendation is classified as follows:

Level of Evidence A. Data derived from multiple randomized clinical trials or, given the nature of population interventions, from well-designed quasi-experimental studies combined with supportive evidence from several other types of studies.†

Level of Evidence B. Data derived from a single randomized trial or nonrandomized studies.

Level of Evidence C. Only consensus opinion of experts, case studies, or standard of care.

*Strength and consistency of the evidence were key considerations for setting the recommendation class, including across different types of study designs, permutations of the intervention strategy and related strategies, implementation settings, and outcomes, including behavioral, risk factor, and clinical end points.

†Due to practical and ethical challenges, evaluation of many population approaches does not lend itself well to typical, medical-model, RCTs. Well-designed quasi-experimental studies, such as time-trend data comparing behaviors and outcomes before versus after an intervention, especially when combined with careful consideration of additional time-varying confounding variables and/or additional data on behaviors and outcomes in similar localities without an intervention, were considered a particularly important means to evaluate the effectiveness of population interventions. Consistent findings from several well-designed quasi-experimental evaluations across populations and outcomes, when combined with supportive evidence from other types of studies including at least some randomized controlled trials demonstrating short-term efficacy of similar strategies, were considered sufficient to merit level of evidence A for population interventions.

Table 3

Media and Education Campaigns*

		Class/Evidence Grade
Diet	• Sustained, focused media and education campaigns, using multiple modes (eg, print, radio, internet, television, social networking, other promotional materials), focused on increasing consumption of specific healthful foods	I B
	• Sustained, focused media and education campaigns, using multiple modes, for reducing consumption of specific less healthful foods/beverages	IIa B
	• Sustained, focused media and education campaigns as part of multicomponent community or national strategies to increase consumption of specific healthful foods/beverages or reduce consumption of less healthful foods/beverages	I B
	• Shorter-term community-based media and education programs that target multiple cardiovascular risk factors and behaviors simultaneously	IIb B
	• On-site supermarket and grocery store educational programs to support purchase of healthier foods	IIa B
Physical activity	• Sustained, focused media and education campaigns, using multiple modes, to promote physical activity	IIa B
	• Shorter-term community-based media and education programs that target multiple cardiovascular risk factors and behaviors simultaneously	IIb B
Smoking	• Sustained, focused media and education campaigns as part of larger multicomponent population-level strategies†	I A
	• Sustained, focused media and education campaigns alone†	IIa B

*Several of these strategies overlap with other population approaches and could be categorized in multiple areas (other Tables). For example, school- and workplace-based educational strategies are reviewed in the section “School and Workplace Approaches.” Given the scope of topics covered in this report, the writing group could not review evidence for every type of intervention, eg, evidence for media and education campaigns to reduce sedentary activities.

†Factors that increase effectiveness include greater duration and dose of exposure to the media campaign and use of strong negative messages about health.

Table 4

Labeling and Consumer Information*

		Class/Evidence Grade
Diet	• Detailed nutrition facts panels on packaged foods and beverages	III B
	• Simplified front-of-pack or point-of-purchase labels or icons to support healthier choices, such as a “healthy choice” icon, “traffic light” label, or monochrome or colored Guideline Daily Amount label, on packaged foods or in grocery stores, cafeterias, vending machines, or restaurants	IIb A†
	• Menu labeling at restaurants or cafeterias to provide consumers with calorie or other nutrient information on in-store menus and menu boards	IIb A
	• Mandated nutrition facts panels or front-of-pack labels/icons as a means to influence industry behavior and product formulations	IIa B
Physical activity	• Point-of-decision prompts to encourage use of stairs	IIa A‡
Smoking	• Cigarette package warnings, especially those that are graphic and health related	I B

*Several of these strategies overlap with other population approaches and could be categorized in multiple areas (other Tables). Given the scope of topics covered in this report, the writing group could not review evidence for every type of intervention, eg, evidence for labeling of cigarette packages for nicotine and tar contents or delivery; point-of-purchase warnings or messages about harm of tobacco use; or rating movies on the presence or depictions of smoking.

†On the basis of a limited number of quasi-experimental studies, the evidence grade is IIa B when such labeling is combined with additional environmental changes, such as availability and locations of types of foods sold in cafeterias.

‡On the basis of modest effect sizes in short-term, quasi-experimental studies; relatively few controlled or long-term studies have been performed.

Table 5

Taxation, Subsidies, and Other Economic Incentives*

		Class/Evidence Grade
Diet†	• Subsidy strategies to lower prices of more healthful foods and beverages	I A
	• Tax strategies to increase prices of less healthful foods and beverages	IIa B
	• Changes in agricultural subsidies to encourage certain crops (eg, fruits, vegetables) and/or reduce other major commodity crops as a means to alter consumption	IIb C
	• Changes in both agricultural subsidies as well as other related policies to create infrastructure that facilitates production, transportation, and marketing of healthier foods, sustained over several decades	IIa B
	• Sustained individual financial disincentives for adiposity or poor diets (eg, higher insurance premiums or deductibles, other surcharges) and/or financial incentives for healthier weight or better diets	IIb C
	• Shorter-term (nonsustained) workplace-based financial incentives to employees to promote healthier diets	IIb A
	• Financial incentives to support building of supermarkets and grocery stores in underserved areas	IIb C‡
	• Direct, nonsustained individual financial incentives for improved diet or weight loss	IIb A§
	• Sustained individual financial disincentives for poor diet as assessed by adiposity (eg, differences in insurance premiums, deductibles, or surcharges).	IIb C
	• Tax incentives to employers to offer comprehensive worksite wellness programs with nutrition, physical activity, and tobacco cessation/prevention components	IIb C
Physical activity†	• Tax incentives for individuals to purchase exercise equipment or health club/fitness memberships	IIb C
	• Increased gasoline taxes to increase active transport/commuting	IIa B
	• Direct, nonsustained individual financial incentives for increased activity/fitness or weight loss	IIb A‡
	• Sustained individual financial disincentives for adiposity or lower activity/fitness (eg, differences in insurance premiums, deductibles, or surcharges)	IIb C
	• Tax incentives to employers to offer comprehensive worksite wellness programs with nutrition, physical activity, and tobacco cessation/prevention components	IIb C
Smoking	• Higher taxes on tobacco products to reduce use and fund tobacco control programs	I A
	• Direct, nonsustained individual financial incentives for tobacco cessation	IIb A‡
	• Sustained individual financial disincentives for tobacco use and/or financial incentives for cessation or non-use (eg, differences in insurance premiums, deductibles, or surcharges)	IIa C
	• Tax incentives to employers to offer tobacco cessation/prevention or comprehensive worksite wellness programs including tobacco cessation/prevention components	IIb C

*Several of these strategies overlap with other population approaches and could be categorized in multiple areas (other Tables). Given the scope of topics covered in this report, the writing group could not review evidence for every type of intervention.

†See Table 7 for local community built–environment strategies that could be directly influenced by financial or economic incentives, such as (for diet) numbers and locations of supermarkets or fast-food restaurants, types of foods available in retail outlets, availability of community gardens and farmers' markets, etc, and (for physical activity) building of parks, transport systems, land-use mix, etc.

[‡]This class/evidence is for effects of such financial incentives on diet and related health outcomes. The class/evidence for effects of neighborhood availability of supermarkets and grocery stores on diet and related health outcomes is I B and IIb B, respectively (Table 7).

[§]Behavior changes often do not persist after financial incentives are removed, and these strategies also appear to work less well for complex behaviors such as diet or weight loss.

Table 6

School and Workplace Approaches*

		Class/Evidence Grade
Diet†	Schools	
	• School garden programs, including nutrition and gardening education and hands-on gardening experiences	IIa A
	• Fresh fruit and vegetable programs that provide free fruits and vegetables to students during the school day	IIa A
	• Multicomponent interventions focused on improving both diet and physical activity, including educational curricula taught by trained teachers, supportive school policies, a formal PE program, serving of healthy food and beverage options in school cafeterias and vending machines, and a parental or family component	I A
	• School-based educational initiatives alone, without other components	IIb A
	• Restricted accessibility (eg, locations, times of use) to school vending machines	IIb B
	• Provision of cold filtered water and reusable water bottles at schools, with education and promotion of water use	IIb B
	Workplaces	
	• Comprehensive worksite wellness programs with nutrition, physical activity, and tobacco cessation/prevention components	IIa A¥
	• Worksite cafeteria or vending machine prompts, labels, or icons alone to make healthier choices	IIb B
	• Increased availability of healthier food/beverage options and/or strong nutrition standards for foods and beverages served, in combination with vending machine prompts, labels, or icons to make healthier choices	IIa B
Physical activity†	Schools	
	• Multicomponent interventions focused on improving both diet and physical activity, including educational curricula taught by trained teachers, supportive school policies, a formal PE program, serving of healthy food and beverage options in school cafeterias and vending machines, and a parental or family component	IIa A
	• Increased availability and types of school playground spaces and equipment	I B
	• Increased number of PE classes, revised PE curricula to increase time in at least moderate activity, and employment of trained PE teachers at schools	IIa A‡
		IIb A‡
	• Regular classroom physical activity breaks during academic lessons	IIa A§
	• Increasing active commuting to school, eg, a walking school bus program with supervised walking routes to and from school	IIb B
	Workplaces	
	• Comprehensive worksite wellness programs with nutrition, physical activity, and tobacco cessation/prevention components	IIa A‖
	• Structured worksite programs that encourage activity and also provide a set time for physical activity during work hours	IIa B§
	• Improving stairway access and appeal, potentially in combination with “skip-stop” elevators that skip some floors	IIa B§
	• Adding new or updating worksite fitness centers	IIa B§
Smoking	• Comprehensive worksite wellness programs with nutrition, physical activity, and tobacco cessation/prevention components	IIa A‖

	Class/Evidence Grade
• See Table 7 for local environment changes and Table 8 for smoking restrictions related to schools and workplaces.[¶]	

PE indicates physical education.

[*] Several of these strategies overlap with other population approaches and could be categorized in multiple areas (other Tables). Given the scope of topics covered in this report, the writing group could not review evidence for every type of intervention, eg, evidence for increasing coverage of and participation in school lunch programs, creating after- or before-school activity programs, regulatory policies to limit screen time in preschool and after-school programs, curricula on hazards of smoking taught by trained teachers at school..

[†] See Table 4 for strategies related to labeling and information approaches to increase consumption of more healthful foods and beverages in cafeterias and vending machines and increase use of stairs; see Table 5 for economic incentives for employees or businesses to improve diet and increase physical activity.

[‡] Evidence IIa A for improving physical activity; evidence IIb B for reducing adiposity.

[§] The evidence is sufficiently consistent for a IIa recommendation but only based on a small number of studies, and additional research is required.

[||] Although studies have varied in methodologic quality, been modest in size (N<400 each), and typically not evaluated sustainability beyond 6–12 mo, interventions targeting higher-risk employees appear especially effective.

[¶] See Table 7 for reducing density of tobacco retail outlets around schools. See Table 8 for smoking restrictions on school campuses, restrictions on tobacco advertising and promotion, and increased enforcement of anti-tobacco regulations around schools. See Table 5 for economic incentives for individuals or businesses to reduce tobacco use and Table 8 for smoking restrictions at workplaces.

Table 7

Local Environmental Change (Community Settings)*

		Class/Evidence Grade
Diet	• Increased availability of supermarkets near homes	IIa B†
	• Increased availability of grocery stores near homes	IIb B
	• Reduced availability of convenience stores near homes	IIb B
	• Reduced availability of fast-food restaurants near homes	IIb B
	• Reduced availability of fast-food restaurants near schools	IIb B
	• Changes in in-store availability of healthier or less healthy foods	IIb B
	• Increased availability of farmers' markets	IIb B
	• Increased availability of community gardens	IIb C
Physical activity	• Improved accessibility of recreation and exercise spaces and facilities (eg, building of parks and playgrounds, increasing operating hours, use of school facilities during nonschool hours)	IIa B
	• Improved land-use design (eg, integration and interrelationships of residential, school, work, retail, and public spaces)	IIa B
	• Improved sidewalk and street design (eg, network of sidewalks, street crossings, and bike lanes to create a safe and comfortable environment that connects to schools, parks, and other destinations)	IIa B‡ IIb B
	• Improved traffic safety	IIa B
	• Improved personal safety (eg, crime related)	IIb B
	• Improved neighborhood aesthetics (eg, appeal, greenness, cleanliness, enjoyable scenery)	IIa B§ IIb B
	• Improved walkability (composite indicator of land-use mix, street connectivity, pedestrian infrastructure, aesthetics, traffic safety, and/or crime safety)	IIa B
Smoking‖	• Reducing density of retail tobacco outlets around homes and schools	I B
	• Development of community telephone lines for cessation counseling and support services	I A¶

RCTs indicates randomized controlled trials.

*Nearly all of the evidence for these local environment approaches is derived from cross-sectional studies only. Several of these strategies overlap with other population approaches and could be categorized in multiple areas (other Tables). Given the scope of topics covered in this report, the writing group could not review evidence for every type of intervention, eg, community building codes to require access to and maintenance of drinking water fountains (evidence for school-based drinking water policies is summarized in Table 6); community group-based physical activity programs or classes; financial incentives or disincentives for remote or nearby parking and drop-off zones.

†Based on cross-sectional studies only; only 2 longitudinal studies have been performed, with no significant relations seen.

‡IIa B for presence and better quality of sidewalks or biking paths for increasing active commuting to school by children. IIb B for street connectivity and active commuting by children; sidewalks or street design and overall physical activity in children; and sidewalks or street design and physical activity by adults.

[§] IIa B for adults; IIb B for children.

[||] See Table 8 for smoking restrictions or better enforcement of existing restrictions in schools, workplaces, or other public places.

[¶] This strategy has been tested largely in individual-based RCTs within communities. The writing group identified 1 additional controlled trial that tested this strategy by randomizing communities.

Table 8

Direct Restrictions and Mandates*

		Class/Evidence Grade
Diet†	• Restrictions on television ads for less healthful foods or beverages aimed at children	I B
	• Restrictions on advertising and marketing of less healthful foods or beverages near schools and public places frequented by youths	IIa B
	• General nutrition standards for foods and beverages marketed and advertised to children in any fashion, including on-package promotion	IIa B
	• Regulatory policies to reduce specific nutrients in foods (eg, *trans* fats, salt, certain fats).	I B
	• Mandates to support production of healthier types of foods (eg, more fruits, vegetables, whole grains)	IIa C
Physical activity†	• Development of specific national guidelines for physical activity modes and amounts, which can then influence other legislative initiatives that impact physical activity, such as legislation dealing with schools and workplaces, transportation funding, the built environment, and regulation of public lands, among others	IIA C
Smoking	• Community (city, state, or federal) restrictions on smoking in public places	I A
	• Local workplace-specific restrictions on smoking	I A
	• Presence of local school-specific restrictions on smoking	IIb B
	• Stronger enforcement of local school-specific restrictions on smoking	IIa B
	• Local residence-specific restrictions on smoking	IIa B
	• Partial or complete restrictions on advertising and promotion of tobacco products	I B
	• Mandatory plain packaging	I C

*Several of these strategies overlap with other population approaches and could be categorized in multiple areas (other Tables). Given the scope of topics covered in this report, the writing group could not review evidence for every type of intervention, eg, regulation of tobacco constituents, such as banning certain characterizing flavoring, setting minimum age limits for smoking or purchasing tobacco, restrictions on smoking in movies.

†See Tables 6 and 7 for school and workplace-related approaches and local community built-environment strategies, respectively, for improving diet and physical activity.