

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

Dariusz Mozaffarian, Ashkan Afshin, Neal L. Benowitz, Vera Bittner, Stephen R. Daniels, Harold A. Franch, David R. Jacobs, Jr, William E. Kraus, Penny M. Kris-Etherton, Debra A. Krummel, Barry M. Popkin, Laurie P. Whitsel and Neil A. Zakai

on behalf of the American Heart Association Council on Epidemiology and Prevention, Council on Nutrition, Physical Activity and Metabolism, Council on Clinical Cardiology, Council on Cardiovascular Disease in the Young, Council on the Kidney in Cardiovascular Disease, Council on Peripheral Vascular Disease, and the Advocacy Coordinating Committee

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Population Approaches to Improve Diet, Physical Activity, and Smoking Habits

A Scientific Statement From the American Heart Association

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Background—Poor lifestyle behaviors, 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 educational 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.

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. (*Circulation*. 2012;126:1514-1563.)

Key Words: AHA Scientific Statements ■ diet ■ nutrition ■ obesity ■ overweight ■ physical activity ■ prevention ■ public policy ■ smoking

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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 are largely caused by 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 Initiative¹⁵ 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 educational 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 regions of the Western world, 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 evidence for efficacy 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 and which strategies 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 of interventions, 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.

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 educational 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)†‡§
Labeling and information	On-site supermarket and grocery store educational programs to support the purchase of healthier foods (IIa B)† 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 and 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, <i>trans</i> fats, salt, certain fats) (I B)†§
Physical activity	
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)†

(Continued)

Table 1. Continued

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) (Ia B)† Improved land-use design (eg, integration and interrelationships of residential, school, work, retail, and public spaces) (Ia B)† Improved sidewalk and street design to increase active commuting (walking or bicycling) to school by children (Ia B)† Improved traffic safety (Ia B)† Improved neighborhood aesthetics (to increase activity in adults) (Ia B)† Improved walkability, a composite indicator that incorporates aspects of land-use mix, street connectivity, pedestrian infrastructure, aesthetics, traffic safety, and/or crime safety (Ia B)†
Smoking	
Media and education	Sustained, focused media and educational campaigns to reduce smoking, either alone (Ia 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 (Ia 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 (Ia B)† Local residence-specific restrictions on smoking (Ia 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 American Heart Association 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. See the more detailed tables and text below for further information on the evidence for each of these interventions, as well as other strategies that were reviewed.

†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.

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. Because of 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 educational 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 mellitus).

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 reviewed recently.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 (AGRICultural OnLine Access), 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 in the online-only 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 Web site 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. Details of the majority of final included studies are provided in the extensive [Supplementary Tables](#) accompanying this report.

The writing group also reviewed the evidence for health-care 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 strategies³⁸ 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. Changes in knowledge alone were not considered sufficient to merit evidence of efficacy. 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

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.

†Because of practical and ethical challenges, evaluation of many population approaches does not lend itself well to typical, medical-model randomized controlled trials. 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.

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 tri-

als. 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, that is, 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 not often found to support an inference on the potential heterogeneity of efficacy; 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 in the online-only Data Supplement](#)), which are cited throughout the text.

Media and Educational Campaigns

The writing group considered the evidence for the effectiveness of media or educational 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 ("Labeling and Consumer Information").

National, Community, and School-Based Media or Educational 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, such campaigns led to improvements in dietary habits, such as reduced consumption of meat and increased consumption of fruits and vegetables.⁴⁴

Long-term community- and school-based media and educational campaigns have also been effective in improving dietary habits of adults, school-aged 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 other concordant (eg, supermarket-based) activities, are 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 with 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, people 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. 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 educational 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 cardiovascu-

lar 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 compared with control communities.^{61–63} In the latter 2 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 educational 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 government-supported programs to increase local production and consumption of fruits and vegetables (“Taxation, Subsidies, and Other Economic Incentives”; “Direct Restrictions and Mandates”).⁶⁰ Targeted dietary habits improved substantially, with associated substantial declines in population blood cholesterol levels, 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 Direct Restrictions and Mandates. In this 5-year period, the prevalence of hypertension was reduced from 15.0% to 12.1% in men and from 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 mellitus and significant increases in regular exercise. No relevant comparison or control groups were available. However, another community-based, multi-component 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 educational 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-up of many years to decades, which suggests that behavioral changes are sustainable when the media and educational 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 educational programs that target multiple cardiovascular risk factors and behaviors simultaneously have been less successful, which suggests 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 prominently featured as one part of successful multicomponent approaches at both national and community levels; their relative contribution to the overall success is difficult to separate in such multicomponent interventions.

National, Community, and School-Based Media or Educational Campaigns to Increase Physical Activity

Several media and educational 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-olds⁶⁸; 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 American Association of Retired Persons’ (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

Table 3. Media and Educational Campaigns*

		Class/Evidence Grade
Diet	Sustained, focused media and educational 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 educational campaigns, using multiple modes, for reducing consumption of specific less healthful foods/beverages	IIa B
	Sustained, focused media and educational 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 educational 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 educational campaigns, using multiple modes, to promote physical activity	IIb B
	Shorter-term community-based media and educational programs that target multiple cardiovascular risk factors and behaviors simultaneously	IIb B
Smoking	Sustained, focused media and educational campaigns as part of larger multicomponent population-level strategies†	I A
	Sustained, focused media and educational 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 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 educational 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.

evaluation of the national VERB campaign, 6 communities received more intensive advertising and marketing because of 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 educational interventions have also attempted to alter physical activity as 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 study⁴⁹ but without clear benefits in the other 2 studies 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 educational 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 Educational Campaigns to Reduce Tobacco Use

Several comprehensive reviews and other recent reports have evaluated the evidence for the effects of anti-tobacco media and educational 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 focused 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 after 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 the 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 educational campaigns are effective for fostering negative attitudes about smoking, reducing smoking initiation among youth, and promoting smoking cessation among active smokers, especially when sustained and 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 to 2006, ≈60% of US adults reported using the nutrient data on the Nutrition Facts panel, and approximately 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. Some 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 more than men and also people with greater education, existing chronic disease, greater awareness of diet-disease relations, or 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 only 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, written communication, November 21, 2011). In 2006, the United Kingdom Food Standards Agency recommended that United Kingdom 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),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 supermarkets¹⁰⁴ related to front-of-pack logos. 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; that is, 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 been evaluated in several interventional studies. In a quasi-experimental intervention in the United Kingdom, a

front-of-pack icon label for healthfulness had no effect 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 (3–4 weeks) controlled interventions found no effects on sales of labeling low-fat food choices in a vending machine located in a teachers' lounge¹⁰⁹ or placing front-of-pack logos on foods in worksite cafeterias.¹¹⁰ In a 12-month controlled intervention, the addition of 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 increasing 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.

Both observational and quasi-experimental studies have evaluated the impact of point-of-purchase information, such as menu or menu board listing of calories and/or nutrients, on food-purchasing behavior (Supplementary Table 4). In observational analyses, customers who report both 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 a 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 short-term study among college students, posting the caloric content of entrees in a college cafeteria for 14-days led to selection of entrees with lower kilocalories without reducing overall sales revenue.¹¹⁷ Similarly, a short-term 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 Conversely, a study that showed 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, the 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 information¹¹⁵ but did not affect average calorie consumption by patrons of these restaurants in low-income areas of New York City compared with either pre-menu labeling consumption or with consumption in control areas in Newark, NJ.¹²⁰ In a controlled trial, the addition of caloric information to a fast-food menu also did not alter food selection or consumption at a single meal among 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. Conversely, 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 that investigated 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. 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}

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.

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 consistent meaningful effects on dietary behaviors of consumers (Table 4). Indeed, for nutrition facts panels, there is reasonable evidence for little to no effect on diet or even contribution to confusion. Although between 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 sex, education, and underlying disease status (Supplementary Table 3), there is limited objective evidence that these labels or icons produce actual 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 in 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: People <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% (posters) and 6.7% (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 graphic¹³⁶ 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 that included adult smokers from the United States, United Kingdom, Canada, and Australia demonstrated that smokers who noticed 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 quit¹⁴¹ 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, for example, 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 relatively 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 available evidence indicates that warning labels are effective at increasing awareness of health risks, countering attractiveness of cigarette advertisements and packages, and also 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 some analyses of costs on a per-calorie basis.^{149,150} However, less healthful foods often contain more calories and are more energy-dense than many 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 healthful 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 otherwise similar foods can vary substantially due to non-intrinsic factors, such as the type of store in which they are sold.^{157–159} Prices also vary substantially by whether the 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 healthful foods, rather than actual availability or price, were associated with fewer healthful food purchases.¹⁶¹

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 healthful foods/beverages.

This interest has been partly driven by the success of pricing policy for tobacco control, as described below. 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 substantial, for example, up to \$200 million per year in Texas.¹⁶² Effects of these existing US taxes on consumption have not been assessed systematically.

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 performed 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 ($r = \pm 0.7–0.8$).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 have little effect on consumption of less healthy foods or beverages or related risk factors.³¹ For example, a 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, an 18% tax on sugar-sweetened beverages (an amount that had been proposed in New York City) would be estimated to significantly lower consumption per person.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 with a comparison cafeteria.¹⁶⁹

Evidence suggests that price-related reductions in consumption of less healthful foods are replaced, at least not fully, with other price-constant similar foods or beverages. In a cross-sectional analysis among adolescents, each 10% greater price for a fast-food meal was associated with a 3% higher probability of fruit and vegetable consumption, a 0.4 kg/m² lower BMI, and a 5.9% lower prevalence 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.¹⁶⁸ Increases in prices of sugar-sweetened beverages and foods consumed away from home were associated not only with decreases in consumption but also with lower total energy intake, body weight, and insulin resistance. On the basis of this analysis, an 18% tax on sugar-sweetened beverages would be estimated to produce an average annual relative weight loss of 0.99 kg per person 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 subsidizing or lowering prices of more healthful foods to increase their 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 lead low-income US consumers to increase their intake of both fruits and vegetables by $\approx 2\%$ to 5%, at a total cost of \approx \$310 million for fruits and \$270 million for vegetables.¹⁷⁴ On the basis of food consumption data and demand elasticity in the United Kingdom, it was estimated that the combination of taxing less healthy foods and using this revenue to subsidize the price of fruits and vegetables would sufficiently alter consumption to prevent >6000 deaths attributable to CVD and cancer each year.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 $\approx 31\%$) and increased relative availability ($\approx 55\%$) 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 the intervention groups than in control groups (overall, 7.8 versus 4.8 servings per day, $P < 0.001$). Six additional months after the intervention ended, 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 further suggest that changes in food pricing can substantially alter risk of clinical events, with effects evident within relatively short time frames. 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 between-country differences in changes in subsidies and pricing of fats and oils.¹⁸⁰ Also, 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 specific 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 overall effects are proportional to price differences, with relatively larger price changes being linked to

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 and 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 nonuse (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 grade is for effects of such financial incentives on diet and related health outcomes. The class/evidence grade 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.

more meaningful differences in consumption. In addition to the health impact of taxation that results from decreased consumption of less healthy foods and beverages, the additional health impact of the tax 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 sub-

sidized 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, the accompanying systems to increase prices of similar import crops, 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, the array of other long-term US agricultural and related policies and investments over the past 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, legumes, and fish.^{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 on diet. This is supported by experiences in Finland, in which the national extension of a regional media and education campaign to improve diet was accompanied by modifications over time 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, a 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 that included 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 educational 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 innovations⁶⁰; 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 past century suggests that sustained efforts over several decades that alter both agricultural and other related policies to create an infrastructure that facilitates production, transportation, and marketing of healthier foods will 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 and Businesses”), it has not been implemented in any free-living population outside of such programs.

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 “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 whether 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 the price of gas 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 the 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 because of 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”).

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, resulting in lower total price. In 2006, the average total 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 because of 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, at 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 among 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 because of 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-level 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 the incentive programs had ended.

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 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 were generally short-term, the long-term sustainability has not been established.²²²

A review of economic incentives relating to a larger spectrum of preventive behaviors, such as 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 behaviors 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 because of the wide diversity 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, 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, subsidization of 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 additional health benefits beyond changes in BMI.

One systematic review identified 20 such RCTs having interventions of at least 12 weeks' duration, conducted in ages ranging from kindergarten through high school.²²⁵ Overall, about half of the studies (9 of 20) demonstrated significant improvements in BMI *z* score after 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, 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).^{225,233–238} 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 that target both diet and physical activity are described above.

Effects of garden-based education programs in schools have been evaluated in at least 10 controlled trials and quasi-experimental studies, with an additional 3 studies

Table 6. School and Workplace Approaches*

		Class/Evidence Grade
Diet†	Schools	
	School garden programs, including nutrition and gardening education and hands-on gardening experiences	Ila A
	Fresh fruit and vegetable programs that provide free fruits and vegetables to students during the school day	Ila 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	Ilb A
	Restricted accessibility (eg, locations, times of use) to school vending machines	Ilb B
	Provision of cold filtered water and reusable water bottles at schools, with education and promotion of water use	Ilb B
	Workplaces	
	Comprehensive worksite wellness programs with nutrition, physical activity, and tobacco cessation/prevention components	Ila A
	Worksite cafeteria or vending machine prompts, labels, or icons alone to make healthier choices	Ilb 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	Ila 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	Ila 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	Ila A‡ Ilb A‡	
Regular classroom physical activity breaks during academic lessons	Ila A§	
Increasing active commuting to school, eg, a walking school bus program with supervised walking routes to and from school	Ilb B	
Workplaces		
Comprehensive worksite wellness programs with nutrition, physical activity, and tobacco cessation/prevention components	Ila A	
Structured worksite programs that encourage activity and also provide a set time for physical activity during work hours	Ila B§	
Improving stairway access and appeal, potentially in combination with “skip-stop” elevators that skip some floors	Ila B§	
Adding new or updating worksite fitness centers	Ila B§	
Smoking		
Comprehensive worksite wellness programs with nutrition, physical activity, and tobacco cessation/prevention components	Ila A	
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, or 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 to increase use of stairs; see Table 5 for economic incentives for employees or businesses to improve diet and increase physical activity.

‡Ila A for improving physical activity; Ilb B for reducing adiposity.

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

||Although studies have varied in methodological quality, have been modest in size ($n < 400$ each), and typically have not evaluated sustainability beyond 6 to 12 months, 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.

evaluating community-based garden programs for children.^{233–235} These garden 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 trials 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} Both studies demonstrated significant increases in fruit consumption. For example, 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%) in 1 trial; the proportion eating fruit or drinking 100% fruit juice at least twice a day was also increased (39% versus 27%).²³⁷ In the other trial, 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, perhaps due to taste preferences or because fewer choices of vegetables were offered to students (carrots and celery) compared with fruits (apples, oranges, pears, plums, pineapple, and kiwi).

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 educational 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 educational 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 after 1 school 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 home²⁴⁴ 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, although other 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 educational 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; the addition of 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 "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, compared with schools not having these factors, greater moderate daily physical activity was seen in schools with fixed playground equipment (eg, slides, 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 the periods of 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 further 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 and 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 that included a total of >18 000 children and with durations that ranged from 6 months to 3 years.²⁵⁹ Because BMI could be an imperfect end point for physical activity interventions because of 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 such 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 little effects on adiposity (Table 6). Several but not all of these 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 the number of classes or time spent in PE or recess, adding trained PE teachers, use of novel activities such as dance classes), which limits 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, compared with passive commuters (eg, by bus, car), children who actively commute (eg, by 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 in percentage of body fat between groups, even after 2 years. This raises the possibility that increased commuting activity could be offset in part 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 on 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 tobacco use 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 “Local Environmental Change to Reduce Smoking”; the evidence for smoking restrictions on campus and increased enforcement of existing restrictions is discussed in “Direct 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 trials, 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} for example, pooled reductions in weight of 1.26 kg (95% confidence interval [CI], -4.6 to -1.0) and in BMI of 0.5 kg/m^2 (95% CI, -0.8 to -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 the combination of such labeling or other prompts together 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: for example, often outcome measures were 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 than in one with concealed stairs; no differences were seen for women.²⁶⁹ In a 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, approximately one third of employees were satisfied with the skip-stop system, one third were neutral, and one third were dissatisfied. Two years later, approximately 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 “Labeling/Information and Physical Activity.”

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, the addition of 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 reviewed recently.¹⁴⁶ Such programs should include components on 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 ($\approx 13\%$ 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 12–18 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 targeting overall population behaviors, interventions on 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 study²⁸⁸ and the only large longitudinal study²⁸⁹ 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 Overall, most of these studies, although cross-sectional, found links between neighborhood supermarkets and better diets or lower adiposity.

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 women²⁸⁵ 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 mellitus.^{173,290,292,293,298,299} In an analysis in Japan, a greater local density of mixed types of stores (supermarkets, grocery, bakeries, etc) was positively associated with consumption of confectioneries and bread but not meats, fish, fruits and vegetables, or rice.³⁰¹ These studies together provide inconsistent evidence for relations of grocery or convenience stores with diet or risk factors.

A few cross-sectional studies have assessed the relation of neighborhood fast-food restaurants to dietary habits, with generally null associations.^{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 obesity³⁰⁶ and diabetes mellitus²⁹⁸ 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, OR, 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 obesity³⁰⁹ and weight gain over time³¹⁰; the inference for built-environment effects is limited in this study 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 In sum, with some exceptions, most studies did not find evidence for relations of neighborhood fast-food restaurants with diet or risk factors.

A small number of cross-sectional studies have evaluated how accessibility of fast-food restaurants around school (rather than home) relates to adiposity in children.^{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. Few studies have investigated the relation of non-fast-food restaurants with diet-related behaviors. Some cross-sectional studies assessed the relation of neighborhood full-service restaurants with dietary habits, with generally null associations.^{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 mellitus.²⁹⁸ Overall, the evidence for effects of fast-food restaurants near school or non-fast-food restaurants near home remains generally limited.

Only a few identified cross-sectional studies evaluated whether neighborhood in-store availability of foods, typically assessed by shelf space, 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 that evaluated 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} In sum, these findings do not permit strong conclusions about causal effects of in-store relative food space or availability; proprietary industry research on this topic has been extensive and would be helpful if released.

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, 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 mellitus across US counties.^{297,298} Neither analysis found a significant independent relation between the density of farmers' markets and prevalent obesity; 1 analysis observed a significant inverse association with prevalent diabetes mellitus.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

Table 7. Local Environmental Change (Community Settings)*

		Class/Evidence Grade
Diet	Increased availability of supermarkets near homes	Ila B†
	Increased availability of grocery stores near homes	Ilb B
	Reduced availability of convenience stores near homes	Ilb B
	Reduced availability of fast-food restaurants near homes	Ilb B
	Reduced availability of fast-food restaurants near schools	Ilb B
	Changes in in-store availability of healthier or less healthy foods	Ilb B
	Increased availability of farmers' markets	Ilb B
	Increased availability of community gardens	Ilb 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)	Ila B
	Improved land-use design (eg, integration and interrelationships of residential, school, work, retail, and public spaces)	Ila 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)	Ila B‡ Ilb B
	Improved traffic safety	Ila B
	Improved personal safety (eg, crime related)	Ilb B
	Improved neighborhood aesthetics (eg, appeal, greenness, cleanliness, enjoyable scenery)	Ila B§ Ilb B
	Improved walkability (composite indicator of land-use mix, street connectivity, pedestrian infrastructure, aesthetics, traffic safety, and/or crime safety)	Ila 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¶

*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.

‡Ila B for presence and better quality of sidewalks or biking paths for increasing active commuting to school by children. Ilb 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.

§Ila B for adults; Ilb 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 randomized controlled trials within communities. The writing group identified 1 additional controlled trial that tested this strategy by randomizing communities.

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, which limits inferences 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 provided grants and loans to increase the number of supermarkets or grocery stores in underserved state communities. The impact of these and similar programs on dietary behaviors, 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 asso-

ciated 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 writing group found that the most consistent evidence for associations of community environment with diet was seen for accessibility of home 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-related (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 2001 sanitation department and geographic information systems data, Block et al mapped all fast-food restaurants in New Orleans, LA.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 2.59 square kilometer (1 square mile) compared with predominantly white neighborhoods. Similar findings were seen in St Louis, MO,³³¹ and South Los Angeles, CA,³³² where 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 in terms of both 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 approximately half as many chain supermarkets as predominantly white communities, and predominantly Latino communities had approximately one third as many as did largely non-Latino communities ($P < 0.01$ each).

A systematic review evaluated 45 observational studies published between January 1995 and January 2009 that assessed various built-environment 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 neigh-

borhood 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 modifies 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 on the basis of individual perception (self-report), direct observation (eg, from community audits), or existing databases in combination with geographic information systems. 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 factors linked to greater 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-environment 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, which limits inferences 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 on the basis of varying metrics incorporating the types, variety, and physical interrelationships of land use (eg, residential, school, entertainment, retail, office) near home. A few studies evaluated simpler 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 original 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 greater), 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, which evaluated 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 after 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 have observed relatively consistent and robust relationships between more diverse land-use mix, that is, 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; for example, 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

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.

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 and adolescents 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 urbanization 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 girls but not in boys³⁶²; 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 added a new Safe Routes to School construction project increased both their active commuting to school and general walking compared with children whose route did not have a Safe Routes to School project added. 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 populations³³⁷ 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, fewer 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, TN, 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, which found 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 have evaluated sidewalks and general physical activity in children, street design and general physical activity or active commuting in adults, or sidewalks or street design and adiposity in adults, which limits 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 adipos-

ity.^{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 Health³⁴⁶ (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- 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} The identified studies were generally cross-sectional. 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-environment 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 that used 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 studies have evaluated whether neighborhood aesthetics such as vegetation or green space, enjoyable scenery, and physical disorder (eg, garbage, broken glass) are linked to physical activity or adiposity (Supplementary Table 10e). Recent systematic reviews collectively evaluated ≈ 20 cross-sectional studies, approximately half in children and half in adults.^{334,337,339,354,356} In children, findings were 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 also varied, including active commuting, overall physical activity, or adiposity. Only approximately half of the investigated relationships were statistically 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, 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 in adults.^{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, which limits 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 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 studies (Supplementary Table 10f). Although the numbers of studies were relatively limited, nearly all found either self-reported or geographic information systems-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 fewer 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 studies in both youth and adults have demonstrated positive associations between density of 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) than in 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

Community services, such as telephone counseling, may assist with smoking cessation (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 12 months in 1 study and at 6 months (but not 18 months) in another.^{383,384} 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, suggests that such an approach at the community level would be effective for reducing tobacco

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, <i>trans</i> 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, for example, regulation of tobacco constituents, such as banning certain characterizing flavoring; setting minimum age limits for smoking or purchasing tobacco; or restrictions on showing 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.

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 reports³⁸⁸ and more recent studies support these findings (Supplementary Table 12).³⁸⁹

The IOM committee and 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. Approximately 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, a 2009 IOM report 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; the Netherlands bans advertising of sweets to children ≤12 years of age; and the United Kingdom bans advertising in or around

television programs aimed at or likely to appeal to children ≤ 15 years of age. Sweden, Norway, and Quebec, Canada, 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 that incorporated legislative restrictions on the maximum salt content of certain foods in the 1990s and the 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 approximately 14.5 g in men (unknown in women) to approximately 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 approximately 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 assessed separately.

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 $\approx 3.5\%$ energy and increased consumption of polyunsaturated fat by $\approx 5.5\%$ 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 was estimated to explain approximately 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 increased soybean oil as its replacement.³⁹⁶ The resulting increases healthful polyunsaturated fat contributed to the substantial population improvements in blood cholesterol levels.³⁹⁶

Beyond this, relatively limited evidence was identified on policy or legislative mandates to increase the production or availability of more healthful foods. As described in 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. 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, such as 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 2008⁹ 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 "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 clinical events 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 were related to particular coronary events. Durations of follow-up from implementation of the ban to assessment of 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 $\approx 6\%$ 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 people 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 after implementation of smoking bans.^{415–418} Herman and Walsh⁴¹⁵ 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. When counties with no prior bans were compared with those with prior bans, Herman and Walsh 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 was not expected to be affected by the smoking ban. Trachsel et al found a 22% lower rate of incident acute MI in the year after 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 $\approx 100\,000$ in these years but also had a large transient tourist population. Rates in both residents and nonresidents were lower, which suggests 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. 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.

As described 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 various levels of compliance with and enforcement of the bans. Localities with the least preexisting partial bans experienced the largest effects of reduced smoking exposure caused by the broader bans.

In all these studies, other factors potentially associated with the 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 people initiating a 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 asthma⁴²⁰ 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 report⁴⁰¹ 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 in part through lower exposure to secondhand smoke and possibly other concomitant effects (Table 8). The pooled analysis suggests a substantial overall effect that increases over time.⁴¹³

Workplace-Based Restrictions on Smoking

Several studies have evaluated smoking restrictions in the workplace (Supplementary Table 13). In a systematic review and meta-analysis of 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 (95% CI, 2.4–3.8).⁴²⁴ Overall, smoke-free workplace policies were associated with a 29% reduction (95% CI, 11%–53%) in total cigarettes smoked. A more recent systematic review that included 37 studies, including 13 quasi-experimental studies, demonstrated similar results, with smoke-free policies in the workplace (majority of studies) or community (some studies) linked to reduced prevalence of active smoking, more at-

tempts 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 people 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 ban⁴³⁴ 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 teenaged workers in worksites.⁴³⁹

Smoke-free workplace policies have also been associated with lower exposure to secondhand smoke. In a systematic review, studies using either self-reported (n=3) or biochemical (n=3) measures of exposure all found significant reductions in secondhand smoke exposure after implementation of a smoke-free workplace policy.⁴²⁴ 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 than 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. After 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 and 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 (1–4 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 (2–5-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 and 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; and less smoking, less progression to experimentation, 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 advertising 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 after 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 people 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 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}

Although relatively few healthcare systems changes have focused on diet or physical activity specifically, 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 to 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 than in 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 Hispanics. 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 factors 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/). Based on the writing group's review, effective behavioral surveillance systems should include at least the following characteristics:

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

naires 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 monitoring of marketing and its impact on consumer behavior. Some approaches also capture exposure to second-hand 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 knowledge, attitudes, policies, marketing, and industry 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 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 the exclusion of products purchased in small amounts.⁴⁹⁴ This complexity is increased by continual reformulation of products by the food industry, which reformulates foods more frequently (eg, $\approx 75\ 000$ 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 whether a product is “whole grain”) or added sugars (eg, $\approx 11\%$ 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 a variety of determinants, including food programs, food access, policy changes (eg, shifts in the Supplemental Nutrition Assistance Program), and 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 diet, policies, and health. Similarly, economic development projects that support supermarkets or grocery stores could include collection of diet and 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, as well as 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 The 2010 Global Burden of Diseases project will substantially expand the assessment of global dietary risk factors,⁴⁹⁷ and updates of this work will be important to assess dietary changes over time and the impact of national dietary policies. Local surveillance is also important, as national-, state-, or even county-level surveillance data may not be sufficient to assess the effectiveness of some community-based efforts, such as in cities, communities, schools, and 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/educational 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. While sufficient evidence exists to implement changes in food and beverage pricing to improve dietary behavior, more research should assess the potential additional effects 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 exposures, behavioral outcomes, 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, which limits 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 were identified in the strength of evidence for effectiveness of several types of interventions and policies that are currently being implemented. These include, for example, the use of front-of-pack labels or icons on packaged foods or of 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 without an accompanying multicomponent strategy. 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 or inconsistent evidence to evaluate the potential heterogeneity of effects, for example, depending on the population (children, adults, specific vulnerable subgroups, etc) or level of intervention (local, state, federal). For some strategies, such as media and educational 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 or 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, which limits inferences 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 some 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.

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Penny M. Kris-Etherton	Pennsylvania State University	Almond Board of California†; National Cattleman's Beef Association†; The Peanut Institute†	None	None	None	None	American Society for Nutrition and National Restaurant Association's Healthy Restaurant Initiative and Menu Partnership*; Building a Healthier America*; California Walnut Commission*; Health Fitness Corporation*; MonaVie†; Unilever*	None
Debra A. Krummel	University of Cincinnati	None	None	None	None	None	None	None
Barry M. Popkin	University of North Carolina at Chapel Hill	Danone Waters†; Nestlé Waters*	None	None	None	None	None	None
Laurie P. Whitsel	Director of Policy Research for American Heart Association	None	None	None	None	None	None	None
Neil A. Zakai	University of Vermont	None	None	None	None	None	None	None

This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be "significant" if (1) the person receives \$10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (2) the person owns 5% or more of the voting stock or share of the entity, or owns \$10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Modest.

†Significant.

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Stephen Cook	University of Rochester	NHLBI K23†	None	None	None	None	None	None
Rachel K. Johnson	University of Vermont	Dairy Research Institute*	None	National Dairy Council*	None	None	International Dairy Foods Association*	None
Allison Karpyn	Food Trust of Philadelphia	Robert Wood Johnson Foundation*†	None	None	None	None	None	None
Jim Sallis	San Diego State University	NIH†	None	SPARK Programs of School Specialty Inc†	None	Santech Inc†	SPARK Programs†	None

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*Modest.

†Significant.

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Supplementary Table 1. Media and Education Campaigns to Promote Healthier Diets

Author, y	Population	Duration	Intervention/Evaluation	Findings
Economic Research Service, 1999 ⁴¹	US population	10 y+	<p>In 1991, the California campaign 5-A-Day—For Better Health! was adopted as a national campaign initiative by the National Cancer Institute to increase consumption of fruits and vegetables. Also in 1991, the produce industry established the PBH Foundation, a nonprofit consumer organization, to partner with the National Cancer Institute and US Department of Health and Human Services. Cooperative agreements were established between PBH and members of the supermarket industry, and a package of supermarket activities was designed for both in-store and promotional use. By using the licensed 5-A-Day logo, supermarkets joined PBH as active partners in promoting increased fruit and vegetable consumption.</p>	<ul style="list-style-type: none"> • Since the launch of the 5-A-Day campaign, intake of fruits and vegetables increased from ≈2.8 servings per day in 1988 to 4.3 servings in 1999. • The independent effects of supermarket-based activities are still being quantified.
Connell et al, 2001 ⁵¹	N=374 shoppers in 3 intervention stores; 378 control shoppers in 3 other stores matched by demographic characteristics	4 wk of in-store audio messages, plus take-home audiocassettes	<p>The 5-A-Day For Better Health audio intervention included 2 components: in-store audio PSAs, and take-home audiotapes. Both contained 5-A-Day messages promoting the value of eating fruits and vegetables. During the 4-wk intervention, 1 of 4 PSAs was broadcast through the in-store audio system approximately every 30 min. The PSAs were rotated throughout the shopping day. Two were 30 s long and 2 others were 60 s long. Shoppers in the intervention stores who agreed to participate in the study were given a set of 2 audiocassettes, each with a 1-h program. The first focused on skill-building information about fruit and vegetable preparation. It featured chefs who described shortcuts for easy ways to prepare vegetable-based meals. The second provided a nutrition knowledge test using celebrity hosts.</p>	<ul style="list-style-type: none"> • At posttest, the original questionnaires were readministered in telephone interviews with 87.7% of the original intervention group and 93.7% of the original control group. • Knowledge scores in the intervention group increased significantly over baseline (from 59.3 to 74.5; $P<0.001$) and as compared with the control group (61.9 to 66.4; $P<0.001$). • Self-reported intake of fruits and vegetables increased significantly ($P<0.01$) in both intervention and control groups (5.39 servings per day to 6.19 servings per day; 5.38 servings per day to 5.63 servings per day, respectively); however, the magnitude of the difference was significantly greater in the intervention group ($P<0.05$).
PBH Gen X Mom 2010 Survey, by OnResearch ⁴²	N=1000 Gen X moms; N=300 Gen Y moms	Online survey	<p>After extensive consumer research, PBH, the CDC, and other national partners launched a new call to action, Fruits & Veggies—More Matters, in March 2007. The Fruits & Veggies—More Matters</p>	<ul style="list-style-type: none"> • Among Gen X moms, total “definite” awareness of the Fruits & Veggies—More Matters campaign grew from 12% in 2007 before the campaign launch to 18% in 2010.

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			<p>campaign replaced the 5-A-Day program as the rallying cry to deliver the benefits of fruits and vegetables to consumers in a way designed to change and sustain their behavior over the long term. Fruits & Veggies—More Matters was developed with moms, the “gatekeepers” to their family’s meals, as the primary target audience. Gen X moms were chosen as a subset for PBH’s targeted efforts. In January 2010, PBH developed and fielded a customized online survey, commissioned through OnResearch, which included 1000 Gen X moms (those born between 1965 and 1979) with children age ≤18 y living at home. The survey included several questions that have been tracked annually since the initial baseline survey was conducted in early February 2007. In 2010, a sample of 300 Gen Y moms (those born between 1980 and 1990) with children ≤18 y living at home was added for comparative purposes, because many of the Fruits & Veggies—More Matters campaign messages are targeted at mothers with younger children. An understanding of Gen Y moms and how they compared with Gen X moms was sought because Gen X moms and their children are aging.</p>	<ul style="list-style-type: none"> • In 2010, 45% of moms said they were more likely to purchase a product with the Fruits & Veggies—More Matters logo on it, up 5% since 2009. • In 2010, of the Gen X moms who were aware of the Fruits & Veggies—More Matters logo, 38% said it motivates them to help their family eat more fruits and vegetables, up from 23% in 2007. This motivational level was consistent among both Gen X and Gen Y moms. • Of those moms who were aware of the Fruits & Veggies—More Matters logo, 74% said that if they saw the Fruits & Veggies—More Matters logo on a product, it would mean that the product was healthy; 66% said it meant that the food was nutritious; and 55% said that it provides a serving of fruit and/or a vegetable. • The Internet remains the most effective medium of communication with Gen X and Gen Y moms. Driving traffic to the Fruits & Veggies—More Matters website as well as providing additional content on the website should help increase awareness and positive brand associations.
Wardle et al, 2001 ⁵²	N=1894 residents of Great Britain. The study targeted groups with a higher prevalence of overweight.	7-wk intervention, with data collected 3 mo after intervention	<p>A survey evaluated the success of the “Fighting Fat, Fighting Fit” campaign in achieving public awareness of the need for preventing obesity. Questions included weight, height, recognition of campaign name, content recall, and participation in the campaign registration scheme.</p> <p>The Fighting Fat, Fighting Fit campaign was the largest health education campaign ever undertaken by the BBC (British Broadcasting Corporation), spanning 7 wk of numerous types of peak and daytime programming across local TV/radio stations, websites, books, and videos.</p> <p>As part of the campaign, people were invited to receive a registration packet for a small fee. The packet included a self-help guide for lifestyle change and 3 registration cards to return over a 5-mo period to chart progress in weight loss, activity levels, and eating habits.</p>	<ul style="list-style-type: none"> • Of the respondents, >50% had heard of the campaign and 30% were able to recall the healthy lifestyle messages. However, only 1% registered to participate. • Those who registered were white and had higher education levels and SES. • Awareness was high in all socio-economic groups, but memory for the healthy lifestyle messages was significantly poorer in those with lower levels of education and those from ethnic minority groups. • Awareness was no higher in overweight vs normal-weight respondents.
Miles et al,	N=2112 from a	5 mo after	To increase active participation in the “Fighting Fat,	<ul style="list-style-type: none"> • Average weight loss was 2.3 kg ($P<0.001$); 78% of

2001 ⁵⁶	random sample of 6000 registrants in Britain. Most were overweight or obese women.	baseline evaluation	<p>Fighting Fit” campaign, the campaign message was supplemented with a booklet offering practical advice about how to make healthy lifestyle changes in eating and physical activity. Each booklet provided registration cards allowing people to register with the campaign. Registration included 6 mo of membership and 3 registration cards to return over a 5-mo period to chart progress in weight, activity levels and eating habits.</p> <p>Registration incentives were available, including free exercise sessions and prizes for those who had made the greatest improvements.</p> <p>The campaign aimed to stimulate behavior change; therefore, both the program and the booklet provided specific guidance for self-management.</p>	<p>those who lost weight completed at least 1 evaluation.</p> <ul style="list-style-type: none"> • The percentage of people classified as obese was reduced by 11% ($P<0.001$) • Satisfaction with weight improved, and the percentage of people saying they were very or quite satisfied with their weight increased from 3% to 17%. • There were significant reductions in fat and snack intake as well as increases in fruit and vegetable intake (an increase of 1.3 portions per day [$P<0.001$]); the number of people eating 5 portions per day increased by 23%. • There were significant increases in brisk walking, moderate activity, and vigorous activity. Overall, 74% of participants increased their activity levels following the campaign. • There also were significant increases in overall psychological well-being and perceptions of health.
Beaudoin et al 2007 ⁵³	Low-income, predominantly black urban population in New Orleans, Louisiana	5 mo Ads and signs were targeted to adults with specific emphasis on black women age 18-49 y.	<p>A mass media campaign resulted from a partnership between the Louisiana Public Health Institute and the city of New Orleans, with funding from the CDC. The campaign was aimed at increasing physical activity levels and intake of fruits and vegetables while lowering consumption of high-calorie snack foods. This study evaluated phase 1 of the intervention (February 2005–August 2005), which focused on the goals listed above. During this phase the campaign produced 2 TV ads, 4 radio ads, 26 tailgate bus signs, 20 large side-panel bus signs, 2 tailgate streetcar signs, and 2 large side-panel streetcar signs. Data collection instruments came from the 2004 and 2005 versions of the BRFSS survey, with locally added questions addressing the media campaign and its intended effects.</p>	<ul style="list-style-type: none"> • From baseline, there were significant increases in message recall measures, positive attitudes toward fruit and vegetable consumption, and positive attitudes toward walking. However, actual behaviors did not change significantly
Sanigorski et al, 2008 ⁴⁵	Intervention: N=1001 (baseline) and 839 (follow-up) children age 4-12 y attending school in Colac, Australia	3 y	<p>Be Active Eat Well was a multifaceted community capacity-building campaign promoting healthy eating and physical activity. The program was designed to build the community’s capacity to create its own solutions to promote healthy eating, physical activity, and healthy weight in children age 4-12 y.</p> <p>The intervention program was designed, planned, and implemented by the key organizations in Colac,</p>	<ul style="list-style-type: none"> • Children in the intervention group gained less weight (–0.92 kg), showed significantly lower increases in waist circumference (–3.14), BMI z score (–0.11), and waist-height ratio (–0.02) compared with children in the control group. • The prevalence of overweight/obesity increased in both groups, and the incidence was not significantly

	Control: N=1183 (baseline) and 979 (follow-up) children from a stratified sample from a nearby town Average age of study population: 8 y at baseline and 11 y at follow-up		including Colac Area Health, Colac Otway Shire, and Colac Neighborhood Renewal, with Deakin University providing support. Numerous intervention strategies were used. Examples of media strategies were broad area coverage (57 newspaper ads, 21 paid TV ads) and local festivals and events.	different between groups. <ul style="list-style-type: none"> • There were no differences in anthropometric measures by SES in the intervention group, whereas in the control group there were significantly greater gains in anthropometric values in children of lower SES status. • Changes in underweight and attempted weight loss were not different between groups.
de Silva-Sanigorski, et al, 2010 ⁴⁸	Children age 0-5 y living in Geelong, Victoria, Australia	2004-2008	Romp and Chomp was a program similar to Be Active Eat Well, designed for children age 0-5 y. Data were evaluated using a repeat cross-sectional quasi-experimental design with measures taken pre- and postintervention from children who underwent annual health checks at ages 2 and 3.5 y.	After the intervention: <ul style="list-style-type: none"> • In the intervention group, 2-y-olds were heavier than the control group at baseline and remained heavier at follow-up ($P<0.05$), although there were reductions in the size of the differences and there was a significantly lower proportion of 2-y-old children who were overweight or obese at follow-up compared with baseline levels ($P<0.05$). • In the 3.5-y-old intervention sample there were significant ($P<0.05$) reductions in mean weight (17.05 kg to 16.76 kg), BMI (16.35 to 16.17), and BMI z score (0.67 to 0.54) at follow-up. • There was a significantly lower prevalence of overweight/obesity in both the 2- and 3.5-y-old subsamples (by 2.5 and 3.4 percentage points, respectively) than in the control sample (a difference of 0.7 percentage points; $P<0.05$) compared with baseline values. • Intervention child behavioral data showed a significantly lower intake of packaged snacks (by 0.23 serving), fruit juice (0.52 serving), and cordial (0.43 serving) than that in the control sample (all $P<0.05$).
Nishtar et al 2004 ⁴⁴	N=500 residents of Pakistan	130 consecutive wk of newspaper articles	THE NEWS—Heartfile Public Awareness Drive intervention involved posting articles on a regular weekly basis for 130 wk on the inside front page of the newspaper. The aim was to evaluate changes in the levels of knowledge and attitudes as indicators of a community health education campaign. The campaign was launched through complimentary space donated by the newspaper group that owns <i>The</i>	Of the regular readers: <ul style="list-style-type: none"> • 93% remembered seeing the Heartfile articles. • Of the 93% who remembered seeing the articles, 87% said the articles significantly supplemented their knowledge about diet, and 5% said they were their sole source of information. Of the 500 regular readers, only those who reported seeing and reading the articles were eligible for another

			<p><i>News</i>, which is the largest circulating daily English newspaper in the country. The postintervention evaluation involved a cross-sectional telephone survey in a major city. A total of 2621 persons were called, but only those who were considered regular readers (N=500) were eligible for the interview.</p>	<p>interview (N=375). Of these:</p> <ul style="list-style-type: none"> • 40% reported making some dietary changes. • 39% changed their exercise habits. • 8% reduced the amount they smoked. 	
Downloaded from http://circ.ahajournals.org/ at Universite de Lausanne - CODUL on September 18, 2012	Lutz et al, 1999 ⁵⁷	5-A-Day For Better Health newsletter intervention	Intervention: newsletters	<p>This intervention included 4 groups: 1 control group and 3 newsletters (computer-tailored, nontailored, and tailored with goal-setting information). All 3 newsletters contained strategies for improving fruit and vegetable consumption. The tailored newsletters used computer algorithms to match individuals' baseline survey information with the most relevant newsletter messages promoting dietary change. Baseline surveys were completed by 710 health maintenance organization clients. Postintervention surveys were completed by 573 participants (80.8%) 6 mo after baseline.</p>	<ul style="list-style-type: none"> • All newsletter groups had significantly higher daily intake (from 3.4 to 4.1 servings vs no increase in control; $P<0.002$) and variety scores (from 6.5 to 8 vs no change in control; $P<0.0001$) compared with the control group, as measured using FFQs. • Although a trend toward improved intake and variety was noted with each added newsletter element, there were no significant differences among newsletter groups.
	Kelder et al, 1995 ⁴⁶	N=2376 6th graders from 13 junior high schools	5 y	<p>The Lunch Bag Program for 6th graders and the Slice of Life for 10th graders consisted of the following:</p> <ul style="list-style-type: none"> • Brief 1-session intervention • Students were provided with lunch bags containing a recipe book, heart-healthy snacks, food lists, a comic book, and several games about healthy foods for students and parents. • Students also wrote their own newspaper, designed to influence intentions to eat healthy foods. • Data were collected at baseline (grade 6) through grade 12 (7 time points total) 	<ul style="list-style-type: none"> • An upward trend in healthier food choices was seen for both males and females in the intervention group. • Females: At all but the final time point (12th grade), a significantly ($P<0.01$) greater number of healthier food choices were made by the intervention group compared with the reference group; the total increase from baseline was 6.0 to 9.5 vs 6.0 to 8.5 choices, respectively. • Knowledge of healthy food choices was significantly greater (at $P<0.01$) in the intervention group vs reference group for all but the 4th time point (9th grade; $P<0.05$); the total increase was 12.5 to 16 vs 12.5 to 15, respectively. • Restraint in salting food was also significantly greater ($P\leq 0.05$) in the intervention group compared with the reference group at all time points. Total restraint increased from 5.6 to 6.7 vs 5.6 to 6.0, respectively. • Males: A significantly higher ($P<0.05$) number of healthy food choices were selected at time points 2-4 (grades 6-10) but not at the final 2 time points (grades 11-12). The total increase from baseline was the same for both the intervention and reference groups.

				<ul style="list-style-type: none"> • Knowledge of healthy food choices was significantly greater ($P \leq 0.01$) in the intervention group compared with the reference group at all but the 3rd time point (grade 8). The total increase in knowledge score was 12.0 to 15.5 in the intervention group vs 12.0 to 14.5 in the reference group. • Restraint in salting food was significantly different ($P < 0.05$) between the 2 groups at all but the final end point (grade 12) compared with the reference group. The total increase in restraint score was 5.4 to 6.2 vs 5.4 to 5.7 in the intervention and reference groups, respectively.
Reger et al, 1998 ⁵⁵	Clarksburg and Bridgeport, West Virginia	7-wk campaign	The concept of The 1% or Less campaign was developed in 1994 by the CSPI. The first demonstration project was conducted from February to April 1995 in West Virginia. The campaign lasted 7 wk and consisted of paid TV/newspaper/radio ads, public relations efforts, taste tests, and educational programs at supermarkets, schools, and worksites. Ads (1 newspaper ad, 2 30-s TV ads, and 2 60-s radio ads) were developed to encourage consumers to switch from whole/2% milk to 1%/skim milk. TV ads ran 366 times during the first 2 wk and last 2 wk of the campaign. Radio ads aired 244 times over a 2-wk period in the middle of the campaign. Fourteen quarter-page newspaper ads were run during the campaign. Data were collected at baseline, immediately following the campaign, and 6 mo later.	<ul style="list-style-type: none"> • 80% of the 1910 taste test participants reported liking the taste of the skim milk sample, and 94% said they liked the taste of 1%, skim, or both. • Milk sales increased by 16% and remained high at follow-up. • The share of low-fat milk sales increased from 18% of overall milk sales to 41% of overall milk sales immediately following the campaign and was sustained at the 6-mo follow-up. • In the postintervention survey, 38% of respondents who reported drinking whole milk reported they had switched to low-fat milk.
Dunt et al, 1999 ⁵⁴	N=591 residents of Greater Shepparton, central Victoria, Australia	3 mo in 1991; pre- and postintervention surveys	Towards a Healthy Diet ran as an early 3-mo component of a 2-y project conducted by the Victoria division of the Heart Foundation. Two 5-wk media campaigns were implemented. Promotional tools included TV, radio, brochures, T-shirts, and other media events. In addition, public policy initiatives were integrated into the media campaigns throughout.	<ul style="list-style-type: none"> • The intervention did not alter either individual dietary behavior or intention to change dietary behavior, as assessed by questionnaires and in supermarket sales figures for milk and table spreads. • The intervention did affect perceptions about the level of interest in healthy diet in the community (more eating places offering healthy food and more local residents eating healthy foods).
Dixon et al, 1998 ⁴³	N=500 residents age ≥ 20 y in Victoria, Australia	Campaign TV ads ran from 1992 to 1995: Phase 1: Sept 1-19, 1992 Phase 2: Oct 3-	The Victoria "2 Fruit 'n' 5 Veg Every Day" campaign was a broadly based, multilevel statewide nutrition promotion initiative aimed at increasing awareness of the need to eat more fruits and vegetables and encouraging increased consumption of these foods. The lead health agency for the	<ul style="list-style-type: none"> • Reported fruit and vegetable consumption increased significantly between phases 1 and 2 (during the most intensive TV advertising) from 1.5 to 1.7 servings per day of fruits ($P < 0.05$) and from 2.6 to 3.1 servings per day of vegetables ($P < 0.001$). • No additional increases were seen across the

		23, 1993 Phase 3: Oct 9-16, 1994 Phase 4: little media coverage	campaign was the Victoria Food and Nutrition Program. The campaign was designed in part after the 5-A-Day For Better Health program. A central feature of the campaign was a short, intensive burst of TV ads conducted over a 3-wk period in the first 2 phases of the campaign and 1 wk in the third phase. The mass media program was primarily TV based, but some print and radio ads were also included. In addition to advertising, community-based health and education professionals, food retailers, and food service providers were also targeted as routes of influence. Data were collected via 4 annual postcampaign telephone surveys conducted ≈2-3 wk postintervention.	remaining phases. However, the initial increase was maintained. <ul style="list-style-type: none"> • Similarly, during the most media-intensive phases (1 and 2), significant increases were found in the level of public awareness, reported consumption, and beliefs about appropriate levels of consumption.
Croft et al, 1994 ⁴⁷	N=9839 adults age ≥18 y living in 2 South Carolina communities (intervention and control)	Intervention phase: February 1988–September 1990	The South Carolina Cardiovascular Disease Prevention Project was designed to reduce CVD morbidity and mortality by decreasing the prevalence and severity of high blood pressure, elevated cholesterol, and smoking. The intervention focused on media and education and involved multiple segments of the community to promote cardiovascular health and help residents make lifestyle changes. Numerous programs were offered, including community classes, grocery store tours, speakers' bureaus, professional education classes, home study courses, and worksite nutrition programs. Media programs included radio and TV PSAs, talk shows, newspaper articles and supermarket ads. A task force of local restaurant managers, registered dietitians, and news media was established to implement the restaurant labeling program entitled "Eat Smart for a Healthy Heart." Data were collected during 3 telephone surveys taken in 1987, 1989, and 1991.	<ul style="list-style-type: none"> • Favorable changes in most eating behaviors and levels of awareness were observed in both the intervention and control communities. • From 1987 to 1991, the intervention community experienced greater absolute changes than the control community in use of animal fats (−8.9 vs −4.0%; $P<0.05$) and unsaturated fats (+8.4% vs +3.6%; $P<0.05$) and in awareness of restaurant nutrition information (+33.0% vs +19.4%; $P=0.0001$). • These favorable changes were noted among both black and white respondents.
Tian et al, 1995 ⁵⁸	7 intervention neighborhoods and 10 control neighborhoods in Tianjin, China	1989-1992	The Tianjin Project was a community-based education program to reduce salt consumption. The main activities included training of healthcare personnel about salt and blood pressure and providing practical advice to patients, community education via distribution of door-to-door leaflets, and distribution of posters and stickers to food retailers. Lower-sodium salt was also introduced in some limited retail stores. Sodium intake	<ul style="list-style-type: none"> • From 1989 to 1992, mean sodium intake decreased in men and women by 22 and 11 mmol/d, respectively, compared with increases of 18 and 4 mmol/d, respectively, in the control area ($P<0.001$ for men, $P=0.065$ for women). • These changes did not vary by education level or occupation groups. • Compared with the control area, systolic blood pressure decreased in men and women in the

			(consecutive 3-d weighed food records) and blood pressure (directly measured) were assessed in representative cross-sectional surveys, with >90% participation.	<p>intervention area by 5 and 6 mm Hg, respectively ($P=0.065$ for men, $P=0.008$ for women).</p> <ul style="list-style-type: none"> • Knowledge related to recommended levels of salt intake, importance of controlling salt, and differences between regular and low-sodium mineral salt also improved. 	
Downloaded from http://circ.ahajournals.org/ at University of Lausanne - CODUL on September 18, 2012	Dowse et al, 1995 ⁶⁵	Mauritius	1987-1992	<p>In 1987, the Mauritius government launched a national prevention program to improve lifestyle-related risk factors by promoting healthier diets, increased exercise, smoking cessation, and reduced alcohol intake. Primary components of the program included extensive use of mass media and widespread community, school, and workplace education activities. Fiscal and legislative measures were also introduced to improve cooking oils (see Supplementary Table 12).</p> <p>Cross-sectional cluster surveys of all adults age 25-74 y living in geographically defined clusters were performed in 1987 and 1992.</p>	<ul style="list-style-type: none"> • 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). • Changes in cooking oils and their estimated effects are presented in Supplementary Table 12. • During this same period, declines were seen in prevalence of hypertension (from 15.0% to 12.1% in men and 12.4% to 10.9% in women), and mean population serum total cholesterol fell by 15%, from 5.5 to 4.7 mmol/L ($P<0.001$). • Conversely, prevalence of overweight/obesity rose, and rates of glucose intolerance did not change.
	Pekka et al, 2002 ⁵⁹ Puska and Stahl, 2010 ⁶⁰	North Karelia, Finland	1972-1977; extended nationally thereafter	<p>The North Karelia Project was a media- and education-based community intervention to improve population blood cholesterol levels and other cardiovascular risk factors by reducing consumption of butter, whole-fat dairy products, nonlean meats, and salt, and increasing consumption of vegetable oil-based margarine and vegetable oils, low-fat dairy products, lean meats, vegetables, berries, and fruit. Diet education was provided via posters, leaflets, and messages; local newspaper and radio coverage; primary care doctors and nurses; schools; collaborative efforts with community groups such as a powerful housewives' organization; and a network of lay community leaders. Local food manufacturers were encouraged to produce healthier food options, for example, cooperating with the food and catering industry to lower the sodium content of foods.</p> <p>The project was subsequently extended to the national level, with additional substantial focus on other policy approaches (see "Multicomponent</p>	<ul style="list-style-type: none"> • Targeted dietary habits improved substantially, with associated declines in population blood cholesterol and blood pressure levels and, over time, rates of CHD.

			Interventions”).	
Lefebvre et al 1987 ⁶³	Pawtucket, Rhode Island	1984-1988	The Pawtucket Heart Health Program was a community-based, multicomponent educational intervention to lower cardiovascular risk factors, based on a blend of social learning theory, community organization models, community psychology tenets, and diffusion research. Point-of-purchase nutrition education in supermarkets was 1 intervention strategy. By using consumer intercept interviews, awareness of shelf labels and their effect on purchase behavior has been continuously evaluated.	<ul style="list-style-type: none"> Between 1984 and 1988, the percentage of shoppers who could identify labels correctly increased from 11% to 24% ($P<0.05$). The percentage who reported they were encouraged to purchase the identified foods increased from 36% to 54% ($P<0.05$).
Farquhar et al, 1990 ⁴⁹	2 treatment cities (N=122,800) and 2 control cities (N=197,500) in California	30-64 mo of education	The Stanford Five-City Project tested whether community-wide health education can reduce risk of stroke and CHD. Treatment cities received a 5-y, low-cost, comprehensive program using social learning theory, a communication-behavior change model, community organization principles, and social marketing methods that resulted in about 26 h of exposure to multichannel and multifactor education. Risk factors were assessed in representative cohort and cross-sectional surveys at baseline and in 3 later surveys.	<ul style="list-style-type: none"> When compared with control communities, significant net reductions in community averages favoring treatment occurred in plasma cholesterol (2%), blood pressure (4%), resting pulse rate (3%), and smoking prevalence (13%). These risk factor changes resulted in decreases in composite total mortality risk scores (15%) and CHD risk scores (16%). Subjects in the treatment communities also gained significantly less weight (0.57 kg) compared with control communities (1.25 kg) over 6 y.
Luepker et al, 1996 ⁶¹	3 upper Midwestern communities with 3 matched comparison communities	1980-1990	The Minnesota Heart Health Program was a 5- to 6-y intervention program that used community-wide and individual health education in an attempt to decrease population risk.	<ul style="list-style-type: none"> In the education communities, CHD incidence declined by 1.8% per year in men ($P=0.03$) and 3.6% per year in women ($P=0.007$), but these declines were not significantly different from secular trends in matched control communities. Stroke incidence did not decline in either education or control communities.
Winkleby et al, 1997 ⁶²	Communities in California, Minnesota, and Rhode Island	1980s	The Stanford Five-City Project, Minnesota Heart Health Program, and Pawtucket Heart Health Program were community-based heart disease prevention interventions conducted in the 1980s. Among 12 total cities, 6 cities received 5–8-y interventions for risk reduction, with a major focus on media and education. When data from the 3 studies were pooled, time trends were estimated for cigarette smoking, blood pressure, total cholesterol level, BMI, and CHD mortality risk in men and women age 25-64 y.	<ul style="list-style-type: none"> The joint estimates of intervention effect were in the expected direction in 9 of 12 gender-specific comparisons. However, none of these were statistically significant.

Multicomponent Interventions (Including Major Components Beyond Media and Education, Such as Environmental Change)				
Author, y	Population	Duration	Intervention/Evaluation	Major Findings
Pekka et al, 2002 ⁵⁹ Puska and Stahl, 2010 ⁶⁰	Finland	1970s to present	The Finnish North Karelia Project was a media- and education-focused community intervention to improve population dietary habits. The project was subsequently extended to the national level, with additional substantial focus on voluntary agreements with industry to increase production and sales of more healthful foods, modifications of taxation and subsidy policies for several foods, government-supported programs to increase local production and consumption of berries and vegetables, and restrictions on milk fat (see “Taxation and Subsidies” and “Direct Restrictions and Mandates”).	<ul style="list-style-type: none"> From the late 1970s to 1998, the proportion of Finns who reported using mostly butter on bread declined from 60% to 5%. Vegetable-oil soft margarines and butter-vegetable oil mixtures were the main replacement for butter. From 1978 to 1998, the proportions of men and women using whole milk declined from 44% to 9% and 35% to 4%, respectively. From 1972 to 1997, the proportion of Finns who mainly used vegetable oil for cooking increased from 1% to 2% to 34%; increases were even higher in urban areas. Overall, between 1972 and 1997, the percentage of energy derived from saturated fats declined from 21% to 14% and from polyunsaturated fat increased from 3.5% to 5.0%, substantially increasing the ratio of polyunsaturated to saturated fats. These and other dietary changes were associated with substantial declines in population cholesterol levels, including 18% declines in North Karelia and similar declines in other monitored areas. On the basis of urine sodium excretion, mean daily salt intakes declined from about 14-15 g in men (unknown in women) to about 11 g in men and 7 g in women. Diastolic blood pressure decreased by 5% in men and 13% in women. Age-standardized CHD mortality among adults age 35-64 y decreased by 73% in North Karelia and by 65% in the whole country between 1971 and 1995. About 75% of this decline could be explained by improvements in population risk factors (especially declines in blood cholesterol) rather than changes in medical treatments.
Bhalla et al, 2006 ⁶⁴	N=4084 Singapore residents	1998-2004	A survey evaluated the National Healthy Lifestyle Program, a population-wide, noncommunicable disease, multicomponent intervention program created in 1992. It aimed to provide information, skill training, and the social and physical	<ul style="list-style-type: none"> Hypertension in Singapore residents age 30-69 y decreased from 28% in 1998 to 24% in 2004. Prevalence of high cholesterol (≥ 6.2 mmol/L) decreased from 26% to 18%.

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			environments necessary to encourage healthy living by Singapore residents. This multiple-strategy program includes innovative media and communication activities, systematic involvement of government agencies, community organizations, workplaces and schools, and collaboration with the food industry to provide healthier food choices. The program is evaluated every 6 y using population-based cross-sectional surveys. This paper reported findings from 1998 to 2004.	<ul style="list-style-type: none"> • Prevalence of diabetes decreased from 9.5% to 7.8%. • Prevalence of obesity was not significantly changed. • Smoking rates decreased from 15% to 12.5%. • Regular exercise increased from 17% to 25%.
Economos et al, 2007 ⁶⁶	N=1178 children in grades 1-3 attending public schools in 3 culturally diverse communities in Somerville, Massachusetts (1 intervention, 2 controls)	Intervention lasted 3 y (September 2002–August 2005); data collected covered 1 school year Pretest: September 2003 Posttest: May 2004	Shape Up Somerville: Eat Smart, Play Hard was one of the first collaborative community-based participatory research initiatives designed to change the environment to prevent obesity in early elementary school-age children. Many groups and individuals within the community, including children, parents, teachers, school food service providers, city departments, policy makers, healthcare providers, before- and after-school programs, restaurants, and the media were involved in the multicomponent intervention.	<ul style="list-style-type: none"> • The average change in BMI <i>z</i> score in the intervention community was -0.130 compared with control 1 ($P<0.02$) and -0.105 compared with control 2 ($P<0.02$). When the 2 control communities were pooled, the average change in BMI <i>z</i> score was -0.1005 in the intervention community compared with the control communities ($P<0.001$). • Parental education was not a significant predictor of BMI <i>z</i> score change, nor were other factors such as the child's sex, grade, age, race, primary language spoken at home, school, or local community.

PBH indicates Produce for Better Health Foundation; PSA, public service announcement; Gen X, Generation X; Gen Y, Generation Y; CDC, Centers for Disease Control and Prevention; BRFSS, Behavioral Risk Factor Surveillance System; SES, socioeconomic status; FFQ, food frequency questionnaire; CSPI, Center for Science in the Public Interest; CVD, cardiovascular disease; CHD, coronary heart disease; and BMI, body mass index.

Note: Reference numbers (eg, Connell et al, 2001⁵⁰) appearing in this supplementary table correspond with those listed in the reference section of the statement. For the purposes of this supplementary table, these meta-analyses or systematic reviews (see "Author, y" column) are considered the primary citation. Additional studies mentioned in the primary citation may be included in the "Intervention/Exposure" and "Findings" columns. The additional studies can be accessed through the primary citation.

Supplementary Table 10a. Local Environmental Change to Improve Physical Activity (Community Settings)

Accessibility of Recreation or Exercise Spaces and Facilities

Children and Adolescents (Outcome: Physical Activity)

Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
IOM Committee on Childhood Obesity Prevention Actions for Local Governments, 2009 ¹⁴⁷	Systematic review, including 4 reviews, 1 longitudinal and 2 cross-sectional studies on the exposure-outcome relation in this section	Children or adolescents	Access to recreational facilities (general)	Physical activity	<ul style="list-style-type: none"> On the basis of 2 reviews and a cross-sectional study, the authors concluded that availability and accessibility of parks or playgrounds in the neighborhood is positively associated with children's level of physical activity and may reduce sedentary time at home. On the basis of 1 review and 1 prospective study, the authors concluded that access to recreational facilities is positively associated with physical activity and inversely associated with obesity. On the basis of a cross-sectional study, it was concluded that access to well-maintained parks is a more important problem in high-density lower-SES neighborhoods.
Committee on Environmental Health, American Academy of Pediatrics, 2009 ³⁶¹	Systematic review, including 5 studies on the exposure-outcome relation in this section	Children	Access to recreational facilities (density-inequalities in access)	Physical activity	<ul style="list-style-type: none"> Density: Of 4 studies, all reported a significant positive association between density of parks and physical activity. Three studies used park area as the environmental variable, and 1 used number of recreational facilities. Epstein et al (2006) conducted a crossover experimental study among 58 children age 8-15 y. The study included 3 phases (baseline, increased sedentary behavior, and decreased sedentary behavior), with each phase lasting for 3 wk. In intervention phases, participants were encouraged to increase or decrease sedentary behaviors by 25%-50% and were provided with up to \$475 for adherence to recommendations. In the decreased sedentary behavior phase, the extent of increase in time spent on physical activity was positively associated with accessible park land (hectares) within 0.8 km ($P=0.01$). Also, in this phase, living in an area with a large community park was positively associated with 38.9 min more MVPA per day. Roemmich et al (2006) studied the association of GIS-derived percentage of park area in the neighborhood with physical activity among 32 boys and 27 girls age 4-7 y. They found a significant positive association between percentage of park area and total physical activity ($P<0.05$). In a similar study, Roemmich et al (2007) studied the same relation among 44 boys and 44 girls age 8-12 y. After adjustment for age, sex, parental overweight, and time activity monitor worn, percentage of park area was associated with total physical activity ($P<0.05$). Also, among a nationally representative sample of US adolescents (N=20,745) in grades 7-12, Gordon-Larsen et al (2006) showed that the number of facilities in the neighborhood was positively associated with physical activity and

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					<p>inversely associated with overweight. After adjustment for population density, the presence of 1, 2, 3, 4, and 5 facilities in the neighborhood was associated with a 3%, 7%, 10%, 14%, and 18% increase in the odds of having 5 bouts of MVPA and with a 5%, 10%, 15%, 20%, and 24% decrease in odds of being overweight, respectively.</p> <ul style="list-style-type: none"> • Inequalities in access: Gordon-Larsen et al (2006) also showed that living in a lower-SES area or areas with a higher percentage of minorities is associated with reduced access to physical activity facilities. Also, among 160 adolescents age 12-18 y, Humbert et al (2006) showed that those who lived in lower-SES areas were more likely than their affluent peers to report that a nearby recreation facility is important for their degree of physical activity.
Sallis and Glanz, 2009 ²⁸	Narrative review, including 1 review on the exposure-outcome relation in this section	Children	Access to recreation facilities (distance)	Physical activity	<ul style="list-style-type: none"> • On the basis of a review by Davison et al (2006) (see below), the authors concluded that proximity to parks, playgrounds, and recreation areas was consistently associated with children's total physical activity.
Ferreira et al, 2007 ³⁴⁴	Systematic review of 150 studies, mostly cross-sectional, published from January 1980 to December 2004, including 45 independent samples in adolescents and 20 in children on the exposure-outcome relation in this section	Children (age 3-12 y) and adolescents (age 13-18 y)	Local environmental characteristics, including access/availability to physical activity equipment, facilities, or programs	Physical activity	<ul style="list-style-type: none"> • A wide range of physical, sociocultural, and economic variables were evaluated in these studies, but only a few were examined in >3 independent samples. • Of 20 independent samples in which the relation between access/availability to physical activity equipment, facilities, or programs and physical activity was assessed in children, 3 samples found a positive association and 17 found no significant association. • Of 45 independent samples in which the relation between access/availability to physical activity equipment, facilities, or programs and physical activity was examined in adolescents, 11 samples found a positive association, 2 found an inverse association, and 32 found no significant association. • On the basis of these findings, the authors concluded that the availability or accessibility of physical activity facilities was unrelated to physical activity.
Davison and Lawson, 2006 ³⁴³	Review of 33 cross-sectional studies, including 12 studies on the exposure-outcome relation in this section	Children age 3-18 y	Perceived or objectively measured environment, categorized into recreational infrastructure (eg, availability of parks/playgrounds),	Physical activity	<p>General:</p> <ul style="list-style-type: none"> • Carver et al (2004): Among 347 Australian girls and boys age 12-13 y, parental reports of the presence of good sporting facilities for their children nearby were associated with higher children's reports of walking or cycling in the neighborhood (for recreation, transport, exercise, or going to school). • Density: Of 10 studies, 9 reported a significant positive association: • Sallis et al (1993): Among preschool children, a significant positive association was seen between parental reports of the number of play areas within walking distance of home and observed levels of physical activity.

transport infrastructure (eg, traffic speed/density, presence of sidewalks), and local conditions (eg, safety, crime)

- Sallis et al (2001): In a study of 137 physical activity areas in 24 public middle schools in San Diego County, California, a significant positive association was seen between the number of permanent area sport facilities (eg, tennis courts, soccer fields, baseball diamonds) and observed physical activity in each play area only in boys, not girls.
 - Timperio et al (2004): Among 919 Australian elementary school children, ages 5-6 and 10-12 y, only older girls (not older boys or younger children) who reported no park in the area had lower rates of walking and cycling (OR=0.5; 95% CI, 0.3-0.8, $P<0.01$).
 - Hume et al (2005): In a study of 127 children age 10 y, the children were instructed to draw pictures of their home and neighborhood. Girls who drew more opportunities for physical activity, eg, the presence of facilities such as gyms and swimming centers, had higher objectively measured physical activity.
 - Zakarian et al (1994): Self-reported number of facilities for sports and exercise in the area was correlated with adolescent self-reported vigorous activity (boys: $r=0.17$; $P<0.001$; girls: $r=0.10$; $P=0.002$).
 - Brodersen et al (2005): Among 4320 English boys and girls, the objectively measured number of sport pitches in the borough was associated with higher self-reported vigorous activity among girls ($\beta=-0.02$; $P=0.03$) but not boys.
 - Norman et al (2006): Among 799 US adolescents, the objectively measured number of private recreational facilities and parks within 1.6 km of home were associated with higher accelerometer-measured MVPA among adolescent girls (unadjusted $\beta=0.110$; $P=0.016$) but not boys.
 - Mota et al (2005): Among 1123 Portuguese students age 13-18 y, adolescents' reports of availability of facilities such as swimming pools, playgrounds, and parks were associated with higher self-reported activity ($P=0.03$). Fein et al (2004): Among 610 high school students in rural Alberta, Canada, a positive association was seen between perceived availability of convenient neighborhood recreation facilities and physical activity levels.
 - Dunton et al (2003): Among 87 US girls age 14-17 y, no association was seen between perceived exercise facilities in the community and self-reported physical activity.
- Distance: Of 2 studies, 1 found a significant association:
- Gomez et al (2004): Among 177 US adolescents in 7th grade, a significant positive association was seen between objectively measured distance to the nearest play area and outdoor activity only in boys ($\beta=-0.317$; $P=0.006$), not girls.
 - Adkins et al: Among 52 US black girls age 8-10 y, no significant association was seen between parental and children's reports of

distance to playgrounds and parks and children's objectively measured physical activity.

Children and Adolescents (Outcome: Obesity)

Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
Carter and Dubois, 2010 ³⁵⁶	Systematic review of 27 studies published between 1999 and 2009 including 4 studies on the exposure-outcome relation in this section	Children and adolescents age 2-18 y	Access to recreation facilities (general, density)	Adiposity, eg, skin-fold thickness, BMI, percentage of lean body mass, etc	<p>Of 4 studies, 1 found a significant inverse association between access to recreational facilities and obesity, and 1 found a significant positive association between the number of locked schools in the neighborhood and BMI.</p> <ul style="list-style-type: none"> • General: Veugelers et al (2008) studied the association of parental perception of access to playgrounds/parks and recreational facilities with overweight and obesity among 5471 students in 5th grade from urban and rural areas of Nova Scotia, Canada. After adjustment for child gender, parental education, and household income, children in the highest tertile of access to playgrounds/parks had significantly lower odds of overweight (OR=0.76; 95% CI, 0.62-0.95) and obesity (OR=0.71; 95% CI, 0.53-0.99). However, after stratification by residence (urban or rural), access to playgrounds/parks was significantly associated only with overweight in rural children (OR=0.68; 95% CI, 0.48-0.97). Also, being in the highest tertile of access to recreational facilities was inversely associated with overweight (OR=0.71; 95% CI, 0.56-0.90) and obesity (OR=0.58; 95% CI, 0.40-0.84). After stratification by residence, significant association was only observed between access to recreational facilities and obesity among rural children (OR=0.47; 95% CI, 0.23-0.95). • Density: Evenson et al (2007) studied the relation between self-reported number of physical activity facilities in the walking distance and overweight among 1554 girls in the 6th grade from 6 states. Participants were asked to report accessibility of 14 types of facilities from their home or school. These facilities included basketball court, beach/lake, golf course, health club, martial arts studio, playing field, park/recreation center/YMCA/YWCA, track, skating rink, swimming pool, walking/biking/hiking path, tennis court, and dance/gymnastic club. After adjustment for school, site, nonschool physical activity, neighborhood SES, no significant association was found with overweight and obesity. In another study using the same population, Scott et al (2007) did not find any significant association between the number of parks, number of unlocked schools, or having at least 1 school within a 0.8-km radius of home and BMI. However, they found a significant association between the number of locked schools in the neighborhood and BMI. • Distance: Burdette and Whitaker (2004) compared 7020 overweight

					(BMI \geq 95th percentile) and nonoverweight children age 3-4 y and did not find any significant difference in mean distance to the nearest playground (kilometers) between overweight (0.31 ± 0.21) and nonoverweight (0.31 ± 0.22 ; $P=0.77$) children.
Dunton et al, 2009 ³⁵⁰	Systematic review, 15 studies published before May 2008 (14 cross-sectional and 1 longitudinal), including 6 studies on the exposure-outcome relation in this section	Children and adolescents age 3-18 y	Access to recreational facilities (general, density)	Obesity	<ul style="list-style-type: none"> In this systematic review, studies were divided into 2 major groups based on the age range of the study populations (3-12 y and 13-18 y). General: Among children age 3-12 y, 1 study found an inverse association and 1 found no association between access to physical activity facilities and obesity. Density: Among children age 3-12 y, 1 study found a positive relation between the number of locked schoolyards and obesity. Among children age 13-18 y, 1 study found an inverse relation between the number of physical activity and recreational facilities and obesity; 2 studies did not find any association between the number of private recreational facilities and obesity; and 2 studies did not find any association between the number of parks and obesity. Distance: Among children age 3-12 y, 2 studies did not find any association between proximity to playgrounds, parks, and play areas and obesity. Among children age 13-18 y, 1 study did not find any association between distance to nearest private recreational facility and obesity; and 1 study did not find any association between areas of parks and distance to the nearest park and obesity.
Papas et al, 2007 ³⁴⁹	Review of 20 studies (18 cross-sectional, 2 longitudinal), including 3 studies on the exposure-outcome relation in this section among children	Children	Objectively measured access to recreational facilities (density, distance)	Direct measures of body weight (eg, BMI)	<p>Density:</p> <ul style="list-style-type: none"> Among 20,745 US adolescents in the National Longitudinal Study of Adolescent Health, after adjustment for population density, Gordon-Larsen et al (2006) found that the number of physical activity facilities per census block group was inversely associated with overweight. Compared with no activity facilities in the block group, having 1, 2, 3, 4, 5, 6, or 7 facilities in the census block was associated with 0.95 (0.90-0.99), 0.90 (0.82-0.98), 0.85 (0.74-0.97), 0.80 (0.67-0.96), 0.76 (0.60-0.95), 0.72 (0.55-0.95), and 0.68 (0.49-0.94) lower odds of overweight, respectively. <p>Distance:</p> <ul style="list-style-type: none"> Two studies (Liu 2002, Burdette 2004) found no relation between distance from home to the nearest playground and obesity. Among 7020 low-income children age 3-4 y participating in WIC programs in Cincinnati, Ohio, Burdette and Whitaker (2004) found no significant relation between distance from the child's home to the nearest playground and obesity. Among 2554 children age 4-18 y living in Indiana, Liu et al (2002) found no significant difference between mean distance to the nearest public play space among obese (567 m) vs nonobese

children (571 m).

Adults (Outcome: Physical Activity)

Author, y	Design Number of Studies	Population	Exposure	Outcome	Findings
Frost et al, 2010 ³³⁷	Systematic review of studies published between 1994 and 2008, including 4 studies on the exposure-outcome relation in this section	Adults (age ≥18 y) in rural areas	Access to recreation facilities (general)	Physical activity	<ul style="list-style-type: none"> • Of 4 studies, 1 reported significant positive association between general access to indoor exercise facilities and regular walking. • Wilcox et al (2003) studied the relation between perceived access to exercise facilities and physical activity level (active/sedentary) among 1242 rural and 1096 urban US women (age ≥40 y). After adjustment for age, race, education, geographical region, neighborhood variables, and health-related behaviors, no significant association was found between access to facilities and sedentary behaviors in urban (OR=0.96; 95% CI, 0.65-1.42) or rural population (OR=1.09; 95% CI, 0.81-1.41). • Among 1000 rural midwestern white women age 25-50 y, Eyster (2003) did not find any significant association between knowing of a place to exercise in the neighborhood and meeting the recommendations for physical activity (OR=0.99; 95% CI, 0.99-1.00). • In a similar study among 567 black women in rural areas of Alabama, Sanderson et al (2003) found no significant association between knowing a place to exercise in the neighborhood and meeting the recommendations for physical activity (OR=0.86; 95% CI, 0.56-1.33). • Bronson et al reported a borderline significant association between access to indoor exercise facilities and regular walking among 1269 rural adults in southeastern Missouri (OR=1.3; 95% CI, 1.0-1.7).
Sallis and Glanz, 2009 ²⁸	Narrative review, including 1 review about the exposure-outcome relation in this section	Adults	Access to recreational facilities (general, distance)	Physical activity	<ul style="list-style-type: none"> • On the basis of a review by Bauman and Bull (2007), the authors concluded that there is a positive relation between proximity to recreational facilities and physical activity.
Bauman and Bull, 2007 ³³⁸	Systematic review of reviews published between 2002 and 2007, including 8 reviews about the exposure-outcome relation in this section	Children and adults	Access to recreational facilities (general, distance)	Physical activity or walking	<ul style="list-style-type: none"> • All 8 studies on the relation between access to recreational facilities and physical activity found a positive association: • A narrative review by Badland and Schofield (2005) found a significant positive association between access to facilities within walking distance and parks and physical activity. • A systematic review by Cunningham and Michael (2004) reported a positive association between proximity to facilities or parks and physical activity. • A meta-analysis by Duncan et al (2005) showed a significant positive relation between availability of physical activity facilities and physical activity. (Please see below for Duncan et al, 2005.)

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					<ul style="list-style-type: none"> • A systematic review by Humpel et al (2002) found a significant positive association between accessibility of facilities, including nearby parks and physical activity. • A systematic review by Lee and Moudon (2004) identified lack of access to facilities as a barrier to physical activity. • A systematic review by McCormack et al (2004) found a significant positive association between shorter distance to resources for activity and level of physical activity. • A systematic review by Trost et al (2004) reported a significant positive association between access to facilities and level of physical activity. • A systematic review by Wendel-Vos et al (2005) found significant positive association between proximity to recreational facilities and vigorous physical activity.
Duncan et al, 2005 ³⁴⁰	Meta-analysis: 16 studies published between January 1989 and February 2005. The number of studies on the exposure-outcome relation in this section was not reported.	Adults	Access to recreational facilities (general)	Physical activity as a binary factor, eg, any walking, sufficient walking, sufficient leisure-time activity	<ul style="list-style-type: none"> • In crude (unadjusted) analyses, no variables demonstrated a significant association with physical activity. • After adjustment for age, income, and educational level, the perceived presence of physical activity facilities was positively associated with physical activity (OR=1.20; 95% CI, 1.06, 1.34). Significant unexplained heterogeneity was present ($P<0.05$).
Humpel et al, 2002 ³³⁹	Review of 19 studies (18 cross-sectional, 1 longitudinal), including 6 studies on the exposure-outcome relation in this section	Adults	Perceived (16 studies) and/or objectively determined (4 studies) physical environment categorized to accessibility of facilities, opportunities for activity, weather, safety, and aesthetics	Physical activity	<ul style="list-style-type: none"> • Among 3392 Australian adults, Ball et al (2001) found that convenience (a park or beach within walking distance, accessible cycle path, shops within walking distance) was positively associated with walking for exercise (yes/no) in the past 2 wk (low vs high, OR=0.60 [0.46-0.77]), after adjustment for age, sex, and education. • Among 2374 older Australian adults, Booth et al found a positive association between access to recreational facilities (eg, recreation center, cycle path, golf course, gym, park) and being active (vigorous activities, walking for exercise, leisure, and moderate activities ≥ 800 kcal/kg per week) (OR=1.14; 95% CI, 1.03-1.26), after adjustment for sociodemographic, social-cognitive, and perceived environmental variables. • Among 413 adults, mean age 51 y, use of bikeways was evaluated in relation to perceived presence of sidewalks, heavy traffic, enjoyable neighborhood scenery, distance from bikeway, and having a busy street or steep hill to cross on the way to the bikeway. After adjustment for age and sex, several factors were inversely associated with bikeway use, including self-reported and GIS distance from the bikeway, a busy street to cross, and a GIS-measured steep-hill barrier. • Among 2053 adults in San Diego, California, no significant association was seen between perceived convenience of exercise facilities (eg, aerobic dance studio, bike lane, running track) and

					<p>vigorous exercise ($P=0.52$).</p> <ul style="list-style-type: none"> When the preceding association was assessed prospectively, 24-month changes in physical activity were predicted by the neighborhood environment but only in initially sedentary men ($P=0.04$). Among 14,674 adults age 18-69 y who participated in the Canada Fitness Survey in 1983, women who reported no physical activity facility in their neighborhood were more likely to participate in physical activity. No significant association was seen in men.
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Adults (Outcome: Obesity)

<p>Frost et al, 2010³³⁷</p> <p>From http://circ.ahajournals.org/ at Universite de Lausanne - CODUL on September 17, 2012</p>	<p>Systematic review of studies published between 1994 and 2008, including 1 study on the exposure-outcome relation in this section</p>	<p>Adults (age ≥ 18 y) in rural areas</p>	<p>Access to recreational facilities (distance)</p>	<p>Physical activity/obesity</p>	<ul style="list-style-type: none"> Boehmer et al (2006) studied the relation between time to walk from home to the nearest recreational facility and obesity among 1476 adults living in rural areas of Missouri, Tennessee, and Arkansas. After adjustment for age, gender, education, neighborhood variables, and health-related behaviors, the presence of a park that was more than a 20-min walk from home was positively associated with obesity (OR=1.53; 95% CI, 1.10-2.11).
<p>Papas et al, 2007³⁴⁹</p>	<p>Review of 20 studies (18 cross-sectional, 2 longitudinal), including 3 studies on the exposure-outcome relation in this section among adults</p>	<p>Adults</p>	<p>Objectively measured access to recreational facilities (density, distance)</p>	<p>Direct measures of body weight (eg, BMI)</p>	<p>Density:</p> <ul style="list-style-type: none"> Of 2 studies, 1 found a significant inverse association: Mobley et al (2006): Among 2692 women, the number of fitness facilities per 1000 residents was associated with 1.39 kg/m² lower BMI ($P<0.05$) and 15.1% lower calculated 1-y CHD risk ($P<0.05$). Rutt and Coleman (2005): Among 996 Hispanic adults in Texas, there was no significant relation between the number of local resources for physical activity and BMI. <p>Distance:</p> <ul style="list-style-type: none"> Of 2 studies, 1 found a significant positive relation between distance from home to the nearest recreational facility and obesity: Giles-Corti et al (2003): Among 1803 Australian adults age 18-59 y, there was a significant positive association between poor access (distance) to recreational facilities and obesity. Rutt and Coleman (2005): Among 996 Hispanic adults in Texas, there was no significant relation between distance to local physical activity facilities and BMI.

Additional Original Articles, 2007-2010*

Author, y	Design and Duration	Population	Intervention/Exposure	Outcome	Major Findings
<p>Coombes et al, 2010³⁴¹</p>	<p>Cross-sectional, 2005</p>	<p>N=6803 residents age >16 y in Bristol, United</p>	<p>Distance by road from home to 5 types of green space, including those with organized layout (formal green spaces), informal design (informal</p>	<ul style="list-style-type: none"> Frequency of visiting green spaces Engaging in at 	<p>After adjustment for age, sex, SES, self-rated health, and area deprivation:</p> <ul style="list-style-type: none"> People who lived farther from formal green space (>2250 m) compared with those living nearer (<830 m) had lower odds of visiting the

		Kingdom	green spaces), habitats such as woodland (natural green spaces), areas designed for children or teenagers (youth green spaces), and playing fields and tennis courts (sport green spaces)	<p>least 5 sessions per week of >30 min of physical activity</p> <ul style="list-style-type: none"> • Overweight or obesity 	<p>green space at least once a week (OR=0.64; 95% CI, 0.55-0.75), lower odds of doing ≥ 5 sessions per week of >30 min of physical activity (OR=0.76; 95% CI, 0.65-0.88), and higher odds of being overweight or obese (OR=1.27; 95% CI, 1.09-1.47).</p> <ul style="list-style-type: none"> • People who lived farther from informal green space (>680 m) compared with those living nearer (<200 m) had lower odds of visiting the green space at least once a week (OR=0.80; 95% CI, 0.68-0.93) and lower odds of being overweight or obese (OR=0.83; 95% CI, 0.72-0.97). • People who lived farther from natural green space (>800 m) compared with those living nearer (<250 m) had lower odds of visiting the green space at least once a week (OR=0.80; 95% CI, 0.68-0.94); similar findings were seen for sport green space (OR=0.87; 95% CI, 0.74-1.02). No relation was seen between distance to these green spaces and activity or adiposity. • After further adjustment for multiple neighborhood variables (road density, number of junctions per kilometer of road, ratio of junctions to cul-de-sacs, percentage of population age >60 y, percentage of nonwhite population, percentage of population who actively transport to work, and percentage of population with limiting long-term illness), only the associations of formal green space with physical activity remained significant.
Witten et al, 2008 ³⁴²	Cross-sectional, 2002-2003	N=12,529 adults (age ≥ 15 y), nationally representative sample in New Zealand	Travel time (by car) to the nearest park derived from GIS	<ul style="list-style-type: none"> • Sedentary behavior (<30 min per week of physical activity) • Meeting activity guidelines (≥ 2.5 h on >5 days per week) • BMI 	<p>After adjustment for age, sex, race, individual SES, deprivation, and type of residence (urban/rural):</p> <ul style="list-style-type: none"> • Distance to the park was not associated with BMI ($\beta=-0.02$; 95% CI, -0.08-0.05), sedentary behaviors (OR=0.84; 95% CI, 0.63-1.11), or meeting physical activity guidelines (OR=1.15; 95% CI, 0.96-1.37).
Boone-Heinonen et al, 2010 ³⁴⁵	Cross-sectional, 1994-1995	N=10,359 US adolescents, grades 7-12, nationally representative, in the National	Percentage of green space coverage and distance to the nearest neighborhood or major parks derived from GIS	Participation in wheel-based activities (eg, bicycling, roller skating); active sports; exercise; and ≥ 5 bouts per week of MVPA	<p>After adjustment for individual and neighborhood SES variables:</p> <ul style="list-style-type: none"> • Green space coverage was positively associated with MVPA in boys and girls (for 10%-20% vs <10% green space: OR=1.62; 95% CI, 1.10, 2.39) and with exercise participation in girls (OR=1.73; 95% CI, 1.21, 2.49) but not boys.

		Longitudinal Study of Adolescent Health			<ul style="list-style-type: none"> • Green space coverage was not significantly associated with wheel-based sports or active sports. • Distance to parks was associated with higher participation in active sports by boys and girls. • Distance to parks was associated with higher participation in wheel-based activities and MVPA in girls but not boys.
Boone-Heinonen et al, 2010 ³⁴⁶⁻³⁴⁸	Prospective cohort, 1994-1995 to 2001-2002	N=12,701 US adolescents, grades 7-12 at baseline, nationally representative, in the National Longitudinal Study of Adolescent Health	Number and population density of pay and public physical activity facilities (per 10,000 population) derived from GIS. Longitudinal analyses also assessed land-cover diversity, street connectivity, and crime rate.	Number of bouts of MVPA	<p>In cross-sectional analyses, after adjustment for individual SES:</p> <ul style="list-style-type: none"> • Number of physical activity facilities within 3 km was associated with MVPA but with some variation by urbanicity and sex. • Density of physical activity facilities was not significantly associated with MVPA. <p>In longitudinal analyses, after adjustment for measured covariates and within-person time-invariant factors:</p> <ul style="list-style-type: none"> • Greater density of pay facilities was positively associated with MVPA in boys but not girls. • Density of public facilities was not associated with higher MVPA. <p>See Supplementary Tables 10b, 10c, and 10d for findings on land-cover diversity, street connectivity, and crime rate, respectively.</p>

IOM indicates Institute of Medicine; SES, socioeconomic status; MVPA, moderate to vigorous physical activity; GIS, geographical information systems; BMI, body mass index; OR, odds ratio; CI, confidence interval; YMCA/YWCA, Young Men's Christian Association/Young Women's Christian Association; WIC, Women, Infants, and Children; and CHD, coronary heart disease.

*Given the array of smaller, cross-sectional, observational studies that were already captured in the published narrative and systematic reviews identified here, in the writing group's additional systematic searches for original articles published after 2007, performed by means of PubMed searches, evaluation of related articles, and hand searches of reference lists, the writing group focused on those additional studies that were randomized trials, quasi-experimental studies, longitudinal studies, or large (N>5000) cross-sectional studies.

Supplementary Table 10b. Local Environmental Change to Improve Physical Activity (Community Settings)

Land-Use Design (Locations and Accessibility of Destinations)*

Children (Outcome: Physical Activity)

Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
<p>Feng et al, 2010³⁵¹</p> <p>Downloaded from http://circ.ahajournals.org/ at Universite de Lausanne - CODUL on September 18, 2012</p>	<p>Systematic review, including 3 studies on the exposure-outcome relation in this section</p>	<p>Children/ adolescents</p>	<p>Land-use mix</p>	<p>Physical activity/travel mode to school</p>	<p>Of 3 studies, 1 found significant positive association between land-use mix and physical activity, and 1 found significant positive association between land-use mix and biking/walking to school:</p> <p>Overall land-use mix:</p> <ul style="list-style-type: none"> • Kligerman et al (2007) studied the relation between land-use mix and objectively measured physical activity among 98 white or Mexican-American adolescents age 14-17 y living in San Diego County, California. Land-use mix was defined as the geometric mean of 5 land uses in 3 buffer sizes (0.4, 0.8, and 1.6 km) around the participant's home. After adjustment for age and ethnicity, land-use mix at a 0.8-km buffer around home was positively associated with physical activity (point estimate and 95% CI were not reported). • Norman et al (2006) studied the relation between land-use mix and objectively measured physical activity among 799 adolescents age 11-15 y living in San Diego County, California. Land-use mix was defined as the geometric mean of acreage for 5 types of land-use (residential, institutional, entertainment, retail, and office). The mean land-use mix for a 1.6-km buffer around participants' homes was 0.38. Given that no significant association was observed between land-use mix and physical activity in bivariate analysis, it was not included in the final model. The estimates of bivariate analysis were not provided. • Kerr et al (2006) studied the association of perceived and objectively measured land-use mix and parental report of mode of transport to school among 259 children age 5-18 y in Seattle, King County, Washington. Perceived land-use mix was computed using NEWS-Y, based on parental responses to questions about proximity to (land-use mix diversity) and accessibility of nonresidential destinations (land-use mix access). Objectively measured land-use mix was computed using the method described in Frank et al (2004) (see below). After adjustment for child age and gender, parental education, and parental concerns, only perceived land-use mix access was positively associated with active commuting to school (OR=1.8; 95% CI, 1.05-3.42). No significant associations were found between walking/biking to school and perceived

					land-use mix diversity (OR=1.9; 95% CI, 0.96-3.79) or GIS-measured land-use mix (OR=1.5; 95% CI, 0.85-2.77).
Galvez et al, 2010 ³⁵⁵	Systematic review of articles published between January 2008 and August 2009, including 2 articles on the exposure-outcome relation in this section	Children/ adolescents	Land-use mix/distance to school	Physical activity/travel mode to school	<p>Both studies found significant positive association between land-use mix and active transport to school. One study found significant inverse association between distance to school and active travel to school.</p> <p>Overall land-use mix:</p> <ul style="list-style-type: none"> Rosenberg et al (2009) studied the relation between perceived land-use mix and physical activity among 171 adolescents (age 12-18 y) living in Boston, Massachusetts; Cincinnati, Ohio; and San Diego, California. The NEWS-Y was used to assess land-use mix. After adjustment for adolescent gender, race, and parental income, land-use mix access was positively associated with walking to shops ($P=0.0001$) and walking to school ($P=0.002$) once per week. No significant association was found between land-use mix access and meeting recommended physical activity levels ($P=0.13$). Larsen et al (2009) studied the relation between GIS-measured land-use mix and self-reported mode of travel between home and school among 614 students age 11-13 y. Land-use mix was defined as evenness of distribution of 6 types of land uses (recreational, agricultural, residential, institutional, industrial, and commercial) in a buffer of 500 m around participants' homes and a buffer of 1.6 km around participants' schools. Land-use mix was calculated as $\frac{\sum_u (p_u \ln p_u)}{\ln N}$ <p>(Note: u indicates land use classification; p, proportion of land dedicated to a particular land use; and N, total number of land uses).</p> <p>In a stepwise logistic regression, after adjustment for gender, household income, residential density, and distance to school, children living in areas in the upper quartile of land-use mix were more likely to actively travel between school and home compared with those living in the lower quartile (OR=3.46; 95% CI, 1.60-7.47). After adjustment for gender, street trees in the home neighborhood, and distance to school, children going to schools in the upper quartile of land-use mix were more likely to actively travel between school and home (OR=2.89; 95% CI, 1.63-5.12).</p> <p>Distance to school:</p> <ul style="list-style-type: none"> In 614 students age 11-13 y, after adjustment for gender, household income, residential density, and land-use mix, Larsen et al (2009) found significant inverse association between distance to school and active transport from school (OR=0.44; 95% CI, 0.35-0.56).

Dunton et al, 2009 ³⁵⁰	Systematic review: 15 studies published before May 2008, including 2 studies on the exposure-outcome relation in this section	Children/ adolescents	Land-use mix	Physical activity	Of 2 studies, 1 found significant positive association between land-use mix and physical activity. Overall land-use mix: <ul style="list-style-type: none"> • Kligerman et al (2007): See above. • Norman et al (2006): See above.
IOM Committee on Childhood Obesity Prevention Actions for Local Governments, 2009 ¹⁴⁷	Systematic review, including 2 reviews and 4 cross sectional studies on the exposure-outcome relation in this section	Children or adolescents	Land-use mix/distance to school	Physical activity/active transport to school or other destinations.	<ul style="list-style-type: none"> • On the basis of a review by Badland and Schofield (2005) and a cross-sectional study by Frank et al (2004), it was concluded that living in a balanced land-use mix in the neighborhood is positively associated with physical activity. • On the basis of a review by Saelens and Handy (2008), it was concluded that proximity to destinations was positively associated with walking and bicycling to destinations. • On the basis of 3 cross-sectional studies by Tal and Handy (2008), Kerr et al (2006) (see above), and McDonald (2007) (see below), it was concluded that distance from home to school was associated with active transport to school.
Brownson et al, 2009 ³⁵²	Systematic review, including 4 studies on the exposure-outcome relation in this section	Children or adolescents	Land-use mix	Physical activity/travel mode to school	Of 4 studies, 1 found significant positive association between land-use mix and walking/biking to school and 1 found significant positive association between land-use mix and physical activity. Land-use mix: <ul style="list-style-type: none"> • Ewing et al (2004) studied the relation between land-use mix at the level of TAZ and mode of travel to school among 3815 students living in Alachua County, Florida. Land-use mix was defined as degree of land-use balance between jobs and residents at the TAZ level and was assessed by 2 indicators. No association was found between land-use variables and active mode of transport to school (estimates were not provided). • Kerr et al (2006): See above. • Norman et al (2006): See above • Kligerman et al (2007): See above.
Lovasi et al, 2009 ³³⁴	Systematic review of 45 US studies (sample size >100) published between January 1995 and January 2009, including 2 studies on the exposure-outcome relation in this section	Children or adolescents	Land-use mix	Walking/travel mode to school	Of 2 studies, 1 found significant positive association between land-use mix and active transport to school and 1 found significant positive association between land-use mix and walking: Overall land-use mix: <ul style="list-style-type: none"> • Kerr et al (2007) studied the relation between land-use mix and self- or parent-reported walking among 3161 children age 5-18 y living in Atlanta, Georgia. Land-use data were obtained from county-level tax

					<p>assessor's parcel data and census data (no further information was provided). After adjustment for sociodemographic variables, the presence of commercial, recreational, or open spaces in the neighborhood was positively associated with probability of walking at least once over a 2-d period among boys (OR=1.5; 95% CI, 1.1-2.1; $P<0.01$) and girls (OR=2.2; 95% CI, 1.5-3.1; $P<0.001$).</p> <ul style="list-style-type: none"> • Kerr et al (2006): See above.
Davison et al, 2008 ³⁵³	Systematic review of studies published before June 2007, including 2 studies on the exposure of interest in this study	Children or adolescents	Land-use mix	Travel mode to school	<p>Of 2 studies, both found significant positive association between land-use mix and active transport to school.</p> <p>Overall land use-mix:</p> <ul style="list-style-type: none"> • McMillan (2007) studied the relation between objectively measured land-use mix and caregivers' reports of travel mode to school among children in grades 3-5 at 16 elementary schools in California. Land-use mix was defined as the proportion of street segments with land-use mix within a buffer of 0.4 km around the school. Data on land-use mix were obtained from environmental audits. After adjustment for sociodemographic variables, household transportation options, social/cultural norms and neighborhood safety (traffic, crime), land-use mix was positively associated with walking/biking to school ($\beta=0.015$; $P=0.001$). • Kerr et al (2006): See above.
Panter et al, 2008 ³⁵⁴	Systematic review of 24 studies published between 2002 and 2007, including 8 studies on the exposure-outcome relation in this section	Children or adolescents	Land-use mix/distance to school	Physical activity/travel mode to school or local destinations	<p>Of 8 studies, 2 found significant positive association between land-use mix and walking; 2 found significant positive association between distance to school and walking/biking to school; and 1 found significant positive association between the presence of walkable destinations in the neighborhood and physical activity.</p> <p>Overall land-use mix:</p> <ul style="list-style-type: none"> • Frank et al (2007) studied the relation between land-use mix and self-reported walking among 3161 US children age 5-20 y. Land-use mix was calculated based on the Frank et al (2004) method. After adjustment for sociodemographic variables, land-use mix was positively associated with walking at least once over 2 d (OR=1.8; 95% CI, 1.4-2.3; $P<0.001$) and walking >0.8 km per day (OR=1.9; 95% CI, 1.3-2.9; $P<0.001$). • Kerr et al (2007): See above. • McDonald (2007) studied the relation between land-use mix and self-reported mode of travel to school among 614 US children age 5-18 y living in Alameda County, California. Land-use mix was defined as evenness of distribution of 5 types of land use (eg, single-family, multifamily, retail/service, manufacturing/trade/other) in a 1-km network buffer around a household residence and was calculated based on the

					<p>Cervero and Kockelman (1997) method. After adjustment for individual, social environmental, and other built-environment variables, no significant association was found between land-use mix and active transport to school.</p> <ul style="list-style-type: none"> • Mota et al (2007) evaluated the relation between self-reported access to destinations and self-reported travel mode to school among 705 Portuguese girls age 11-18 y. No significant difference was observed between active and passive travelers in terms of their level of agreement with the statement, “many stores are within easy walking distance of my home” ($P=0.91$). • Among 480 US girls age 10-15 y, Evenson et al (2006) found a positive association between the presence of walkable destinations and physical activity above median (OR=1.78; 95% CI, 1.11-2.83). • Ewing et al (2004): See above. <p><i>Distance to school:</i></p> <ul style="list-style-type: none"> • Timperio et al (2006) studied the relation between objectively measured distance to school and parental report of walking/biking to school among 912 Australian children age 5-6 y and 10-12 y. After adjustment for sociodemographic and neighborhood variables, proximity to school was positively associated with active transport to school among children age 5-6 y (OR=5.2; 95% CI, 2.2-12.3), and 10-12 y (OR=10.2; 95% CI, 5.9-17.6). • Ziviani et al (2004) studied the relation between parental perception of distance to school and parental report of mode of transport to school among 164 children age 6-11 y living in Brisbane, Australia. Distance to school was inversely associated with walking to school at least once per week (OR=0.54; 95% CI, 0.35-0.74; $P=0.001$).
Children (Outcome: Obesity)					
Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
Feng et al, 2010 ³⁵¹	Systematic review, including 3 studies on the exposure-outcome relation in this section	Children/ adolescents	Land-use mix	Adiposity	<p>All 3 studies found no significant association between land-use mix and adiposity.</p> <p>Land-use mix:</p> <ul style="list-style-type: none"> • Norman et al (2006) studied the relation between land-use mix and objectively measured BMI among 799 adolescents age 11-15 y living in San Diego County, California. Land-use mix was defined as the geometric mean of acreage for 5 types of land use (residential, institutional, entertainment, retail, and office). The mean land-use mix for a 1.6-km buffer around participants’ homes was 0.38. Given that no significant association was observed between land-use mix and obesity in bivariate analysis, it was not included in the final model. The estimates of bivariate analysis were not provided.

					<ul style="list-style-type: none"> • Kligerman et al (2007) studied the relation between land-use mix and objectively measured BMI among 98 white or Mexican-American adolescents age 14-17 y living in San Diego County, California. Land-use mix was defined as the geometric mean of 5 land uses in 3 buffer sizes (0.4, 0.8, and 1.6 km) around participants' homes. After adjustment for age and ethnicity, land-use mix was not associated with BMI (point estimate and 95% CI were not reported). • Spence et al (2008) studied the association of GIS-measured land-use mix with objectively measured overweight among 501 Canadian children age 4-6 y living in Edmonton, Alberta. Land-use mix within a buffer of 1.5 km around participants' homes was estimated based on the density of 4 types of land uses (institutional, maintenance, dining, and leisure). After adjustment for child age, sex, physical activity, junk food consumption, neighborhood-level education, and proportion of employed women in the neighborhood, land-use mix was not associated with being overweight in girls (OR=0.80; 95% CI, 0.47-1.36) or boys (OR=0.87; 95% CI, 0.58-1.30).
Galvez et al, 2010 ³⁵⁵	Systematic review of articles published between January 2008 and August 2009, including 1 article on the exposure-outcome relation in this section	Children	Land-use mix	Overweight	<ul style="list-style-type: none"> • Spence et al (2008): See above.
Carter and Dubois, 2010 ³⁵⁶	Systematic review of 27 studies published between 1999 and 2009, including 1 study on the exposure-outcome relation in this section	Children/ adolescents	Land-use mix	Adiposity	<ul style="list-style-type: none"> • Spence et al (2008): See above.
Dunton et al, 2009 ³⁵⁰	Systematic review, 15 studies published before May 2008, including 2 studies on the exposure-outcome relation in this section	Children/ adolescents	Land-use mix	Adiposity	<p>Both studies found no significant association between land-use mix and adiposity.</p> <ul style="list-style-type: none"> • Spence et al (2008): See above. • Norman et al (2006): See above.

Adults (Outcome: Physical Activity)

Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
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Feng et al, 2010 ³⁵¹	Systematic review, including 2 studies on the relation between exposure and outcome of interest in this section	Adults	Land-use mix	Physical activity/walking	<p>Of 2 studies, 1 found significant positive association between land-use mix and walking and 1 found significant correlations between land-use mix and physical activity:</p> <p>Land-use mix:</p> <ul style="list-style-type: none"> • Li et al (2008) studied the association of land-use mix with self-reported physical activity among 1221 adults age 50-75 y living in Portland, Oregon. Land-use mix was defined as evenness of distribution of various land-use types and was computed based on the methods of Frank et al (2004). After adjustment for age, gender, race/ethnicity, employment status, home ownership, household income, health status, fruit and vegetable intake, fried-food consumption, BMI, and neighborhood factors, including residential density, median household income, and percentage of black and Hispanic residents, land-use mix was positively associated with neighborhood walking (PR=4.07; 95% CI, 2.29-7.23), walking for transportation (PR=5.76; 95% CI, 2.70-12.31), walking for errands (PR=1.50; 95% CI, 1.01-2.22), and meeting physical activity recommendations (PR=1.46; 95% CI, 1.05-2.04). • Frank et al (2005) studied the relation between land-use mix and accelerometer-measured physical activity among 357 adults age 20-69 y living in Atlanta, Georgia. Land-use mix was defined as evenness of distribution based on the area of 3 types of land uses (residential, commercial, and office) in a 1-km network-based street buffer around participants' homes and was calculated based on the method of Frank et al (2004). The mean calculated land-use mix was 0.38. After adjustment for age, education, and gender, land-use mix was significantly correlated with natural log of the minutes of moderate physical activity per day ($r=0.145$; $P=0.01$). However, the association of land-use mix and physical activity was not assessed in the final multivariate regression model.
Prost et al, 2010 ³³⁷	Systematic review of studies published between 1994 and 2008, including 3 studies on the exposure-outcome relation in this section	Adults	Presence of walkable destinations	Physical activity	<p>Of 3 studies, 1 found significant positive association between perceived presence of walkable destinations and physical activity:</p> <p><i>Land-use mix (presence of walkable destinations):</i></p> <ul style="list-style-type: none"> • Deshpande et al (2005) studied the association of perceived presence of walkable destination and self-reported physical activity among 274 adults with diabetes in rural areas from 12 communities in Missouri, Tennessee, and Arkansas. After adjustment for BMI, health status, and physical impairment, significant positive association was found between presence of walkable destinations and physical activity (OR=2.30; 95% CI, 1.25-4.23). • Sanderson et al (2003) studied the relation between perceived presence of walkable destinations and physical activity among 567 women age 20-50 y living in 3 predominantly black rural areas of Alabama. After adjustment for age, marital status, education, number of children, annual

					<p>income level, employment status, and general health, no significant association was found between perceived presence of walkable destinations (yes/no) and meeting recommendations for physical activity (OR=1.06 [0.74-1.52]).</p> <ul style="list-style-type: none"> Eyler (2003) studied the relation between perceived presence of walkable destinations and self-reported physical activity among 1000 white women age 20-50 y in rural areas of Missouri and Illinois. No association was found between the presence of places within walking distance (yes/no) and meeting recommendations for physical activity (OR=0.91; 95% CI, 0.68-1.25). Adjustment for age, general health status, and self-efficacy did not change the results, and the adjusted OR was not reported.
Brownson et al, 2009 ³⁵²	Systematic review, including 3 studies about the exposure-outcome relation in this section	Adults	Land-use mix	Physical activity/walking	<p>Of 3 studies, 1 found significant correlation between land-use mix and moderate physical activity, 1 found significant positive association between social land use and walking for transport, and 1 found significantly higher land-use access in high-walkable neighborhoods.</p> <p>Land-use mix:</p> <ul style="list-style-type: none"> Frank et al (2005): See above. Forsyth et al (2008) studied the relation between percentage of social land use in the neighborhood and physical activity among 715 US adults living in the Twin Cities area of Minnesota. Percentage of social land use was calculated as total area in parcels, with social uses divided by total land area in parcels, with water area removed. Social uses included daycare centers, medical clinics and offices, theaters, bowling alleys, lodge halls and amusement parks, sports/public assembly facilities, tax-exempt community recreational facilities, library, exempt property owned by the board of education, and other exempt property. After adjustment for age, sex, race, education, marital status, home ownership, tenure, overall health, car ownership, total household members, and other neighborhood variables, social land use was inversely associated with walking for leisure and positively associated with walking for transport. Saelens et al (2003) studied the association of self-reported measure of land-use mix with objectively assessed physical activity among 107 adults age 18-65 y living in 2 nonadjacent census tracts in San Diego, California. A NEWS questionnaire was used to obtain land-use data. Land-use mix diversity was assessed by a question about walking proximity to nonresidential land uses such as a small grocery store, restaurants, and post office (subscale score range: 1-5). To assess land-use mix access, participants were asked if they do most of their shopping at local stores and if they find it difficult to park in local shopping areas (subscale score range: 1-4). After adjustment for age and education, residents of the high-walkable neighborhood had significantly higher land-use mix access (3.2 vs 2.8; $P<0.05$); higher land-use mix diversity (3.5 vs 2.8; $P<0.05$); and higher total physical activity (210.5 vs 139.9 min per week; $P<0.01$).

Casagrande et al, 2009 ³⁵⁷	Systematic review of studies (population \geq 90% black) published before August 2007, including 2 studies on the exposure-outcome relation in this section	Adults	Land-use mix	Physical activity	<p>Of 2 studies, 1 found significant correlation between land-use mix and moderate physical activity.</p> <p>Land-use mix</p> <ul style="list-style-type: none"> Atkinson et al (2005) studied the relation between land-use mix and physical activity among 102 US adults (age 20-65 y). The NEWS questionnaire was used to obtain self-reported data on land-use mix diversity and land-use mix access. In bivariate analysis, land-use mix diversity was not significantly correlated with accelerometer-measured moderate-intensity ($r=0.02$; $P=0.86$) and vigorous-intensity ($r=0.13$; $P=0.21$) physical activity. Land-use mix access was not correlated with accelerometer-measured moderate-intensity ($r=0.14$; $P=0.18$), and vigorous-intensity ($r=0.19$; $P=0.06$) physical activity either. Among 357 adults age 20-69 y living in Atlanta, Georgia, Frank et al (2005) found significant correlation between land-use mix and natural log of the minutes of moderate physical activity per day ($r=0.145$; $P=0.01$). This association was not assessed in the final multivariate regression model.
Chow et al, 2009 ³⁵⁸	Systematic review, including 2 studies on the exposure-outcome relation in this section	Adults	Land-use mix	Physical activity	<p>Of 2 studies, 1 found significantly higher land-use access in high-walkable neighborhoods.</p> <p><i>Land-use mix</i></p> <ul style="list-style-type: none"> Eyler (2003): See above. Saelens et al (2003): See above.
Lovasi et al, 2009 ³³⁴	Systematic review of 45 US studies (sample size >100) published between January 1995 and January 2009, including 4 studies on the exposure-outcome relation in this section.	Adults	Land-use mix	Physical activity	<p>Of 4 studies, 1 found significant positive association between land-use mix and walking, 1 found significant correlations between land-use mix and physical activity, 2 found significant positive association between neighborhood walkability and land-use mix, and 1 found significant positive association between count of nonresidential and specific destinations in the neighborhood and walking.</p> <p>Land-use mix:</p> <ul style="list-style-type: none"> Cerin et al (2007) studied the association of objectively assessed land-use mix and perceived access to destinations with self-reported weekly minutes of walking for transport among 2650 adults age 20-65 y living in 32 neighborhoods from 154 census collection districts in Adelaide, Australia. Land-use mix was defined as evenness of distribution of 5 types of land uses (residential, commercial, industrial, recreational, and other) in a 1-km network buffer around a participant's home and was calculated based on the Cervero and Kockelman (1997) method. Perceived land-use mix and proximity of destinations was assessed by a subscale of NEWS. After adjustment for sociodemographic factors, perceived proximity to commercial destinations was positively associated with transport-related walking ($\beta=12.4$; 95% CI, 0.2-28.8). However, after adjustment for type of neighborhood (residential,

					<p>recreational, commercial/industrial), the association was no longer statistically significant ($\beta=8.3$; 95% CI, $-4.4-21.0$). Furthermore, after adjustment for sociodemographic factors and type of neighborhood, perceived proximity to commercial workplace was positively associated with transport-related walking ($\beta=15.0$; 95% CI, 3.3-26.7). No significant association was found between perceived proximity to schools and walking for transport; or between land-use mix and walking for transport.</p> <ul style="list-style-type: none"> • Hoehner et al. (2005) studied the association of land-use mix with transportation and recreational physical activity among 1073 adult residents of Savannah, GA and St. Louis, MO. Perceived land-use mix was assessed through participants' response to questions about presence and count of specific destinations in their neighborhood. Objective measures of land-use mix included the count of nonresidential and specific destinations in the neighborhood and were assessed through environmental audits. After adjustment for age, gender, and education, people who reported 7–13 destinations within 5-min walking distance from their home were more likely to be involved in any kind of walking for transport compared to those who reported no destination within 5-min walking distance from their home (OR=2.4; 95% CI: 1.3–4.3). Also, based on environmental audits, living in neighborhood with 43-131 nonresidential destinations (fourth quartiles) was associated with higher probability of walking for transport compared to living in the neighborhood with 0-10 nonresidential destinations (OR=3.5; 95% CI: 2.3–5.5). • Frank et al (2005): See above. • Saelens et al (2003): See above.
Saelens and Handy, 2008 ³⁵⁹	Systematic review of 13 reviews published between 2002 and 2006 and 29 original studies published between 2005 and 2006, including 3 reviews and 11 original studies on the exposure-outcome relation in this section (4 of which were included)	Children and adults	Land-use mix	Physical activity/walking	<ul style="list-style-type: none"> • On the basis of 3 reviews by Badland and Schofield (2005), Heath et al (2006), and Saelens et al (2003), it was concluded that living in an area with balanced land-use mix is positively associated with physical activity. • Among the 11 original studies, 2 were in children, both described elsewhere in this Table (see Kerr 2006 and McMillan 2007). Of the 9 in adults, 1 is described elsewhere in this Table (see Hoehner 2005) and another in the walkability Table, below (see Frank 2006). • Of the studies on the relation between proximity of nonresidential destinations and walking for transport, 8 found a positive association and 3 found a null or an unexpected association. • Of the studies on the relation between proximity of nonresidential destinations and walking for recreation, 3 found a positive association and 4 found a null or unexpected association. • Of the studies on the relation between proximity of nonresidential destinations and general walking, 3 found positive association and 1 found no association.

Bauman and Bull, 2007 ³³⁸	Systematic review of reviews published between 2002 and 2007, including 5 reviews on the exposure-outcome relation in this section	Children and adults	Land-use mix	Physical activity/walking	<p>Land-use mix:</p> <ul style="list-style-type: none"> Of 6 reviews, 5 found sufficient evidence to conclude that land-use mix was positively associated with physical activity. One of these studies was a meta-analysis by Duncan et al (2005) (see below). Of 3 reviews, 2 reported positive association between land-use mix and walking.
Duncan et al, 2005 ³⁴⁰	Meta-analysis: 16 studies published between January 1989 and February 2005. The number of studies on the exposure-outcome relation in this section was not reported.	Adults	Various environmental characteristics, including neighborhood shops and services	Physical activity as a binary factor, eg, any walking, sufficient walking, sufficient leisure-time activity, etc	<ul style="list-style-type: none"> In crude (unadjusted) analyses, no variables demonstrated a significant association with physical activity. After adjustment for age, income, and education level, the perceived presence of shops and services was positively associated with physical activity (OR=1.30; 95% CI, 1.14, 1.46).

Adults (Outcome: Obesity)

Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
Feng et al, 2010 ³⁵¹	Systematic review, including 3 studies on the relation between exposure and outcome of interest in this section	Adults	Land-use mix	Adiposity	<p>All 3 studies found an inverse association between land-use mix and obesity.</p> <p>Land-use mix:</p> <ul style="list-style-type: none"> Frank et al (2004) used data from SMARTRAQ to study the relation between land-use mix and self-reported measure of obesity (BMI \geq30) among 10,878 adult residents of Atlanta, Georgia. Land-use mix was defined as evenness of distribution based on areas of 4 types of land use (residential, commercial, office, and institutional) in a 1-km network buffer around a household residence. A land-use mix formula was calculated that could take values between 0 (single land-use environment) and 1 (even distribution of square footage across all 4 land uses). The mean land-use mix in this study was 0.15. After adjustment for age, income, and educational attainment, land-use mix was inversely associated with obesity (OR=0.88; 95% CI, 0.84-0.92; $P<0.000$). Li et al (2008) studied the association of land use with objective measure of overweight/obesity (BMI \geq25) among 1221 adults age 50-75 y living in Portland, Oregon. Land-use mix was defined as evenness of distribution of various land-use types and was computed based on the Frank et al (2004) method (see above). After adjustment for age, gender, race/ethnicity, employment status, home ownership, household income, health status, fruit and vegetable intake, fried-food consumption, and neighborhood factors, including residential density, median household

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					<p>income, and percentage of black and Hispanic residents, land-use mix was inversely associated with risk of being overweight or obese (PR=0.75; 95% CI, 0.62-0.90).</p> <ul style="list-style-type: none"> • Mobley et al (2006) studied the relation between land-use mix and BMI among 2692 women enrolled in the CDC WISEWOMAN program. Land-use mix was defined as evenness of distribution based on square areas of 5 types of land use (residential, commercial, office, institutional, rural) in ZIP codes of each participant's residence and computed based on the Frank et al (2004) method. The mean land-use mix was 0.49 (0.00-0.96). After adjustment for demographic, socioecological and other built-environment variables, land-use mix was inversely associated with BMI ($\beta=-2.60$; $P<0.05$).
Frost et al, 2010 ³³⁷	Systematic review of studies published between 1994 and 2008 including 1 study on the effect exposure-outcome relation in this section.	Adults in rural areas	Presence of walkable destinations	Obesity	<ul style="list-style-type: none"> • Boehmer et al (2006) studied the association of perceived proximity to destinations with self-reported measure of obesity (BMI ≥ 30) among 2210 adults in rural areas from 13 counties in Missouri, Tennessee, and Arkansas. After adjustment for gender, age, and education, participants who disagreed/strongly disagreed that there were many destinations to go within easy walking distance from their home did not have a significantly different risk of obesity compared with those who agreed/strongly agreed with this statement (OR=1.25; 95% CI, 0.99-1.57). Those who reported no destination within a 10-min walk from home did not have a significantly different risk of obesity compared with those who reported 7-11 destinations within a 10-min walk from their home (OR=1.38; 95% CI, 0.99-1.92).
Brownson et al, 2009 ³⁵²	Systematic review, including 2 studies about the exposure-outcome relation in this section	Adults	Land-use mix	Adiposity	<p>Both studies found significant inverse association between land-use mix and adiposity.</p> <p>Land-use mix</p> <ul style="list-style-type: none"> • Rundle et al (2007) studied the relation between land-use mix in the census tract of residence and objectively assessed BMI among 13,102 adults living in New York City. Land-use mix was defined as the balance between commercial and residential land uses and was calculated by multiplying the ratio of residential building area by the ratio of commercial building area for each tract. The product was then scaled by a factor of 4. The calculated index ranged from 0 to 1 and had a mean of 0.34. After adjustment for individual- and neighborhood-level sociodemographic characteristics, land-use mix was inversely associated with BMI ($\beta=-0.55$; $P<0.01$). Further adjustment for other built-environment variables (subway stop, bus stop, population, and intersection densities) did not greatly alter results ($\beta=-0.46$; $P<0.05$). • Frank et al (2004): See above.
Lovasi et al, 2009 ³³⁴	Systematic review of 45 US studies	Adults	Land-use mix/prese	Adiposity	Of 4 studies, 2 found significant positive association between land-use mix and adiposity.

	(sample size >100) published between January 1995 and January 2009, including 4 studies on the exposure-outcome relation in this section		presence of walkable destinations		<p>Land-use mix:</p> <ul style="list-style-type: none"> • Rundle et al (2007): See above. • Frank et al (2004): See above. • Boehmer et al (2006): See above. • Boehmer et al (2007) studied the association of perceived presence of walkable destinations and obesity among 1032 adult residents of high- and low-income areas of Savannah, Georgia, and St Louis, Missouri. After adjustment for age, gender, education, and other environmental variables, people who strongly disagreed that “there are many destinations to go to within easy walking distance from my home” did not have a significantly different risk of obesity compared with those who agreed with this statement (OR=1.5; 95% CI, 0.8-2.6).
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Additional Original Articles 2007-2010*

Author, y	Design and Duration	Population	Intervention/Exposure	Outcome	Findings
Rodríguez et al, 2009 ²⁷¹	Cross-sectional, 2000-2002	N=5529 adults age 45-84 y in Baltimore, Maryland; Chicago, Illinois; Forsyth County, North Carolina; Los Angeles, California; New York City, NY; and St Paul, Minnesota	Land-use (evenness of distribution of residential, institutional, retail, and office in a 200-m buffer around participants' homes) calculated using the Certero and Kockelman (1997) method. Self-reported presence of all destinations, stores, and schools or YMCAs within walking distance (20 min)	Self-reported walking (minutes per week) for transport (level 1: none; level 2: from 0 to 150 min per week; level 3: ≥150 min per week) Self-reported minutes per week of walking for exercise (level 1: none; level 2: from 0 to 90 min per week; level 3: ≥90 min per week).	<p>After adjustment for age, gender, education, race/ethnicity, family income, and proportion of 400-m buffer from home accessible via roads:</p> <p>Walking for transport:</p> <ul style="list-style-type: none"> • People who lived in the areas in the 4th quartile of land-use mix did not have significantly different odds of walking for transport (level 2 vs 1: OR=1.26; 95% CI, 0.71-2.24 and level 3 vs 1: OR=1.36; 95% CI, 0.63-2.96). • Perceived presence of walkable destinations was positively associated with walking for transport (level 2 vs 1: OR=1.13; 95% CI, 1.03-1.24 and level 3 vs 1: OR=1.26; 95% CI, 1.06-1.50). • Perceived presence of stores within walking distance was positively associated with walking for transport >150 min per week (level 2 vs 1: OR=1.13; 95% CI, 0.98-1.30 and level 3 vs 1: OR=1.29; 95% CI, 1.07-1.55). • Perceived presence of schools and YMCA within walking distance was positively associated with walking for transport (level 2 vs 1: OR=1.06; 95% CI, 0.83-1.35 and level 3 vs 1: OR=1.18; 95% CI, 0.87-1.60). <p>Walking for exercise:</p> <ul style="list-style-type: none"> • People who lived in the areas in the 4th quartile of land-use mix were more likely to walk for exercise >90 min per week (level 2 vs 1: OR=1.05; 95% CI, 0.87-1.27 and level 3 vs 1: OR=1.29; 95% CI, 1.08-1.54). • Perceived presence of walkable destinations was positively associated with walking for exercise (level 2 vs 1: OR=1.12; 95% CI, 1.07-1.18 and

					<p>level 3 vs 1: OR=1.30; 95% CI, 1.20-1.41).</p> <ul style="list-style-type: none"> Perceived presence of stores in walking distance was positively associated with walking for exercise >90 min per week (level 2 vs 1: OR=1.04; 95% CI, 0.95-1.13 and level 3 vs 1: OR=1.18; 95% CI, 1.07-1.29). Perceived presence of schools and YMCA within walking distance was positively associated with walking for exercise >90 min per week (level 2 vs 1: OR=1.08; 95% CI, 0.98-1.18) and level 3 vs 1: OR=1.18; 95% CI, 1.05-1.32).
Wells and Yang, 2008 ³⁶⁰	Observational, longitudinal, 2003-2006	N=32 low-income, primarily black women (age 23-60 y) living in 4 southeastern US towns	<ul style="list-style-type: none"> 1 group moved to neotraditional neighborhoods and 1 group moved to conventional suburban neighborhoods Land-use mix was assessed by multiple different metrics without control for multiple testing. Population density 	Number of steps walked per week, assessed by pedometer	<p>After adjustment for race, household size, and premove steps:</p> <ul style="list-style-type: none"> Unexpectedly, 1 metric of greater land-use mix, an increase in service-jobs population density after the move, was associated with fewer steps walked per week ($P=0.013$). Most land-use mix variables were not associated with walking in this small sample.
Boone-Heinonen et al, 2010 ³⁴⁶	Observational, longitudinal, 1994-1995 to 2001-2002	N=12,701 US adolescents, grades 7-12 at baseline, in the nationally representative National Longitudinal Study of Adolescent Health	Neighborhood land-cover diversity, street connectivity, physical activity facilities, and crime rate derived from GIS	Bouts of MVPA	<p>In longitudinal analyses, after adjustment for measured covariates and within-person time-invariant factors:</p> <ul style="list-style-type: none"> Land-cover diversity was not significantly associated with higher MVPA. <p>See Supplementary Tables 10a, 10c, and 10d for findings on physical activity facilities, street connectivity, and crime rate, respectively.</p>

CI indicates confidence interval; NEWS-Y, Neighborhood Environment Walkability Scale–Youth; OR, odds ratio; GIS, geographical information systems; IOM, Institute of Medicine; TAZ, traffic analysis zone; BMI, body mass index; PR, prevalence ratio; SMARTRAQ, Strategies for Metro Atlanta’s Regional Transportation and Air Quality; WISEWOMAN, Well-Integrated Screening and Evaluation for Women Across the Nation; CDC, Centers for Disease Control and Prevention; YMCA, Young Men’s Christian Association; and MVPA, moderate to vigorous physical activity.

*Given the array of smaller, cross-sectional, observational studies that were already captured in the published narrative and systematic reviews identified here, in the writing group’s additional systematic searches for original articles published after 2007, performed by means of PubMed searches, evaluation of related articles, and hand searches of reference lists, the writing group focused on those additional studies that were randomized trials, quasi-experimental studies, longitudinal studies, or large ($N>5000$) cross-sectional studies.

Supplementary Table 10c. Local Environmental Change to Improve Physical Activity (Community Settings)

Street and Sidewalk Design

Children (Outcome: Physical Activity)

Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
<p>Downloaded from http://cph.aphapublications.org/ at Universite de Lausanne - CODD on September 18, 2012</p> <p>NIOM Committee on Childhood Obesity Prevention Actions for Local Government, 2009¹⁴⁷</p>	<p>Systematic review including 4 reviews, 1 quasi-experimental, and 1 cross-sectional study on the exposure of interest in this section</p>	<p>Children or adolescents</p>	<p>Pedestrian infrastructure (sidewalk availability) and street design (street connectivity)</p>	<p>Physical activity</p>	<p>Pedestrian infrastructure:</p> <ul style="list-style-type: none"> On the basis of 3 reviews by Davison and Lawson (2006) (see below), Badland and Schofield (2005), and Saelens et al (2003), it was concluded that the presence of sidewalks is positively associated with walking or biking for transportation or recreation. On the basis of a review by Booth et al (2005), it was concluded that availability of sidewalks might be associated with obesity. In a quasi-experimental analysis, Boarnet et al (2005a) studied the relation between parental reports of presence of a SR2S construction project on the way to school and change in the mode of transport to school among 862 children in grades 3-5 in California. Children whose route to school included a newly installed sidewalk were more likely to increase their active transport to school than children whose route did not include a new sidewalk ($P < 0.01$). <p>Street design:</p> <ul style="list-style-type: none"> On the basis of a review by Badland and Schofield (2005) and a cross-sectional study by Frank et al (2004), it was concluded that street connectivity is positively associated with physical activity.
<p>Committee on Environmental Health, American Academy of Pediatrics, 2009³⁶¹</p>	<p>Systematic review, including 1 quasi-experimental study on the exposure of interest in this section</p>	<p>Children</p>	<p>Pedestrian infrastructure (sidewalk availability)</p>	<p>Physical activity</p>	<p>Pedestrian infrastructure:</p> <ul style="list-style-type: none"> Boarnet et al (2005a): See above
<p>Lovasi et al, 2009³³⁴</p>	<p>Systematic review of 45 US studies (sample size >100) published between January 1995 and January 2009, including 1</p>	<p>Children or adolescents (age 10-15 y)</p>	<p>Pedestrian infrastructure (availability of sidewalk and walking trail)</p>	<p>Physical activity</p>	<p>Pedestrian infrastructure:</p> <ul style="list-style-type: none"> Evenson et al (2006) studied the association of self-reported presence of walking or biking infrastructure with self-reported physical activity and mode of transport to school among 480 US girls age 10-15 y. After adjustment for site, race/ethnicity, and grade, presence of neighborhood

	study on the exposure of interest in this section				bicycle or walking trails was positively associated with physical activity above the median (OR=1.68; 95% CI, 1.16-2.44) and active commuting to school (OR=1.59; 95% CI, 1.05-2.40). The presence of sidewalks was not associated with physical activity (OR=1.34; 95% CI, 0.89-2.02) or active commuting (OR=1.05; 95% CI, 0.66-1.67).
Downloaded from http://circ.ahajournals.org/ at Universite de Lausanne - CODUL on September 18, 2012	Panter et al, 2008 ³⁵⁴ Systematic review of 24 studies published between 2002 and 2007, including 5 on the exposure of interest in this section	Children (4-11 y) or adolescents (12-18 y)	Pedestrian infrastructure (sidewalk availability) and street design (street connectivity).	Walking or cycling to school or other local destinations	<p>Pedestrian infrastructure:</p> <p>Of 5 studies, 3 reported significant positive association between the presence of sidewalks and active mode of transport, and 1 study reported the same between the presence of bicycle or walking trails and physical activity.</p> <ul style="list-style-type: none"> • Mota et al (2007) evaluated the relation between self-reported presence of infrastructure for walking and self-reported travel mode to school among 705 Portuguese girls age 11-18 y. No significant difference was observed between their level of agreement with the statement “there are pavements on most of the streets in my neighborhood “ and active vs passive commuting ($P=0.19$). • Kerr et al (2006) evaluated the association of parental perception of neighborhood characteristics with travel mode to school among 259 US girls and boys age 4-18 y. After adjustment for sociodemographic and other perception variables, significant positive association was observed between perceived presence of walking or cycling infrastructure (eg, sidewalks and pedestrian/bike trails) and active commuting to school (OR=2.5; 95% CI, 1.30-4.67). • Evenson et al (2006): See above. • Among 726 US youth age 10-15 y, Evenson et al (2004) found significant positive association between the presence of sidewalks on main roads (higher sidewalk coverage) and active travel to school. • Among 1395 US boys and girls age 8-18 y, Fulton et al (2003) found significant positive association between parental report of presence of sidewalks and walking to school. <p>Street design:</p> <p>Both studies showed significant positive association between street connectivity and active commuting to school.</p> <ul style="list-style-type: none"> • Mota et al (2007): See above. • Kerr et al (2006): See above.
	Davison et al, 2008 ³⁵³ Systematic review of studies published before June 2007, including 3 on the exposure of interest in this section	Children or adolescents	Pedestrian infrastructure (sidewalk availability) and street design (street connectivity)	Active commuting	<p>Pedestrian infrastructure:</p> <p>All 3 studies found significant positive association:</p> <ul style="list-style-type: none"> • Kerr et al (2006): See above. • Boarnet et al (2005a): See above. • In a quasi-experimental study evaluating California’s SR2S program, Boarnet et al (2005b) showed a significant increase in children’s observed walking after completion of the sidewalk gap closure projects.

Bauman and Bull, 2007 ³³⁸	Systematic review of reviews published between 2002 and 2007, including 1 on the exposure of interest in this section	Children or adolescents	Pedestrian infrastructure (sidewalk availability) and street design (street connectivity)	Physical activity	<p>Pedestrian infrastructure:</p> <ul style="list-style-type: none"> Davison and Lawson (2006): See below. The authors thought there was adequate evidence to conclude that sidewalk availability was positively associated with physical activity. <p>Street design:</p> <ul style="list-style-type: none"> Davison and Lawson (2006): See below.
Davison and Lawson, 2006 ³⁴³	Systematic review of 33 studies, including 7 on the exposure of interest in this section	Children or adolescents	Pedestrian infrastructure (sidewalk availability and conditions) and street design (street connectivity)	Physical activity or active commuting	<p>Pedestrian infrastructure:</p> <p>Of 4 studies, 2 studies found significant association between the presence of sidewalks and physical activity, and 1 study found significant association between sidewalk characteristics and physical activity.</p> <ul style="list-style-type: none"> Ewing et al (2004) found that the proportion of street kilometers with sidewalks was positively associated with children's rates of walking or cycling to school ($\beta=1.480$; t statistic: 2.09). Mota et al (2005) studied the relation between perceived presence of sidewalks on streets in the neighborhood and self-reported physical activity among 1123 adolescents. No significant relation was found between their level of agreement with the statement "there are sidewalks on most of the streets in my neighborhood" and activity ($P=0.15$). Jago et al (2005) studied the relation between objectively assessed sidewalk conditions and physical activity among 210 Boy Scouts. Sidewalk characteristics such as distance from sidewalk to curb, average height of trees, sidewalk material, and sidewalk type were positively associated with objectively measured light-intensity physical activity ($\beta=0.20$; $P=0.003$). Boarnet et al (2005a): See above. <p>Street design:</p> <p>Of 4 studies, 2 found significant positive association between street connectivity and physical activity.</p> <ul style="list-style-type: none"> Among 105 US students age 9-11 y, Braza et al (2004) found a positive relation between street connectivity (objectively measured number of intersections per street kilometer) in a 0.8-km buffer around schools and active commuting (walking or biking to school) by students. Among 799 US boys and girls age 11-15 y, Norman et al found a positive association between intersection density and objectively measured MVPA in girls but not boys. Mota et al (2005) found no relation between perceived street connectivity and self-reported physical activity among Portuguese adolescents in grades 7-12. Timperio et al (2006) studied route directness (connectivity) and parental reports of walking or riding to school for 912 Australian children. Greater route directness was associated with less walking and cycling to school in older children (10-11 y) but not in younger children (5-6 y).

Children (Outcome: Obesity)					
Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
Carter and Dubois, 2010 ³⁵⁶	Systematic review of 27 studies published between 1999 and 2009, including 1 on the exposure of interest in this section	Children and adolescents	Street design (street connectivity)	Obesity	Street design: <ul style="list-style-type: none"> In a study of a nationally representative sample of US children age 5-18 y, Grafova (2008) found no association between street connectivity and obesity. However, children living in neighborhoods built after 1969 were more likely to be obese than those living in neighborhoods built before 1969.
Papas et al, 2007 ³⁴⁹	Review of 20 studies, including 1 study on the exposure of interest in this section	Adolescent	Street design (street connectivity)	Obesity	Street design: <ul style="list-style-type: none"> In a study of 20,745 US adolescents, Nelson et al (2006) did not find a significant association between street connectivity and obesity.
Additional Original Articles (Children)*					
Author, y	Design and Duration	Population	Intervention/Exposure	Outcome	Findings
Boone-Heinonen et al, 2010 ³⁴⁸	Observational, cross-sectional, 1994-1995 National Longitudinal Study of Adolescent Health	N=17,659 US adolescents, grades 7-12, nationally representative	Street connectivity measures, including intersection density and link-node ratio, within 1, 3, 5, and 8.05 km of home, derived from GIS	Participation in MVPA	After adjustment for age, race, household income, parental education, census tract poverty, county level crime, and population density within the neighborhood buffer: <ul style="list-style-type: none"> Intersection density within 1 km was most consistently associated with MVPA. Relations appeared to vary by urbanicity and sex.
Boone-Heinonen et al, 2010 ³⁴⁶	Observational, longitudinal, 1994-1995 to 2001-2002 National Longitudinal Study of Adolescent Health	N=12,701 US adolescents, grades 7-12 at baseline, nationally representative	Neighborhood land-cover diversity, street connectivity, physical activity facilities, and crime rate derived from GIS	Bouts of MVPA	In longitudinal analyses, after adjustment for measured covariates and within-person time-invariant factors: <ul style="list-style-type: none"> Street connectivity was not significantly associated with higher MVPA. <p>See Supplementary Tables 10a, 10b, and 10d for findings on physical activity facilities, land-cover diversity, and crime rate, respectively.</p>
Carver et al, 2010 ³⁶²	Observational, prospective,	Children (age 8-9 y; N=170) and	Objectively measured characteristics of	<ul style="list-style-type: none"> Change in frequency of parent-reported (for 	In crude (unadjusted) analyses: Age 8-9 y:

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	2001-2004 Children Living in Active Neighborhoods Study	adolescents (age 13-15 y; N=276) from 19 government primary schools in high- (n=10) and low- (n=9) SES neighborhoods of Melbourne, Australia	neighborhood (a radius of 800 m around children's homes), including <ul style="list-style-type: none"> Total lengths of walking tracks Total numbers of intersections per neighborhood (intersection density) 	children age 8-9 y) or self-reported (by adolescents age 13-15 y) walking or cycling to/from 15 neighborhood destinations between 2004 and 2006 <ul style="list-style-type: none"> Change in MVPA measured by accelerometer in 4-6 complete consecutive days in 2001, 2004, and 2006 	<ul style="list-style-type: none"> Active commuting increased over follow-up in both boys and girls. In crude analyses, total length of walking tracks was positively associated with change in active commuting in girls ($\beta=0.0016$; $P=0.015$) but not boys. Age 13-15 y: <ul style="list-style-type: none"> Active commuting tended to decrease over follow-up in both boys and girls. Total length of walking tracks was positively associated with change in active commuting in girls ($\beta=0.0016$; $P=0.002$). Intersection density was positively associated with change in active commuting among boys ($\beta=0.03$; $P=0.030$).
Hume et al, 2009 ³⁶³	Observational, prospective, 2004-2006 Children Living in Active Neighborhoods Study	Children (age 8-9 y, N=121) and adolescents (age 13-15 y, N=188) from 19 government primary schools in high- (n=10) and low- (n=9) SES neighborhoods of Melbourne, Australia	Parents' self-reported satisfaction with neighborhood characteristics, including number of pedestrian crossings (strongly agree/agree=1; others=0)	Change in frequency of parent-reported (children age 8-9 y) or self-reported (children 13-15 y) walking or cycling to/from school between 2004 and 2006 dichotomized into 2 groups (increased, not changed)	After adjusting for gender, maternal education, and clustering of children by school: <ul style="list-style-type: none"> Parents' satisfaction with the number of pedestrian crossings was associated with increased frequency of active commuting to school over 2 y (OR=2.4; 95% CI:1.1-5.4; $P=0.03$).

Adults (Outcome: Physical Activity)

Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
Feng et al, 2010 ³⁵¹	Systematic review, including 5 reviews on the exposure of interest in this section	Adults	Street design (street connectivity)	Physical activity	Street design: <ul style="list-style-type: none"> On the basis of a review by Frank and Engelke (2003), it was concluded that street networks are associated with mode of transportation. On the basis of a review by Saelens et al (2003) and a review by Sallis et al (2004), it was concluded that street connectivity is associated with ease of active travel between places. On the basis of 3 reviews by Saelens et al (2003), Frank et al (2004), and Ewing and Cervero (2001), it was concluded that street connectivity is positively associated with active transport by reducing trip distance and providing alternate routes.
Frost et al, 2010 ³³⁷	Systematic review of studies published	Adults (age ≥ 18 y) in rural areas	Pedestrian infrastructure (availability of	Physical activity	Pedestrian infrastructure: Of 7 studies, 3 studies found significant positive association between presence of

	between 1994 and 2008, including 7 studies on the exposure of interest in this section		sidewalk, shoulder, and walking trail)		<p>sidewalks and physical activity, 1 found positive association between presence of shoulders on streets and physical activity, and 1 found positive association between presence of walking trails and physical activity.</p> <ul style="list-style-type: none"> • Deshpande et al (2005) studied the association between neighborhood sidewalks and walking among 274 adults with diabetes in rural areas from 12 communities in Missouri, Tennessee, and Arkansas. After adjustment for BMI, health status, and physical impairment, no significant association was found between presence of sidewalks and physical activity (OR=1.28; 95% CI, 0.71-2.29), but positive association was seen between presence of shoulders on streets and physical activity (OR=2.4; 95% CI, 1.3-4.5). • Eyler (2003) found no association between perceived presence of sidewalks and meeting recommendations for physical activity among white women age 20-50 y in rural areas of Missouri and Illinois (OR=0.99; 95% CI, 0.97-1.01). • Among 1194 adults in rural areas of a southeast county, Addy et al (2004) found positive association between perceived presence of sidewalks and occasional walking (OR=2.23; 95% CI, 1.27-3.92) but not regular walking (OR=1.39; 95% CI, 0.77-2.51). • Parks et al (2003) studied the association between perceived presence of walking trails and meeting the recommendations for physical activity among 1818 adults in a nationally representative sample of US rural areas. After adjustment for age, race, education, and gender, a positive association was seen in lower-income urban participants (OR=1.89; 95% CI, 1.06-3.41) but not rural or higher-income urban participants. • Among 1148 adults from a southeastern US rural community, Reed et al (2006) found positive association between perceived presence of sidewalks and meeting recommended physical activity levels (OR=3.59; 95% CI, 1.05-12.24) only among white participants. • Sanderson et al (2003) studied the relation between perceived presence of sidewalks and physical activity among 567 adults from rural areas of Alabama. After adjustment for age, marital status, education, number of children, annual income level, employment status, and general health, no significant association was found between presence of sidewalks and meeting recommendations for physical activity (OR=1.28; 95% CI, 0.82-2.01). • Among 102 black and white women age ≥ 50 y in rural areas of South Carolina, Wilcox et al (2003) found an inverse association between perceived absence of sidewalks and physical activity ($\beta=-0.21$, $P<0.02$).
Committee on Environmental Health, American Academy of Pediatrics, 2009 ³⁶¹	Systematic review, including 2 studies that evaluated the exposure of interest in this section	Adults	Pedestrian infrastructure (sidewalk availability and conditions)	Physical activity	<p>Pedestrian infrastructure:</p> <p>Of 2 studies, 1 found positive association between availability of sidewalks and physical activity and 1 between sidewalk conditions and physical activity.</p> <ul style="list-style-type: none"> • Giles-Corti studied 1803 Australian adults age 18-59 y stratified by SES. After adjustment for age and sex, participants from lower-SES areas were more likely to feel there was availability of sidewalks in their neighborhood (OR=1.88; 95% CI, 1.31-2.71; $P=0.001$). After adjustment for age, sex, number of children age <18 y at home, education, household income, and

					<p>work status, sidewalk availability was positively associated with walking for transport (OR=1.65; 95% CI, 1.12-2.41; $P=0.011$), trend toward walking for recreation (OR=1.41; 95% CI, 0.99-2.03; $P=0.058$), and meeting recommended levels of walking (OR=1.65; 95% CI, 0.95-2.87; $P=0.077$). In similar analyses, presence of sidewalks was positively associated with both performing vigorous exercise (OR=1.52; 95% CI, 1.05-2.21; $P=0.027$) and meeting recommended levels of vigorous exercise (OR=2.73; 95% CI, 1.39-5.37; $P=0.003$).</p> <ul style="list-style-type: none"> • Hoehner et al (2005) studied perceived availability of sidewalks and objective measures of sidewalk conditions and physical activity among 1068 adult residents of a low-walkable city (St Louis, Missouri) and high-walkable city (Savannah, Georgia). More than 90% of participants strongly agreed or agreed with the presence of sidewalks on most streets in their community. No association was found between sidewalk availability and meeting the recommendations for transportation activity (OR=0.9; 95% CI, 0.4-1.7) or recreational activity (OR=0.9; 95% CI, 0.5-1.7). Sidewalk levelness (percent of street segments with sidewalks with little or no unevenness) was inversely associated with meeting recommendations for transportation activity (OR=0.5; 95% CI, 0.3-0.8) but not recreational activity (OR=0.8; 95% CI, 0.6-1.2).
<p>Lovasi et al, 2009³³⁴</p>	<p>Systematic review of 45 US studies (sample size >100) published between January 1995 and January 2009, including 2 studies on exposure of interest in this section</p>	<p>Adults</p>	<p>Pedestrian infrastructure (availability of sidewalks and walking trails)</p>	<p>Physical activity</p>	<p>Pedestrian infrastructure:</p> <p>Of 2 studies, 1 found positive association between presence of walking/bicycling trail and physical activity.</p> <ul style="list-style-type: none"> • King et al (2000) evaluated presence of sidewalks and inactivity in a nationally representative US sample of 2912 women age ≥ 40 y from different racial/ethnic groups. After adjustment for age, race, employment, marital status, location, education, neighborhood, personal barriers characteristics, physical health, and preference for home-based exercise, no significant association was found between presence of sidewalks and being inactive (OR=1.08; 95% CI, 0.87-1.34). • Among 1194 low- and high-SES residents of a rural southeastern US county, Wilson et al (2004) evaluated self-reported and objectively assessed sidewalk availability and walking. Objective data showed similar rates of sidewalk availability in low- vs high-SES areas, although low-SES participants perceived lower availability. Sidewalk availability was not significantly related to walking in either group. Low-SES residents had less access to objectively assessed walking and bicycling trails (3.2 vs 59.2 km). After adjustment for age, sex, race, education, and BMI, compared with not having access, those who both had access and used walking/bicycling trails were more likely to meet physical activity guidelines among low-SES (OR=2.81; 95% CI, 1.38-7.93; $P=0.05$) but not high-SES participants. Access alone, without use, was not associated with meeting physical activity guidelines (OR=1.17; 95% CI, 0.53-2.55).

Casagrande et al, 2009 ³⁵⁷	Systematic review of minority studies (population ≥90% black) published before August 2007, including 6 studies on the exposure of interest in this section	Black adults (age ≥18 y)	Pedestrian infrastructure (sidewalk availability)	Physical activity	<p>Pedestrian infrastructure:</p> <p>Of 6 studies, 2 found positive association between presence of sidewalks and physical activity.</p> <ul style="list-style-type: none"> • King et al (2000): See above. • Eyler (2003): See above. • Wilcox et al (2003): See above. • Sanderson et al (2003): See above. • Ainsworth et al (2003) studied perceived presence of sidewalks and meeting recommendations for physical activity among 917 black women age 20-50 y in South Carolina. Most (77.2%) women reported no sidewalks in their neighborhood. After adjustment for education and county of residence, sidewalk availability was positively associated with meeting recommendations (OR=1.57; 95% CI, 1.14-2.17). • Young et al (2003) studied perceived presence of sidewalks and meeting recommendations for physical activity among 234 black women age 20-50 y in Baltimore, Maryland. Most (94%) women reported availability of sidewalks in their neighborhood. No significant association was seen between sidewalk availability and meeting recommendations for physical activity (OR=0.30; 95% CI, 0.04-2.32).
Saelens and Handy, 2008 ³⁵⁹	Systematic review of 13 reviews published between 2002 and 2006 and 29 original studies published between 2005 and 2006, including 6 reviews and 10 original studies on the exposure of interest in this section	Children and adults	Pedestrian infrastructure (sidewalk availability) and street design (street connectivity)	Walking	<p>Pedestrian infrastructure:</p> <ul style="list-style-type: none"> • On the basis of 4 reviews by Handy (2005), Heath et al (2006), McCormack et al (2004), and McMillan (2005), the authors concluded that presence of sidewalks is associated with walking. • Of 8 studies, 2 found positive association between pedestrian infrastructure and walking for transportation. • Of 6 studies, 4 found positive association between pedestrian infrastructure and walking for recreation. • Of 4 studies, 2 found positive association between pedestrian infrastructure and walking in general. <p>Street design:</p> <ul style="list-style-type: none"> • On the basis of 2 reviews by Badland and Schofield (2005) and Saelens et al (2003), the authors concluded that street connectivity is associated with walking. • Of 7 studies, 3 found positive association between street connectivity and walking for transportation. • Of 4 studies, none found positive association between street connectivity and walking for recreation. • Of 6 studies, 3 found positive association between street connectivity and walking in general.
Bauman and Bull, 2007 ³³⁸	Systematic review of reviews published	Adults	Pedestrian infrastructure (sidewalk)	Physical activity or walking	<p>Pedestrian infrastructure:</p> <p>Of 6 reviews, 3 found significant positive association between sidewalk</p>

	between 2002 and 2007, including 6 reviews about the exposure of interest in this section		availability) and street design (street connectivity)		<p>availability and physical activity, and 3 found positive association between sidewalk availability and walking.</p> <ul style="list-style-type: none"> • A review by Trost et al (2002) did not find sufficient evidence to conclude that sidewalk availability is associated with physical activity levels. • A meta-analysis by Duncan et al (2005) showed presence of sidewalks was positively associated with physical activity (see below). • A systematic review by Humpel et al (2002) concluded that presence of safe sidewalks was positively associated with physical activity. • A systematic review by McCormack et al (2005) concluded that sidewalk safety was positively associated with physical activity and walking for recreation. • A systematic review by Owen et al (2004) found significant positive association between presence of sidewalks and walking for transport. • A review by Wendel Vos Droomers et al (2005) concluded that presence of sidewalks was positively associated with walking. <p>Street design: Three studies found positive association between street connectivity and physical activity. One study found positive association between street connectivity and walking.</p> <ul style="list-style-type: none"> • Badland and Schofield (2005) found positive association between street connectivity and the number of intersections and physical activity. • Vojnovic (2006) found positive association between street connectivity and physical activity. • Wendel Vos et al (2005) found positive association between street connectivity and active commuting. • McCormack et al (2004) found positive association between street connectivity and physical activity and walking.
Duncan et al, 2005 ³⁴⁰	Meta-analysis of 16 studies published between January 1989 and February 2005. The number of studies that evaluated the exposure of interest in this section was not reported.	Adults	Pedestrian infrastructure (sidewalk availability)	Physical activity	<p>Pedestrian infrastructure:</p> <ul style="list-style-type: none"> • After adjustment for age, income, and education, the perceived presence of sidewalks was positively associated with physical activity (OR=1.29; 95% CI, 1.17-1.41). The presence of sidewalks explained 6% of physical activity variance.
Adults (Outcome: Obesity)					
Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings

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Frost et al, 2010 ³³⁷	Systematic review of studies published between 1994 and 2008, including 1 on the exposure of interest in this section	Adults (age ≥18 y) in rural areas	Pedestrian infrastructure (sidewalk availability)	Obesity	<p>Pedestrian infrastructure:</p> <ul style="list-style-type: none"> Boehmer et al (2006) studied the association between perceived presence of sidewalks and obesity among 2210 adults in rural areas from 13 counties in Missouri, Tennessee, and Arkansas. After adjustment for gender, age, and education, no significant association was found between sidewalk availability and obesity (OR=1.19; 95% CI, 0.95-1.48).
Lovasi et al, 2009 ³³⁴	Systematic review of 45 US studies (sample size >100) published between January 1995 and January 2009, including 2 studies on the exposure of interest in this section	Adults	Pedestrian infrastructure (sidewalk availability and conditions)	Obesity	<p>Pedestrian infrastructure:</p> <p>Of 2 studies, 1 found significant inverse association between sidewalk availability and obesity.</p> <ul style="list-style-type: none"> Boehmer et al (2006): See above. Boehmer et al (2007) evaluated perceived presence and observed conditions of sidewalks and obesity among 1032 adult urban residents of high- and low-income areas of Savannah, Georgia, and St Louis, Missouri. After adjustment for age, gender, education, and other environmental variables, people who strongly disagreed that “there are sidewalks on most of the streets in my community” had significantly greater odds of obesity compared with those who agreed with this statement (OR=2.2; 95% CI, 1.1-4.3). Poor condition of sidewalks was also positively associated with obesity (OR=2.1; 95% CI, 1.3-3.6). This association was stronger among lower-income participants.
Papass et al, 2007 ³⁴⁹	Review of 20 studies, including 3 studies on the exposure of interest in this section	Adults	Pedestrian infrastructure (sidewalk availability) and street design (street connectivity)	Direct measures of body weight (eg, BMI)	<p>Pedestrian infrastructure:</p> <p>Of 2 studies, 1 found inverse association between sidewalk availability and odds of overweight.</p> <ul style="list-style-type: none"> Giles-Corti et al (2003) evaluated sidewalk availability and obesity among 1803 Australian adults age 18-59 y. After adjustment for age, gender, education, occupation, SES, smoking status, time spent watching TV, leisure-time physical activity, physical activity level compared with peers, and other environmental variables, living on a street with no sidewalks or sidewalks on only 1 side of the street was positively associated with overweight (OR=1.35; 95% CI, 1.03-1.78). A nonsignificant trend was seen between sidewalk availability and obesity (OR=1.62; 95% CI, 0.98-2.68). Rutt and Coleman (2005) did not find significant association between sidewalk availability and BMI among 996 Hispanic adults in Texas. <p>Street design:</p> <ul style="list-style-type: none"> In a study of 10,878 US adults age 18-100 y, Frank et al (2004) did not find significant association between the number of intersections within a 1-km radius of home and obesity.
Booth et al, 2005 ³⁶⁷	Narrative review of 9 studies, including 1 on the exposure of	Adults	Pedestrian infrastructure (sidewalk availability)	Overweight /obesity	<p>Pedestrian infrastructure:</p> <ul style="list-style-type: none"> Giles-Corti et al (2003): See above.

	interest in this section				
Additional Original Articles 2007-2010 (Adults)*					
Author, y	Design and Duration	Population	Intervention/Exposure	Outcomes	Findings
Cleland et al, 2008 ³⁶⁴	Observational, prospective, 2004-2006	N=357 mothers of children in the Children Living in Active Neighborhoods study in Melbourne, Australia	Self-reported characteristics of neighborhood, including infrastructure	Self-reported time spent on walking for leisure (low: <90 min per week; high ≥90 min per week) or for transport (low:<30 min per week; high ≥90 min per week) in the local neighborhood	<ul style="list-style-type: none"> After adjustment for highest level of schooling and corresponding baseline walking variables, no significant association was found between sidewalk availability and walking for leisure or transport.
Hou et al, 2010 ³⁶⁵	Observational, prospective, 1985-1986 to 2000-2001	N=5115 young US adults in the CARDIA cohort	Time-varying street network data within 1 km of home, derived from GIS	Self-reported walking, bicycling, and jogging	<p>After adjustment for time-varying individual-level and census-level covariates:</p> <ul style="list-style-type: none"> Neighborhood street density was positively associated with walking, bicycling, and jogging in low-urbanicity areas. In middle- and high-urbanicity areas, street density had no relation to activity in men and was inversely associated with activity in women.
Fitzhugh et al, 2010 ³⁶⁶	Quasi-experimental, 2005-2007	Residents of 3 neighborhoods in Knoxville, Tennessee (1 intervention and 2 control neighborhoods)	Construction of an urban greenway/trail in a neighborhood that lacked connectivity of the residential pedestrian infrastructure to nonresidential destinations	2-h counts of directly observed (1) total physical activity in the general neighborhood and (2) active commuting to school	<ul style="list-style-type: none"> At follow-up, total physical activity was significantly higher in the intervention neighborhood ($P=0.028$). During follow-up, total physical activity significantly increased in the intervention neighborhood (median difference=+8.5; $P<0.001$) and decreased in control neighborhoods (median difference=-1; $P<0.001$). Active transport to school was not significantly changed in either intervention or control neighborhoods.

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SIOM indicates Institute of Medicine; SR2S, Safe Routes to School; OR, odds ratio; CI, confidence interval; GIS, geographical information systems; MVPA, moderate to vigorous physical activity; SES, socioeconomic status; BMI, body mass index; and CARDIA, Coronary Artery Risk Development in Young Adults.

*Given the array of smaller, cross-sectional, observational studies that were already captured in the published narrative and systematic reviews identified here, in the writing group's additional systematic searches for original articles published after 2007, performed by means of PubMed searches, evaluation of related articles, and hand searches of reference lists, the writing group focused on those additional studies that were randomized trials, quasi-experimental studies, longitudinal studies, or large (N>5000) cross-sectional studies.

Supplementary Table 10d. Local Environmental Change to Improve Physical Activity (Community Settings)

Neighborhood Safety and Crime

Safety and Physical Activity in Children and Adolescents (Reviews)

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Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
Galvez et al, 2010 ³⁵⁵	Systematic review of articles published between January 2008 and August 2009, including 8 articles about the exposure-outcome relation in this section	Children or adolescents age ≤18 y	Safety: overall, traffic-related, crime-related	Physical activity	<p>Overall safety:</p> <ul style="list-style-type: none"> Five studies found positive association between parental perception of safety and children's physical activity. Wen et al found that parental perception of neighborhood safety was positively associated with time spent playing outdoors in children age 10-12 y ($P=0.06$). Veugelers et al found positive association between parental perception of neighborhood safety and playing sports without a coach (OR=1.23; 95% CI, 1.04-1.46). Beets et al found parental perception of a neighborhood's safety for children to play outside fully mediated the effect of neighborhood quality on parental reports of children's activity. Carver et al found positive association between parental perceptions of safety and adolescent boys' physical activity after school. They found no associations between parental perceptions of neighborhood safety and children's physical activity outside school hours. Kerr et al found that perceived safety was positively associated with use of indoor exercise equipment in girls age 11-15 y. <p>Traffic safety:</p> <ul style="list-style-type: none"> Two studies found significant association between subjective measures of road safety and physical activity. Rosenberg et al found positive association between parental perception of road safety and parental reports of children's (age 5-11 y) activity in parks ($P=0.047$). They also found positive association between adolescents' perception of road safety and walking to a park ($P=0.003$). Carver et al found inverse association between self-reported concerns about road safety and physical activity during evenings and outside school hours among adolescent girls. <p>Crime safety:</p> <ul style="list-style-type: none"> Among 3 studies that evaluated neighborhood crime, 1 found significant inverse association with walking, 1 found significant positive association with sedentary behaviors, and 1 found no association. Rosenberg et al found an inverse association between adolescents' concerns over crime safety and walking to shops ($P=0.03$). Brown et al found positive association between sex offenders per capita (IRR=2.35; 95% CI, 1.27, 4.34) and burglaries per 100 capita (IRR=1.25; 95% CI, 1.05, 1.47) in the school area and playing video games among boys. Also, they found positive association between burglaries (IRR=1.19; 95% CI, 1.038, 1.356) and larcenies (IRR=1.05; 95% CI, 1.00,

					1.10) in the school area and hours of television watching among the girls. Martin and McCaughtry did not find any significant association between self-reported crime attributes of the neighborhood (eg, crime, litter, gangs) and physical activity among black children.
IOM Committee on Childhood Obesity Prevention Actions for Local Governments, 2009 ¹⁴⁷	Systematic review, including 2 reviews, 2 longitudinal studies, and 1 cross-sectional study on the exposure-outcome relation in this section	Children or adolescents	Safety (overall, crime)	Physical activity	Overall safety: <ul style="list-style-type: none"> On the basis of a review by Carver et al³⁶⁸ (see below), a longitudinal study by Cleland et al³⁶⁴, and a cross-sectional study by Weir et al,³⁶⁹ the committee concluded that perceived safety significantly affects walking in both children and adults. Crime safety: <ul style="list-style-type: none"> On the basis of a review by Ferreira et al³⁴⁴ and a longitudinal study by Gordon-Larsen et al,³⁷⁰ the committee concluded that safety from crime was associated with physical activity.
Carver et al, 2008 ³⁶⁸	Narrative review, including 11 studies about the exposure-outcome relation in this section	Children or adolescents (United States, Australia, New Zealand, United Kingdom, and Europe)	Safety (traffic, crime)	Physical activity	Traffic safety (perceived measures): <ul style="list-style-type: none"> On the basis of the descriptive findings of 6 studies, road safety is a common concern among both parents and children. Three studies found significant inverse association between parental concerns about road safety and children's physical activity. Among 2 studies on the relation between adolescents' perceptions of road safety and physical activity, 1 reported positive association and 1 reported no association. Also, 1 study compared perceptions of parents and their children and found that children age 10-12 y were less concerned about road safety than their parents were. However, parental perception of road safety was a stronger predictor of children's walking and cycling in the neighborhood. Traffic safety (objective measures): <ul style="list-style-type: none"> A study that used objective measure of road safety found significant inverse association between GIS-derived need to cross a busy road on the most direct route to school and walking or cycling to school among children age 5-6 y and 10-12 y. Crime safety (perceived measures): <ul style="list-style-type: none"> On the basis of the descriptive findings of 3 studies, harm from strangers is a common concern among parents. For instance, 1 study reported 88% of parents of 5-6-y-olds and 81% of parents of 10-12-y-olds reported stranger danger as a concern. However, the only study on the relation between parental perception of stranger danger and physical activity did not find any significant association, which the authors thought could relate to high prevalence of the concern. Another study found no associations between adolescents' perception of stranger danger and walking or cycling in their neighborhood. Crime safety (objective measures): <ul style="list-style-type: none"> Most studies reviewed used a subjective measures of crime safety. However, 2 studies that used objective measures reported significant associations. A study of Mexican-American adolescents found significant inverse association

					between the number of violent crimes committed within a radius of 0.8 km of home during the past year and outdoor physical activity, although only among girls. Another study, after adjusting for SES, sex, age, BMI, and ethnicity, found that objectively measured social disorder was inversely associated with time spent on recreational physical activity among children and adolescents age 11-16 y. However, this study did not find a significant association between physical disorder (eg, wrecked vehicles) and physical activity.
Panter et al, 2008 ³⁵⁴	Systematic review of 24 studies published between 2002 and 2007, including 13 studies about the exposure-outcome relation in this section	Children (age 5-11 y) or adolescents (age 12-18 y) in the United States, Australia, and Europe	Safety (traffic, crime)	Walking or cycling to school or other local destinations	<p>Traffic safety:</p> <ul style="list-style-type: none"> All 5 studies that evaluated the relation between road safety and active travel reported significant association; however, the characteristics of the road evaluated in the studies were to some extent different. For example, 1 study found significant inverse association between parental reports of no lights or crossings in the neighborhood and parental perception that children had to cross busy roads to get to school and active travel to school. Another study found significant positive association between self-perception of safety and walking among the girls. This study found inverse association between parental concerns about traffic and walking or cycling among the boys. Another study found inverse association between unsafe roads and walking regardless of the child's or parents' perception of safety. <p>Crime safety:</p> <ul style="list-style-type: none"> Among the 8 studies on the relation between parental perception of personal safety and active commuting, 3 reported significant inverse association. For instance, 1 study³⁷¹ found lower parental concern of safety was associated with 5.2 higher odds of active commuting to school (OR=5.2; 95% CI, 2.71-9.96). However, 5 other studies did not find any significant association between parental concerns about personal safety (eg, stranger danger) and walking or cycling among children and adolescents.
Davison et al, 2008 ³⁵³	Systematic review of studies published before June 2007, including 8 studies on the exposure-outcome relation in this section	Children or adolescents (age <18 y)	Safety (traffic, crime)	Active commuting	<p>Traffic safety:</p> <ul style="list-style-type: none"> Among the 4 studies on the relation between perceived traffic safety and mode of transport to school, only 1 study found significant inverse association between parental concerns about traffic safety and active commuting to school. <p>Crime safety:</p> <ul style="list-style-type: none"> Among the 4 studies on the relation between concerns about crime or strangers and children's mode of transport, only 1 study found significant positive association between parental perception of safe neighborhood and active commuting to school. On the basis of the finding of the studies on the exposure-outcome relation in this section and studies about other environmental characteristics, the authors concluded that parental perception of environmental attributes is a stronger predictor of children's active commuting compared with objectively measured characteristics.
Ferreira et al,	Systematic review	Children and	Safety (crime)	Physical	Crime safety:

2007 ³⁴⁴	of 150 studies published from January 1980 to December 2004, including 3 cross-sectional studies on the exposure-outcome relation in this section	adolescents (age ≤18 y)		activity	<ul style="list-style-type: none"> • Among the studies on the relation between crime incidence (measured objectively) and adolescents' physical activity, 2 found significant inverse association. This finding was at odds with the lack of association between adolescents' physical activity and the neighborhood safety estimates they perceived. • Although a wide range of potential correlates at the physical, sociocultural, and economical levels were identified in this study, only a few were examined in >3 independent samples.
Davison and Lawson, 2006 ³⁴³	Systematic review of 33 studies, including 12 studies on the exposure-outcome relation in this section	Children or adolescents age <18 y	Safety (traffic, crime)	Physical activity	<p>Crime safety:</p> <ul style="list-style-type: none"> • Among 9 studies that examined the association between perceived safety and children's physical activity, 7 found no association. Only studies by Molnar et al and Gomez et al found significant association. <p>Traffic safety:</p> <ul style="list-style-type: none"> • All 3 studies that examined the relation between road safety and physical activity reported an inverse association. Timperio et al reported that parental perception that their children had to cross many roads to get to a play area was associated with significantly lower rates of walking and cycling among children. Also, in a second study, Timperio et al, using the same sample but using an objective assessment of the environment, found that the presence of a busy road barrier was associated with lower rates of active commuting to school among children age 5-6 y and 10-12 y. Also, Carver et al reported that parental concerns about traffic were associated with lower rates of walking or cycling among girls and boys.
Safety and Obesity Among Children and Adolescents (Reviews)					
Dunton et al, 2009 ³⁵⁰	Systematic review, including 15 studies (14 cross-sectional), with a few studies on the exposure-outcome relation in this section	Children and adolescents	Physical environment characteristics	BMI	<ul style="list-style-type: none"> • Positive associations with obesity outcomes were found for number of neighborhood hazards (low-SES areas) and parental perceptions of heavy traffic (older children).
Galvez et al, 2010 ³⁵⁵	Systematic review of articles published between January 2008 and August 2009, including 8 articles on the exposure-outcome relation of interest in this section	Children and adolescents age ≤18 y	Safety (overall, crime, traffic, physical disorder)	Obesity	<ul style="list-style-type: none"> • Among 3 studies evaluating parental perception of safety, 2 found significant association with healthy weight among 5th grade girls and children age ≥11 y, and 1 reported no association. • Among 2 studies that examined adolescents' perception of safety and BMI, 1 found an inverse association only in racial groups other than blacks and whites (a combined group of Hispanics, Asians, American Indians, and other racial groups). • Among 3 studies that evaluated neighborhood conditions or physical disorder, 1 found positive association, 1 found inverse association, and 1 found no association. • In 2 studies, there was no associations between crime and obesity.

					<ul style="list-style-type: none"> The findings from 1 longitudinal study suggested TV as a mediator of the relation between neighborhood safety and obesity.
Carter and Dubois, 2010 ³⁵⁶	Systematic review of 27 studies published between 1999 and 2009, including 7 studies on the exposure-outcome relation in this section	Children and adolescents (age 2-18 y) living in the United States, Canada, Australia, United Kingdom, and Germany	Safety	Adiposity (skin-fold thickness, BMI, percentage of lean body mass, etc)	<ul style="list-style-type: none"> Among the 7 studies that examined the relation between neighborhood safety and child adiposity, only 1 found significant relation and only in 1 age group. Timperio et al (2004) evaluated the relation between parental and children's perceptions of neighborhood environment and overweight and obesity among 291 children age 5-6 y and 919 children age 10-12 y in Melbourne, Australia. After adjustment for gender, family SES, school area SES, and number of cars owned adjusted for clustering by school, parents' perception of heavy traffic in local streets was associated with overweight or obesity among children age 10-12 y (OR=1.4; 95% CI, 1.0-1.8). Also, among children of this age group, parents' perception of lack of road safety in the neighborhood was associated with obesity (OR=3.9; 95% CI, 1.0-15.2).

Safety and Physical Activity Among Children and Adolescents (Original Articles)*

Author, y	Design, Duration	Population	Intervention/Exposure	Outcome	Major Findings
Boone-Heinonen et al, 2010 ³⁴⁶	Observational, prospective, 1994-1995 to 2001-2002	N=12,701 US adolescents, grades 7-12 at baseline, in the nationally representative National Longitudinal Study of Adolescent Health	Neighborhood land-cover diversity, street connectivity, physical activity facilities, and crime rate derived from GIS	Bouts of MVPA	<p>In longitudinal analyses, after adjustment for measured covariates and within-person time-invariant factors:</p> <ul style="list-style-type: none"> Higher crime rates were associated with significantly lower MVPA. <p>See Supplementary Tables 10a, 10b, and 10c for findings on physical activity facilities, land-cover diversity, and street connectivity, respectively.</p>
Carver et al, 2010 ³⁶²	Observational, prospective, 2001- 2006	Children (age 8-9 y; N=170) and adolescents (age 13-15 y; N=276) from 19 government primary schools in high- (n=10) and low- (n=9) SES neighborhoods of Melbourne, Australia (Children Living in Active Neighborhoods Study)	<p>Objectively measured neighborhood characteristics in 800-m radius around home:</p> <ul style="list-style-type: none"> Total length of local roads and unsealed (unpaved) roads suitable for vehicles (GIS derived) Local road index calculated by dividing total length of all local roads and unsealed (unpaved) roads suitable for vehicles by total length of all roads in the neighborhood (GIS derived) Total numbers of speed 	<p>Change in frequency of parent-reported (for children age 8-9 y) or self-reported (adolescents age 13-15 y) walking or cycling to/from 15 neighborhood destinations between 2004 and 2006</p> <p>Change in MVPA measured by accelerometer in 4-6 complete consecutive days in 2001, 2004, and 2006</p>	<p>Age group 8-9 y:</p> <ul style="list-style-type: none"> Number of traffic/pedestrian lights and total length of walking paths were positively associated with changes in active transport among girls ($\beta=0.45$, $P=0.004$ and $\beta=0.0016$, $P=0.015$, respectively). Slow points were associated with change in physical activity before school ($\beta=1.55$, $P=0.021$) among boys. <p>Age group 13-15 y:</p> <ul style="list-style-type: none"> Among boys, speed bumps were positively associated with change in physical activity after school ($\beta=0.23$, $P=0.015$). Among girls, total length of local roads ($\beta=0.49$, $P=0.005$), intersection density ($\beta=0.05$, $P=0.036$), and number of speed bumps ($\beta=0.33$, $P=0.020$) were associated with change in physical activity during nonschool hours.

			bumps, gates/barriers on roads, slow points or sections of road narrowing, and traffic/pedestrian lights (obtained from street directory data)		<ul style="list-style-type: none"> • Among boys, intersection density was positively associated with change in active transport ($\beta=0.03$, $P=0.030$). • Among girls, total length of walking paths was positively associated with change in active transport ($\beta=0.0016$, $P=0.002$).
Crawford et al, 2010 ³⁷²	Observational, prospective, 2001-2006	Children (age 10-12 y at baseline; N=301) from 19 government primary schools in high- (n=10) and low- (n=9) SES neighborhoods of Melbourne, Australia (Children Living in Active Neighborhoods Study)	<p>Objectively measured characteristics of neighborhood (a radius of 2 km around home) in 2004 and 2006, including:</p> <ul style="list-style-type: none"> • Number of accessible public open spaces • Number of public open sports venues • Total length of walking and cycling tracks • Distance to school • Number of intersections and cul-de-sacs • Total length of "access" paths • Total length of "busy" roads and "local" roads <p>Also assessed, parental perceptions of local environment in 2001, 2004, 2006, including perception of heavy traffic, road safety lights/crossings, sporting venues, and public transport</p>	<p>Change in MVPA measured by accelerometer in 4-6 complete consecutive days in 2001, 2004, and 2006</p> <p>Change in BMI z score from objectively measured height and weight in 2001, 2004, and 2006</p>	<ul style="list-style-type: none"> • After adjustment for age and clustering by school, baseline BMI, and other covariates significantly associated with outcome, no significant associations were seen between these neighborhood factors and 5-y changes in physical activity or BMI z score.
Hume et al, 2009 ³⁶³	Observational, prospective, 2004-2006	Children (age 8-9 y in 2004; N=121) and adolescents (age 13-15 y in 2004; N=188) from 19 government primary schools in high- (n=10) and low- (n=9) SES neighborhoods of Melbourne, Australia (Children Living in Active Neighborhoods	<ul style="list-style-type: none"> • Parent-reported concerns over heavy traffic, stranger danger, road safety, and traffic lights or pedestrian crossings in area of residence • 6-point Likert-type responses were dichotomized to strongly agree/agree (=1) vs others (=0). 	Change in frequency of parent-reported (for children age 5-6 y) or self-reported (children age 10-12 y) walking or cycling to/from school between 2004 and 2006, dichotomized into 2 groups (increased, not changed)	<p>After adjusting for gender, SES, and clustering by school:</p> <ul style="list-style-type: none"> • Parental perception of no traffic lights or pedestrian crossings for child use was associated with lower frequency of increased active commuting to school: over 2 y, OR=0.4; 95% CI, 0.2, 0.8; $P=0.01$. • No significant associations were seen between parental concerns about heavy traffic, stranger danger, or road safety and outcome (OR or P value not reported).

Study)					
Safety and Physical Activity Among Adults (Reviews)					
Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
Duncan et al, 2005 ³⁴⁰	Meta-analysis, 16 studies published between January 1989 and February 2005. The number of studies on the exposure-outcome relation in this section was not reported.	Adults	Various environmental characteristics	Physical activity as a binary factor, eg, any walking, sufficient walking, sufficient leisure-time activity	<ul style="list-style-type: none"> In crude (unadjusted) analyses, no variables demonstrated a significant association with physical activity. After adjustment for age, income, and education level, absence of heavy traffic as a problem was positively associated with physical activity (OR=1.22; 95% CI, 1.08, 1.37).
Ferreira et al, 2007 ³⁴⁴	Systematic review of 150 studies published from January 1980 to December 2004, mostly cross-sectional, including several on the exposure-outcome relation in this section	Youth	Environment characteristics	Physical activity	<ul style="list-style-type: none"> Although a wide range of potential correlates at the physical, sociocultural and economic level was identified in this study, only a few were examined in > 3 independent samples. Within the sociocultural environment, crime incidence (measured objectively) was inversely associated with adolescents' physical activity in 2 of 3 studies available, a finding that was at odds with the lack of association between adolescents' physical activity and neighborhood safety estimates they perceived.
Foster et al, and Giles-Corti 2008 ³⁷³	Systematic review of 41 quantitative studies published before July 2007 on the exposure-outcome relation in this section	Adults	Neighborhood safety (traffic, crime)	Physical activity	<ul style="list-style-type: none"> Among the 11 studies that examined the effect of perceived neighborhood safety (traffic, crime) and physical activity exclusively among women, 4 found significant positive association between feeling safe and physical activity. Among 25 studies on the subjective measure of safety (traffic, crime) in both women and men, 20 studies found significant positive association between perception of safety and physical activity. Among 7 studies on the objective measure of safety in both women and men, 5 studies found significant positive association between safety and physical activity. Among 6 studies on perceived safety in older adults (age >50 y), 5 studies found significant positive association between perception of safety and physical activity.
Saelens and Handy, 2008 ³⁵⁹	Systematic review of 13 reviews	Children and adults	Safety (traffic, crime)	Walking	<ul style="list-style-type: none"> All 4 reviews concluded that significant associations exist between attributes of safety and walking.

	published from 2002 and 2006 and 29 original studies published between 2005 and 2006, including 4 reviews and 15 original studies on the exposure-outcome relation in this section				<ul style="list-style-type: none"> • Traffic safety: Among 8 original studies that examined the relation between traffic and walking for transportation, 2 found inverse association. Among 6 studies the examined the relation between traffic and recreational walking, none found inverse association. Among 2 studies that examined the relation between traffic and walking in general, 1 found inverse association. • Crime safety: Among 7 original studies that examined the relation between personal safety and walking for transportation, 3 found positive association. Among 5 studies that examined the relation between personal safety and recreational walking, 1 found positive association. Among 4 studies that examined the relation between personal safety and walking in general, 2 found positive association.
Frost et al, 2010 ³³⁷	Systematic review of studies published from 1994-2008, including 17 on the exposure-outcome relation in this section	Adults age ≥ 18 y in rural areas	Safety (traffic, crime)	Physical activity	<ul style="list-style-type: none"> • Traffic safety: Among 8 studies that evaluated traffic safety (perceived or objectively measured), 4 studies reported significant positive associations between light traffic or perceived safety from traffic and physical activity. • Crime safety: Among 9 studies that evaluated crime safety (perceived or objectively measured), 4 reported significant association with physical activity and 2 reported significant association with walking.
McCormack et al, 2010 ³⁷⁴	Systematic review of studies published before 2009, including 19 studies on the exposure-outcome relation in this section	Children and adults	Safety (traffic, crime)	Park use or park-based physical activity	<ul style="list-style-type: none"> • All 19 studies found association with safety attributes and park use or park-related physical activity. Safety attributes were categorized into 2 major groups: safety from crime and safety from injury. • Crime safety: <ul style="list-style-type: none"> – 3 studies found positive association between the presence of lighting and park use. – 4 studies found positive association between the presence of law enforcement and increased security and park use; however, 2 studies found inverse association between police presence and park use. – 3 studies found an inverse association between the presence of the homeless in the park and park use. • Safety from injury: <ul style="list-style-type: none"> – 3 studies found an inverse association between the presence of glass, syringes, and debris and park use. – 3 studies found an inverse association between heavy traffic and park use.

OR indicates odds ratio; CI, confidence interval; IRR, incidence rate ratio; IOM, Institute of Medicine; GIS, geographical information systems; SES, socioeconomic status; BMI, body mass index; and MVPA, moderate to vigorous physical activity.

*Given the array of smaller, cross-sectional, observational studies that were already captured in the published narrative and systematic reviews identified here, in the writing group's additional systematic searches for original articles published after 2007, performed by means of PubMed searches, evaluation of related articles, and hand searches of reference lists, the writing group focused on those additional studies that were randomized trials, quasi-experimental studies, longitudinal studies, or large (N>5000) cross-sectional studies.

Supplementary Table 10e. Local Environmental Change to Improve Physical Activity (Community Settings)

Aesthetic Conditions*

Children

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Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
Carter and Dubois, 2010 ³⁵⁶	Systematic review of 27 studies published between 1999 and 2009, including 4 studies (3 cross-sectional, 1 prospective) on the exposure-outcome relation in this section	Children and adolescents (age 2-18 y) living in the United States, Canada, Australia, United Kingdom, or Germany	Aesthetics (enjoyable scenery, greenness, physical disorder)	Adiposity (skin-fold thickness, BMI, percentage of lean body mass, etc)	<p>Of 4 studies, 2 found inverse association between greenness and adiposity; 1 found positive association between physical disorder and adiposity; and 1 did not identify significant association between enjoyable scenery and adiposity.</p> <p>Greenness:</p> <ul style="list-style-type: none"> Liu et al (2007) studied greenness and adiposity among 7334 children age 3-18 y who were visited for routine well-child care in a network of primary care clinics in Marion County, Indiana. Satellite imagery of the amount of plant life quantified NDVI within a 2-km circular buffer of each home. After adjustment for age, race, gender, and median neighborhood family income, NDVI was inversely associated with odds of obesity in children who lived in areas with high population density (OR=0.90; $P<0.01$) but not in areas with low population density (OR=1.13; $P=0.31$). In a prospective study, Bell et al (2008) evaluated 3831 children age 3-16 y who received well-child care from a clinic network in Marion County, Indiana. After adjustment for age, sex, race, health insurance status, and baseline weight, mean NDVI in a 1-km circular and network buffer around the home was inversely associated with BMI z score 2 y after the first visit ($\beta=-0.06$; 95% CI, -0.09, -0.02). <p>Physical disorder:</p> <ul style="list-style-type: none"> Among 2482 US children age 5-18 y, Grafova (2008) evaluated neighborhood physical disorder (eg, garbage, broken glass on the streets) and obesity. After adjustment for age, gender, race, ethnicity, family wealth, income-to-needs ratio, mother's BMI, primary caregiver's level of education, number of children in the household, sex of household head, mother's annual hours of work, and region, living in areas with no physical disorder was associated with lower odds of obesity (OR=0.5; 95% CI, 0.4-0.8). <p>Enjoyable scenery:</p> <ul style="list-style-type: none"> Evenson et al (2007) evaluated children's perceptions of enjoyable neighborhood scenery among 1554 US 6th grade girls. After adjustment for school, site, nonschool physical activity, neighborhood SES, percentage receiving a free or reduced-price lunch, and race, no association was observed with overweight (OR=0.9; 95% CI, 0.7-1.3).

Lovasi et al, 2009 ³³⁴	Systematic review of 45 US studies (sample size >100) published between January 1995 and January 2009, including 2 on the exposure-outcome relation in this section	US children of low SES, black race, or Hispanic ethnicity	Aesthetics (enjoyable scenery, greenness, physical disorder)	Physical activity/obesity	Of 2 studies, 1 found significant inverse association between greenness and adiposity in areas of high population density, and 1 did not identify significant association between physical disorder and adiposity. <ul style="list-style-type: none"> Green space: Liu et al (2007): See above. Physical disorder: Molnar et al evaluated objectively measured neighborhood physical disorder and parent-reported recreational physical activity among 1378 boys and girls age 11-16 y in 80 neighborhood clusters in Chicago, Illinois. After adjustment for age, sex, race, BMI, family SES, and neighborhood education, no significant association was found between a composite score of neighborhood physical disorder and physical activity.
Panter et al, 2008 ³⁵⁴	Systematic review of 24 studies published between 2002 and 2007, including 4 cross-sectional studies on the exposure-outcome relation in this section	Children (age 5-11 y) or adolescents (age 12-18 y)	Aesthetics (general, enjoyable scenery, physical disorder, greenness)	Walking or cycling to school or other local destinations	Of 4 studies, 3 found significant associations. <ul style="list-style-type: none"> General aesthetics: Among 259 parents of children age 5-18 y, after adjustment for child age, gender, and parental education, Kerr et al (2006) found positive association between parental perception of neighborhood aesthetics and children's actively commuting to school at least once per week (OR=2.5; 95% CI, 1.33-4.80). Enjoyable scenery: In a cross-sectional study of 480 US girls age 10-15 y, Evenson et al (2006) found significant positive association between presence of enjoyable scenery and physical activity level above the median (OR=1.91; 95% CI, 1.17-3.11). No significant association was seen with active commuting to school. Greenness: Evenson et al (2006) did not find any significant association between presence of trees and active commuting. Physical disorder: Evenson et al (2006) found inverse association between reporting bad smells in the neighborhood and walking or cycling to school (OR=0.43; 95% CI, 0.24-0.75). No association was seen between presence or absence of litter and active commuting.
Adults					
Frost et al, 2010 ³³⁷	Systematic review of studies published between 1994 and 2008, including 4 cross-sectional studies on the exposure-outcome relation in this section	Adults age ≥18 y in rural areas	Aesthetics (enjoyable scenery, greenness, physical disorder)	Physical activity/obesity	General aesthetics: 1 study found an association with physical activity. <ul style="list-style-type: none"> Deshpande et al (2005) evaluated neighborhood aesthetic quality and physical activity in 278 persons with diabetes. After adjustment for BMI, health status, and physical impairment, a positive association was seen between perception of the community as pleasant for physical activity and being regularly physically active (OR=2.27; 95% CI, 1.07-4.81). Enjoyable scenery: Among 4 studies, 2 found associations with physical activity and 1 with obesity. <ul style="list-style-type: none"> Wilcox et al (2000) found that after adjustment for age, race, education, neighborhood characteristics, region, psychosocial factors, and health variables, presence of enjoyable scenery was associated with leisure-time physical activity among rural (OR=1.71; 95% CI, 1.16-2.53) but not urban (OR=1.29; 95% CI, 0.88-1.89) middle-aged women. Kirby et al (2007) found positive association between presence of enjoyable scenery and total minutes per week of walking ($\beta=0.186$; $P<0.05$) but not with overall physical activity or subtypes of strenuous,

					<p>moderate, or light physical activity.</p> <ul style="list-style-type: none"> • Deshpande et al (2005) saw a trend between presence of enjoyable scenery and being regularly physically active (OR=1.76; 95% CI, 0.96-3.21). • After adjustment for age, gender, and education, Boehmer et al (2006) found that not having enjoyable community scenery was associated with obesity (OR=1.8; 95% CI, 1.3-2.6) among 2210 adults in rural Missouri, Tennessee, and Arkansas. <p>Greenness: 1 study found no association with physical activity.</p> <ul style="list-style-type: none"> • Deshpande et al (2005) (see above) did not find significant association between tree-lined streets and physical activity (OR=0.66; 95% CI, 0.26-1.70). <p>Physical disorder: Of 2 studies, neither found significant associations.</p> <ul style="list-style-type: none"> • Deshpande et al (2005) (see above) found only nonsignificant trends between being regularly physically active and living in a well-maintained community (OR=1.58; 95% CI, 0.78-3.22) or community free from garbage (OR=1.87; 95% CI, 0.90-3.91); sample size was small (N=278). • After adjustment for age, gender, and education, Boehmer et al (2006) did not find significant association between living in a well-maintained community or a community free from garbage and odds of being obese in 2210 adults living in rural Missouri, Tennessee, and Arkansas.
Lovasi et al, 2009 ³³⁴	Systematic review of 45 US studies (sample size >100) published from January 1995 to January 2009, including 6 studies on the exposure-outcome relation in this section	US children or adults of low SES, black race, or Hispanic ethnicity	Aesthetics (enjoyable scenery, greenness, physical disorder)	Physical activity/obesity	<p>Enjoyable scenery: Among 4 studies, 2 found association with physical activity and 1 with obesity; and 1 did not find any significant association with obesity.</p> <ul style="list-style-type: none"> • Brownson et al (2001) evaluated perceived neighborhood aesthetics and physical activity among 1818 US adults. After adjustment for age, sex, race, income, and education, presence of enjoyable scenery was positively associated with meeting recommendations for physical activity (OR=1.46; 95% CI, 1.13-1.88). • King et al (2000) evaluated the influence of enjoyable scenery in a nationally representative sample of 2912 US women age ≥ 40 y from different racial/ethnic groups. After adjustment for age, race, employment, marital status, location, education, neighborhood, personal barriers characteristics, physical health, and preference for home-based exercise, absence of enjoyable scenery was associated with being physically inactive (<20 min activity) (OR=1.42; 95% CI, 1.12-1.79). • Boehmer et al (2007) assessed perceived neighborhood aesthetics and obesity in 1032 urban residents of high- and low-income areas of Savannah, Georgia, and St Louis, Missouri. After adjustment for age, gender, education, and other environmental variables, people who strongly disagreed that “there are many interesting things to look at while walking in my neighborhood” had greater odds of obesity than those who strongly agreed with this statement (OR=2.6; 95% CI, 1.2-5.6). • Boehmer et al (2006) (see above) found no significant association between enjoyable scenery and odds of obesity. <p>Physical disorder: Of 2 studies, 1 found positive association with obesity.</p>

					<ul style="list-style-type: none"> Boehmer et al (2007) found significant positive association between observed physical disorders and obesity (OR=3.6; 95% CI, 1.8-7.2). Boehmer et al (2006): See above.
Humpel et al, 2002 ³³⁹	Review including 19 studies (18 cross-sectional, 1 longitudinal), including 3 cross-sectional studies on the exposure-outcome relation in this section.	Adults	Perceived (16 studies) and objectively assessed (4 studies) local environment, including accessibility of facilities, safety, and aesthetics	Physical activity	<p>Among variables pertaining to aesthetics, friendly neighborhood, attractive local area, pleasant scenery, and living environment were positively associated with physical activity:</p> <ul style="list-style-type: none"> Ball et al (2000) found perceived lower neighborhood attractiveness associated with less walking for exercise (10+ min) in 3392 adults after adjustment for age, sex, and education (OR=0.57; 95% CI, 0.41-0.79). King et al (2000): See above. Sallis et al (1997) found no significant relation of enjoyable scenery with walking for exercise or strength/vigorous exercise in young adults, mean age 20.6 y, after adjustment for age, sex, race, and SES, but sample size was very small (N=110).
Adults and Children					
Sallis and Glanz, 2009 ²⁸	Narrative review, including 1 review on the exposure-outcome relation in this section	Children and adults	Aesthetics (general)	Physical activity	<ul style="list-style-type: none"> On the basis of the finding of a systematic review of systematic reviews by Bauman and Bull (2007) (see below), the authors concluded that the aesthetic quality of a neighborhood was associated with physical activity.
Saelens and Handy, 2008 ³⁵⁹	Systematic review of 13 reviews published between 2002 and 2006 and 29 original studies published between 2005 and 2006, including 6 reviews and 9 original studies on the exposure-outcome relation in this section	Children and adults	Aesthetics (general)	Walking	<ul style="list-style-type: none"> On the basis of findings of 6 reviews, the authors concluded that aesthetic qualities were associated with walking. Of 9 original studies, 4 found positive associations: 1 of 5 studies for aesthetics and walking for transportation; 2 of 2 studies for aesthetics and recreational walking; and 1 of 2 studies for aesthetics and overall walking.
Bauman and Bull, 2007 ³³⁸	Systematic review of reviews published between 2002 and 2007, including 6 reviews on the exposure-outcome relation in this	Children and adults	Aesthetics (general)	Physical activity or walking	<p>Of the 6 reviews, all focused on adults, and 5 concluded that the aesthetic quality of a neighborhood was associated with physical activity or walking.</p> <ul style="list-style-type: none"> A narrative review by Vojnovic (2006) found positive association between aesthetics of environment and walking or cycling. A narrative review by Badland and Schofield (2005) reported positive association between aesthetic factors and nonmotorized transport use. A systematic review by Wendel Vos et al (2005) did not find consistent relation between aesthetics and walking.

	section				<ul style="list-style-type: none">• A systematic review by Owen et al (2004) concluded that there was positive association between an aesthetically pleasant environment and walking.• A narrative review by McCormack et al (2004) found positive relation between cleanliness, scenery, varied building designs, and greenery and physical activity.• A systematic review by Humpel et al (2002) found positive association between perception of pleasant neighborhood and physical activity.
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BMI indicates body mass index; NDVI, normalized difference vegetation index; OR, odds ratio; CI, confidence interval; and SES, socioeconomic status.

Given the array of smaller, cross-sectional, observational studies that were already captured in the published narrative and systematic reviews identified here, in the writing group's additional systematic searches for original articles published after 2007, performed by means of PubMed searches, evaluation of related articles, and hand searches of reference lists, the writing group focused on finding any additional studies that were randomized trials, quasi-experimental studies, longitudinal studies, or large (N>5000) cross-sectional studies. No such studies not already included here were identified.

Supplementary Table 10f. Local Environmental Change to Improve Physical Activity (Community Settings)

Walkability (Composite Indicators)*

Children (Outcome: Physical Activity)

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Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
Feng et al, 2010 ³⁵¹	Systematic review, including 2 studies on the exposure and outcome of interest in this section	Children/ adolescents	Walkability	Physical activity	<p>Of 2 studies, 1 found positive association between walkability and physical activity and 1 found positive association between walkability and active transport to school.</p> <ul style="list-style-type: none"> • Kligerman et al (2007) evaluated a GIS-based walkability index and accelerometer-measured physical activity among 98 white or Mexican-American adolescents (age 14-17 y) in San Diego County, California. Walkability was defined as the weighted sum of z scores for land-use mix, intersection density, residential density, and retail density. After adjustment for age and ethnicity, the walkability index up to a 0.8-km buffer around home was positively associated with physical activity ($\beta=0.278$; $P=0.008$). • Kerr et al (2006) evaluated a GIS-based walkability index and parent-reported mode of transport to school among 259 children age 5-18 y in Seattle, Washington. The Frank et al (2005) method (see below) was used to calculate a walkability index for each block (subunit of census tract). After adjustment for child age, gender, and parental education and concerns, living in a neighborhood with a high walkability index was positively associated with active commuting to school (OR=1.9; 95% CI=1.04-3.59).
Brownson et al, 2009 ³⁵²	Systematic review, including 4 studies about the exposure of interest in this section	Children/ adolescents	Walkability	Physical activity	<p>Of 4 studies, 1 found association with physical activity, 1 with sedentary behaviors, and 1 with active commuting to school.</p> <ul style="list-style-type: none"> • Kligerman et al (2007): See above. • Kerr et al (2006): See above. • Merchant et al (2007) evaluated walkability in 160 children from 2 public elementary schools in Hamilton, Ontario, Canada. Walkability was assessed as the sum of the scores from questions in each domain of the NEWS questionnaire, including parental perceptions of population density, street connectivity, land-use mix, walking/cycling infrastructure, aesthetics, traffic safety, and crime safety. Children at the school with less walkability spent substantially more time watching TV (107 vs 6 min per day; $P<0.05$) and on the computer (102 vs 18 min per day; $P<0.05$) but also slightly less time sitting on weekends (43 vs 61 min per day; $P<0.05$). • Norman et al (2006) assessed walkability and physical activity among 799 adolescents age 11-15 y in San Diego, California. The Frank et al (2005) method (see below) was used to calculate a GIS-based walkability composite measure for a 1.60-km buffer around the home. After adjustment for age,

					ethnicity, and household education, no association was found between walkability index and MVPA. The authors felt that variability in walkability was fairly small in this study.
Sallis and Glanz, 2009 ²⁸	Narrative review, including 1 study on the exposure of interest in this section	Children	Walkability	Physical activity	<ul style="list-style-type: none"> • Kerr et al (2006): See above.
Downloaded from http://circ.ahajournals.org/ at Universite de Lausanne - CODUL on September 18, 2012 Lovasi et al, 2009 ³³⁴	Systematic review of 45 US studies (sample size >100) published between January 1995 and January 2009, including 1 study on the exposure of interest in this section	Children	Walkability	Physical activity	<ul style="list-style-type: none"> • Kerr et al (2006): See above.
Saelens and Handy, 2008 ³⁵⁹	Systematic review of 13 reviews published between 2002 and 2006 and 29 original studies published between 2005 and 2006, including 1 original study on the exposure of interest in this section	Children	Walkability	Physical activity	<ul style="list-style-type: none"> • Kerr et al (2006): See above.
Children (Outcome: Obesity)					
Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
Feng et al, 2010 ³⁵¹	Systematic review, including 1 study on the exposure of interest in this section	Children	Walkability	Overweight	<ul style="list-style-type: none"> • Spence et al (2008) evaluated walkability and overweight in 501 children age 4-6 y in Edmonton, Alberta, Canada. Walkability was defined as the weighted sum of z scores for intersection density, dwelling density, and land-use mix. After adjustment for age, gender, physical activity, junk-food consumption, neighborhood-level education, and proportion of employed women in the neighborhood, the walkability index was inversely associated with overweight in girls (OR=0.78; 95% CI, 0.66-0.91) but not boys

					(OR=0.90; 95% CI, 0.79-1.03).
Galvez et al, 2010 ³⁵⁵	Systematic review of articles published between January 2008 and August 2009, including 1 on the exposure of interest in this section	Children	Walkability	Overweight	<ul style="list-style-type: none"> Spence et al (2008): See above.
Brownson et al, 2009 ³⁵²	Systematic review, including 1 study on the exposure of interest in this section	Children/ adolescents	Walkability	BMI	<ul style="list-style-type: none"> Among 799 adolescents age 11-15 y in San Diego, California, Norman et al (2006) (see above) found no association between a GIS-based walkability index and BMI. The authors felt that variability in walkability was fairly small in this study.
Dunton et al, 2009 ³⁵⁰	Systematic review, 15 studies published before May 2008, including 2 on the exposure of interest in this section	Children/ adolescents	Walkability	Overweight/ BMI	<p>Of 2 studies, 1 found inverse association between walkability and physical overweight but only among girls.</p> <ul style="list-style-type: none"> Spence et al (2008): See above. Norman et al (2006): See above.

Adults (Outcome: Physical Activity)

Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
Feng et al, 2010 ³⁵¹	Systematic review, including 1 study on the exposure of interest in this section	Adults	Walkability	Physical activity	<ul style="list-style-type: none"> Frank et al (2005) assessed walkability and physical activity in 523 adults age 20-69 y in metropolitan Atlanta, Georgia. Walkability was defined by weighted sum of z scores for intersection density, dwelling density, and land-use mix. After adjustment for age, sex, education, and ethnicity, people in the highest quartile of walkability had higher odds of meeting physical activity guidelines than those in the 1st quartile (OR=2.40; 95% CI, 1.18-4.88).
Brownson et al, 2009 ³⁵²	Systematic review, including 2 studies about the exposure of interest in this section	Adults	Walkability	Physical activity	<p>Of 2 studies, both found significant association between walkability and physical activity.</p> <ul style="list-style-type: none"> Saelens et al (2003) evaluated walkability and BMI in 107 adults age 18-65 y in 2 nonadjacent neighborhoods in San Diego, California. Walkability was quantified using the NEWS questionnaire, based on mean scores on reported accessibility of nonresidential destinations, street connectivity, walking/cycling infrastructure, aesthetics, traffic safety, and crime safety. After adjustment for age and education, residents of the low-walkable

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					<p>neighborhood had significantly lower objectively measured physical activity (130.7 vs 194.8 min during the past week; $P<0.01$).</p> <ul style="list-style-type: none"> Frank et al (2005): See above.
Saelens and Handy, 2008 ³⁵⁹	Systematic review of 13 reviews published between 2002 and 2006 and 29 original studies published between 2005 and 2006, including 1 original study on the exposure of interest in this section	Adults	Walkability	Physical activity	<ul style="list-style-type: none"> Among adult residents of King County, Washington, Frank et al (2006) examined the relation between walkability index in a 1-km network buffer around home and time spent walking/cycling for transport. After adjustment for demographics, the walkability index was positively associated with time spent walking/cycling for transport.
Bauman and Bull, 2007 ³³⁸	Systematic review of reviews published between 2002 and 2007, including 7 reviews on the exposure of interest in this section	Adults	Walkability	Physical activity or walking	<p>Of 7 reviews, 3 reported significant positive association between walkability and overall physical activity, and 4 between walkability and walking:</p> <ul style="list-style-type: none"> A narrative review by Badland and Schofield (2005) found positive association between walkability and physical activity. A systematic review by Lee et al (2004) found positive association between walkability (based on self-reported data) and meeting recommendations for physical activity. A systematic review by McCormack et al (2005) found positive association between walkability and physical activity. A narrative review by Saelens et al (2003) found positive association between walkability and transport-related physical activity. A systematic review by Sallis et al (2004) found positive association between walkability and walking trips. A systematic review by Owen et al (2004) found positive association between walkability score and walking for transport. A review by Wendel Vos Droomers et al (2005) found positive association between walkability indexes and walking.
Adults (Outcome: Obesity)					
Author, y	Design and Number of Studies	Population	Exposure	Outcome	Findings
Brownson et al, 2009 ³⁵²	Systematic review, including 1 study on the exposure of interest in this section	Adults	Walkability	BMI	<ul style="list-style-type: none"> Among 107 adults in San Diego, California, Saelens et al (2003) (see above) found no significant difference in BMI of residents of higher vs lower walkable neighborhoods (27.3 vs 25.4, $P=0.097$)

Chow et al, 2009 ³⁵⁸	Systematic review, including 1 study on the exposure of interest in this section	Adults	Walkability	BMI	<ul style="list-style-type: none"> Saelens et al (2003): See above.
Saelens and Handy, 2008 ³⁵⁹	Systematic review of 13 reviews published between 2002 and 2006 and 29 original studies published between 2005 and 2006, including 1 original study on the exposure of interest in this section	Adults and children	Walkability	BMI	<ul style="list-style-type: none"> Among adult residents of King County, Washington, Frank et al (2006) (see above) found walkability to be inversely associated with BMI. Using NHANES III data, Doyle et al (2006) evaluated county-level walkability and BMI among 9229 US adults. Walkability was defined by z scores of average block size, percentage of all blocks having areas <0.03 km², and intersection density. After adjustment for demographics, walkability index was inversely associated with obesity ($\beta=-0.054$; $P<0.05$).
Papas et al, 2007 ³⁴⁹	Review of 20 studies, including 2 studies on the exposure of interest in this section	Adults	Walkability	BMI	<p>Of 2 studies, 1 found significant association between walkability and obesity.</p> <ul style="list-style-type: none"> Saelens et al (2003): See above. Doyle et al (2006): See above.

GIS indicates geographical information systems; OR, odds ratio; NEWS, Neighborhood Environment Walkability Scale; MVPA, moderate to vigorous physical activity; CI, confidence interval; BMI, body mass index; and NHANES, National Health and Nutrition Examination Survey.

*Given the array of smaller, cross-sectional, observational studies that were already captured in the published narrative and systematic reviews identified here, in the writing group's additional systematic searches for original articles published after 2007, performed by means of PubMed searches, evaluation of related articles, and hand searches of reference lists, the writing group focused on those additional studies that were randomized trials, quasi-experimental studies, longitudinal studies, or large (N>5000) cross-sectional studies. No such studies not already included here were identified.

Note: Reference numbers (eg, Sallis and Glanz, 2009²⁸) appearing in Supplementary Table 10a through 10f correspond with those listed in the reference section of the statement. For the purposes of this supplementary table, these meta-analyses or systematic reviews (see "Author, y" column) are considered the primary citation. Additional studies mentioned in the primary citation may be included in the "Intervention/Exposure" and "Findings" columns. The additional studies can be accessed through the primary citation.

Supplementary Table 11. Local Environmental Change to Reduce Tobacco Use (Community Settings)

Reducing the Density of Tobacco Retail Outlets

Author, y	Design	Population	Duration	Intervention/Evaluation	Major Findings
West et al, 2010 ³⁷⁵	Observational, cross-sectional	N=205 Latino adolescents recruited from 7 high schools in San Diego, California, and participating in a larger RCT evaluating the effectiveness of a counseling intervention to increase medication adherence	2004-2005	Baseline data, including data on alcohol and tobacco use, were collected from participants. US Census Bureau data from the San Diego GIS were used to identify neighborhood characteristics. Alcohol and tobacco retailer addresses were obtained from the San Diego County Department of Environmental Health, Food and Housing Division. Distance to the nearest retailer from each participant's residential area was measured by the shortest road path.	Homes: <ul style="list-style-type: none"> After ordinal regression while adjusting for hypothesized social predictors, greater distance from home to the nearest retailer was associated with lower alcohol and tobacco use (OR=0.90; 95% CI, 0.82, 0.99).
Pearce et al, 2009 ³⁷⁶	Observational, cross-sectional	N=12,529 persons age 15+ y living in noninstitutional permanent dwellings and participating in the New Zealand Health Survey	2002-2004	Smoking status was ascertained by questionnaire and categorized as "heavy" for 10+ cigarettes per day and "light" otherwise. Street addresses of supermarkets and local convenience stores were collected from territorial authorities in New Zealand and used to geocode geographical access to tobacco by road for each census block. Accessibility of outlets (measured as road travel time with a car) in each census block was divided into quartiles and paired with individual-level data. Multivariate-adjusted regression assessed if the neighborhood differed between smokers and nonsmokers and whether relationships for heavy smokers differed from light smokers and nonsmokers.	Homes: <p>After adjusting for individual-level demographic and socioeconomic variables:</p> <ul style="list-style-type: none"> Persons living in the highest quartile for best supermarket access (<1.89 travel min by car) had 23% higher odds of being a smoker (OR=1.23; 95% CI, 1.04, 1.42) compared with the lowest quartile (>6.54 travel min). Persons living in the highest quartile for best convenience store access (<0.98 travel minutes) had 19% higher odds of being a smoker (OR=1.19; 95% CI, 1.04, 1.38) compared with the lowest quartile. Results were not statistically significant after adjustment for neighborhood deprivation and rural/urban residence. Similar nonsignificant results were obtained for heavy smokers compared with light smokers and nonsmokers.
Li et al, 2009 ³⁷⁷	Observational, cross-sectional	N=55,467 individuals in 398 communities in Massachusetts	1999-2005.	BRFSS data were used to categorize individuals as current smokers or noncurrent smokers and obtain individual demographic characteristics. Large cities in Massachusetts were divided into communities according to ZIP code, and community-level sociodemographic data were obtained from the 2000 US Census. Tobacco retail outlet density was calculated by geocoding	Homes: <ul style="list-style-type: none"> Higher tobacco retailer density near home was positively associated with current smoking. Each 1 additional retailer per 16 km of road was associated with 13% higher odds of current smoking (OR

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				the Massachusetts state Department of Revenue license registry of tobacco retailers. Mixed-effects logistic regression models assessed individual- and community-level predictors of smoking.	=1.13; 95% CI, 1.00, 1.27), after adjusting for other covariates.
Novak et al, 2006 ³⁷⁸	Observational, cross-sectional	N=2116 youth (age 11-23 y) living in 178 randomly selected census tracts in Chicago	1995-1996 and 1997-1999	Smoking behavior and demographic characteristics were obtained by interviewer-administered questionnaires in 2 waves (1995-1996 and 1997-1999). Trained raters drove at 8 kph down every street within the selected census tracts. Both sides of blocks were videotaped, and observer logs gathered data on land use, physical conditions, patterns of social interaction, and retail locations licensed to sell tobacco. Density was computed by dividing the number of block faces with at least 1 retail outlet by the total number of observed block faces. Generalized estimation equation models, adjusted for neighborhood confounders and another with propensity score strata, were used to evaluate the relation of retail tobacco outlet density with youth smoking.	Homes: <ul style="list-style-type: none"> After adjustment for census-tract level confounders, youths living in areas at the 75th percentile of retail tobacco outlet density were 21% more likely to have smoked in the past month (OR=1.21; 95% CI, 1.04, 1.41), compared with those living at the 25th percentile. Findings were similar in the propensity score-adjusted model (OR=1.20; 95% CI, 1.00, 1.44).
Chuang et al, 2005 ³⁷⁹	Observational, cross-sectional	N=8121 adults age 25-74 y in 4 cities in northern California in the Stanford Heart Disease Prevention Program	5 cross-sectional assessments between 1979 and 1990	Individual-level data, including data on smoking, demographics, and SES, were collected from 5 cross-sectional surveys. Convenience store addresses were collected from business listings of telephone books for the years corresponding to the surveys and geocoded. The distance, number, and density of stores within a 1.6-km radius in each neighborhood were estimated. These scores were divided into tertiles, and multilevel models were adjusted for individual and neighborhood characteristics.	Homes: <ul style="list-style-type: none"> Persons living in areas with high compared with low convenience store density have higher smoking prevalence. Shorter distance to a store and higher number of stores within a 1.6-km radius of home were associated with higher smoking prevalence. ORs and 95% CIs were not provided.
McCarthy et al, 2009 ³⁸⁰	Observational, cross-sectional	N=19,306 students from 245 randomly sampled schools in California participating in the California Student Tobacco Survey	2003-2004	Data on tobacco use were collected from students who were categorized as established smokers if they had smoked at least 1 cigarette in the last month and at least 100 lifetime cigarettes. Students were categorized as experimental smokers if they had smoked at least 1 cigarette in the last month but <100 lifetime cigarettes. Retailer density was assessed using geocoded 2006 California Board of Equalization data on tobacco retail licensees. The number of retail outlets within a 1.6-km radius buffer area around each school was counted. Random-intercept models in a generalized linear mixed-model	Schools: <ul style="list-style-type: none"> The number of retailers within a 1.6-km radius of schools was associated with greater likelihood of students being experimental smokers (OR=1.11; 95% CI, 1.02, 1.21) in urban high schools but not middle schools. The number of retailers within a 1.6-km radius was not significantly associated with likelihood of being an established smoker (OR=1.06; 95% CI, 0.94, 1.20) in all student groups.

				framework evaluated the relation of tobacco retailer density with tobacco use.	
Henriksen et al, 2008 ³⁸¹	Observational, cross-sectional	N=24,875 adolescents enrolled in 135 randomly selected schools in California participating in the California Student Tobacco Survey conducted by the California Department of Public Health	2005-2006	Tobacco use data were obtained from the survey. Tobacco outlet addresses were obtained from state retailer licensing data using unique postal ZIP codes within 0.8 km of high schools. Distance from each school street address to every tobacco outlet within 0.8 km was measured "as the crow flies," and tobacco outlet density was measured by the total number within 0.8 km of each school. After multiple regressions and adjustment for school and neighborhood demographics, the association between density and proximity of tobacco outlets in high school neighborhoods and school smoking prevalence was evaluated.	Schools: <ul style="list-style-type: none"> • Prevalence of current smoking was 3.2 percentage points higher at schools in neighborhoods with the highest tobacco outlet density (≥ 5 outlets) vs neighborhoods without any tobacco outlets. • The density of retail cigarette advertising in school neighborhoods was similarly associated with high school smoking prevalence. • Proximity (presence of a tobacco outlet within 300 m of a school; distance to the nearest tobacco outlet from school) was not associated with smoking prevalence.

Provision of Community Telephone Quit Lines

Author, y	Design	Population	Duration	Intervention/Evaluation	Major Findings
Ossip-Klein et al, 1991 ³⁸⁵	RCT	N=1813 smokers with intention to quit, recruited from a 10-county region in Western New York state	From 1985 to 1987, with an 18-mo follow-up	Counties were matched on population size and other demographics, and pairs of counties were randomly assigned to manual only (American Lung Association self-help packet, containing a quit manual, maintenance manual, and relaxation tape) or manual plus hotline intervention. Participants in hotline counties were offered access to a telephone hotline, hotline stickers, and flyers and were encouraged to call the hotline in addition to the manual-only intervention. Validation of abstinence was by significant-other report for all subjects and salivary cotinine levels for about 50% of subjects.	<ul style="list-style-type: none"> • In the hotline group, 35.9% (n=321) of subjects called the hotline at least once during the 18-mo follow-up. • Abstinence was consistently higher in the manual-plus-hotline counties compared with manual-only counties across all follow-ups and abstinence definitions. • 1-, 3-, and 6-mo 48-h abstinence prevalence was higher in manual-plus-hotline counties based on both significant-other report and salivary cotinine ($P < 0.05$ each). • Abstinence rates were higher in hotline counties at 12 and 18 mo (10.3% vs 6% at 18 mo for salivary cotinine validation), and continuous abstinence from months 3 to 18 (6.6% vs 4.0%).

RCT indicates randomized controlled trial; GIS, geographical information systems; OR, odds ratio; CI, confidence interval; BRFSS, Behavioral Risk Factor Surveillance System; and SES, socioeconomic status.

Note: Reference numbers (eg, West et al, 2010³⁷⁵) appearing in this supplementary table correspond with those listed in the reference section of the statement. For the purposes of this supplementary table, these meta-analyses or systematic reviews (see "Author, y" column) are considered the primary citation. Additional studies mentioned in the primary citation may be included in the "Intervention/Exposure" and "Findings" columns. The additional studies can be accessed through the primary citation.

Supplementary Table 12. Direct Restrictions and Mandates for Diet

Restrictions on Advertising to Children

Author, y	Design	Population	Duration	Intervention/Evaluation	Major Findings
IOM Committee on Food Marketing and the Diets of Children and Youth, 2006 ³⁸⁹	Review	Children and adolescents	Variable	Variable	<ul style="list-style-type: none"> • There is moderate to strong evidence that television advertising influences food and beverage preferences, purchase requests, beliefs, and dietary intake of children and adolescents. • Current 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.
Powell et al, 2007 ³⁹⁰	Observational, cross-sectional	A sample of 98,306 30-s equivalent food-product ads seen by US television viewers age 2-11 y and 12-17 y	2003-2004	Food products and their related nutritional contents were examined in aggregate and by 5 separate categories that included cereals, sweets, snacks, drinks, and other food products. Ads viewed were weighted by television ratings data to provide actual exposure measures of the nutritional content of food advertising seen by children and adolescents.	<ul style="list-style-type: none"> • 97.8% and 89.4% of advertised foods seen by viewers age 2-11 y and 12-17 y, respectively, were high in fat, sugar, or sodium. • Nearly half of all calories among the advertised products came from sugar. • 97.6% of cereal ads seen by children age 2-11 y were for high-sugar cereals. • Among children, no substantial differences were found in the nutritional content of ads seen by blacks vs whites. • Among adolescents, a slightly higher proportion of food ads were for high-sugar products, overall and across all food-product categories, seen by blacks vs whites.
Gantz et al, 2007 ³⁹¹	Observational, cross-sectional	All TV programs displayed in 1 wk in top 10 networks for 3 age groups (2-7 y, 8-12 y, and	2005	The Kaiser Family Foundation used samples of >1600 h of all genres of programming viewed by children and combined a detailed analysis of advertising content with viewing data from a large national sample of children to determine how many ads young people	<ul style="list-style-type: none"> • Children age 8-12 y were watching the most food ads on TV, an average of 21 ads per day or >7600 ads per year, followed by adolescents age 13-17 y (17 food ads per day), and children age 2-7 y (12 food ads per day).

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		13-17 y), totaling 1638 h		actually see, given the mix of programming they watch.	<ul style="list-style-type: none"> Most ads were for candy and snacks (34%), sugared cereals (28%), and fast foods (10%); none of the 8854 ads reviewed marketed fruits and vegetables.
Chou et al 2008 ³⁹²	Observational, longitudinal	N=14,852 children, a nationally representative sample of the US population age 12-16 y	1996-1999	The 1979 Child-Young Adult National Longitudinal Survey of Youth and the 1997 National Longitudinal Survey of Youth were used to estimate the effects of fast-food restaurant advertising on children and adolescents being overweight. The advertising measure used was the number of hours of spot television fast-food restaurant advertising messages seen per week.	<ul style="list-style-type: none"> The findings estimated that a ban on television fast-food restaurant ads would reduce the number of overweight children age 3-11 y by 18% and the number of overweight adolescents age 12-18 y by 14%.
Veerman et al, 2009 ³⁹³	Simulation study	Children age 6-12 y in NHANES 2003-2004, a nationally representative US survey	2003-2004	Body measurement data from NHANES and literature related to television advertising and dietary consumption levels were used to construct a mathematical simulation model to estimate the potential effects of reducing the exposure of US children age 6-12 y to TV food advertising on the prevalence of overweight and obesity.	<ul style="list-style-type: none"> Reducing exposure to zero would decrease average BMI by 0.38 kg/m² and lower prevalence of obesity by 14.6% (from an absolute prevalence of 17.8% to 15.2%).

Restrictions on Specific Dietary Factors

Author, y	Design	Population	Duration	Intervention/Evaluation	Major Findings
Leth et al, 2006 ³⁹⁵	Quasi-experimental (pre- vs postintervention)	Major foods in Denmark before and after legislation banning <i>trans</i> fat	2003-2005	In March 2003, Denmark passed a regulation to impose a maximum of 2% industrially produced <i>trans</i> fatty acid in oils and fats destined for human consumption. The law was applied at the source, not in the final product, covered all oils and fats used in foodstuffs on the Danish market or exported from Denmark, and limited products claiming to be “free from <i>trans</i> fat” to <1 g <i>trans</i> fat per 100 g in oil or fat used for production. This study evaluated the <i>trans</i> fat content of the 253 and 148 sample foods before (2003) and after (2005) implementation of the law.	<ul style="list-style-type: none"> The number of samples that contained >2% TFA was significantly reduced, and most of these products contained only between 2% and 6% TFA. Danish regulation helped reduce the amount of industrially produced TFA used in foods to a very low level.. Producers successfully developed new methods of production without increasing prices or reducing the variety of products on the market.
Angell et al 2009 ²³	Quasi-experimental (pre- vs postintervention)	All licensed food establishments, including	2006-2008	In 2006, the New York City Department of Health and Mental Hygiene proposed an amendment to the city's health code to restrict use of artificial <i>trans</i> fat in fry oils,	<ul style="list-style-type: none"> Primary analyses of outcomes of this regulation show that restaurant use of artificial <i>trans</i> fat for frying, baking, or cooking or in spreads has

		restaurants, in New York City		spreads, and all other ingredients and products in all licensed food establishments, including restaurants, school cafeterias, catering businesses, senior centers, and offerings from street-food vendors. The FDA threshold (up to 0.5 g of <i>trans</i> fat per serving) was adopted as the threshold for labeling the products containing any <i>trans</i> fat. This restriction went into full effect in November 2008.	<p>decreased from 50% to <2%.</p> <ul style="list-style-type: none"> After 2 y, dozens of national chains had removed artificial <i>trans</i> fat and 13 jurisdictions, including California, had adopted similar laws.
Pekka et al, 2002 ⁵⁹ Puska and Stahl, 2010 ⁶⁰	Quasi-experimental (pre-vs postintervention)	Finland	1980s to present.	A multicomponent national intervention to improve dietary habits was instituted after 1977, which included media and education, substantial focus on voluntary agreements with industry, modifications to taxation and subsidy policies for several foods, and government-supported programs to increase local production and consumption of berries (see other relevant Tables for more details on these interventions). In addition, national legislative restrictions were implemented on the maximum percentage of milk fat in whole milk and low-fat milk (1980s, 1990s) and maximum salt content of certain foods (1990s).	<ul style="list-style-type: none"> In 1978, 44% of men and 35% of women used whole milk, whereas in 1998 the respective proportions were only 9% and 4%, respectively. Low-fat milk became the standard milk used in schools and catering. As measured by urine sodium excretion, mean daily salt intakes declined from about 14 to 15 g in men (unknown in women) to about 11 g in men and 7 g in women. These and other dietary changes were associated with substantial declines in population cholesterol levels, including 18% declines in North Karelia between 1972 and 1997 and similar declines in other monitored areas. Diastolic blood pressure decreased by 5% in men and 13% in women. Age-standardized CHD mortality among adults age 35-64 y decreased by 73% in North Karelia and by 65% in the whole country between 1971 and 1995. About 75% of this decline could be explained by improvements in population risk factors rather than changes in medical treatments.
Uusitalo et al, 1996 ³⁹⁶	Quasi-experimental (pre- vs postintervention) using serial cross-sectional surveys	N=5080 and 5162 subjects in 1987 and 1992 in Mauritius, including a subset of 2059 subjects age 30-	1987-1992	In 1987, the Ministry of Health initiated a multicomponent intervention program to modify multiple lifestyle-related risk factors. One component was a regulatory policy to change the composition of general cooking oil, limiting the	<ul style="list-style-type: none"> From 1987 to 1992, the estimated mean reduction in intake of saturated fat related to changes in intake of cooking oil was 3.5% of energy in men and 3.6% in women, and estimated mean increase in intake of

		64 y with assessment of diet in 1992		content of palm oil and mandating its replacement with soybean oil. Five years after this regulatory intervention, in 1992, a follow-up survey and a 24-h recall were performed to assess whether changes in the composition of cooking oil had influenced population blood cholesterol levels. Phospholipid fatty acid concentrations were also measured.	<p>polyunsaturated fat was 5.5% of energy in men and 5.6% in women.</p> <ul style="list-style-type: none"> From 1987 to 1992, mean total blood cholesterol levels fell by 0.79 mmol/L in men and 0.82 mmol/L in women ($P < 0.001$ each). Changes in saturated and polyunsaturated fat consumption due to changes in cooking oil explained 48% of this decrease in men and 49% of the decrease in women.
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Mandates for Specific Dietary Factors

Author, y	Design	Population	Duration	Intervention/Evaluation	Major Findings
Pekka et al, 2002 ⁵⁹	Quasi-experimental (pre- vs postintervention)	Finland	Late 1970s to 1980s	The Berry and Vegetable Project aimed to increase the feasibility of growing berries in Finland. The Ministry of Agriculture and the Ministry of Commerce financed a major collaborative project between berry farmers, industry, various commercial sectors, and health authorities to develop and grow berries in Finland. In addition to media and education campaigns, the project supported sales campaigns, development of new berry products, and related relevant activities.	<ul style="list-style-type: none"> Over the period of the project, many Finnish farmers switched from dairy to berry production. At a national level, berry production and consumption rose gradually from initially very low levels. These changes, together with other changes in food supply, were associated with substantial reductions in population CVD risk factors and rates of CVD events.
Puska and Stahl, 2010 ⁶⁰	Quasi-experimental (pre- vs postintervention)	Finland	2000 to present	A media- and education-focused community intervention in North Karelia to improve dietary habits was subsequently extended to the national level after 1977, with additional substantial focus on other policy strategies. In the 2000s, additional government budget policies were developed to support domestic vegetable consumption and other health-related food innovations.	<ul style="list-style-type: none"> The specific impact of budget policies that were developed to support domestic vegetable consumption and health-related food innovations has not been reported.
Uusitalo et al, 1996 ³⁹⁶	Quasi-experimental (pre- vs postintervention) using serial cross-sectional surveys	N=5080 and 5162 subjects in 1987 and 1992 in Mauritius, including a subset of 2059	1987-1992	This intervention is described in this Table above, in "Restrictions on Specific Dietary Factors." The intervention included both a restriction on palm oil in cooking oil and a mandate to increase use of soybean oil	<ul style="list-style-type: none"> From 1987 to 1992, the estimated mean reduction in intake of saturated fat related to changes in intake of cooking oil was 3.5% of energy in men and 3.6% in women, and the

		subjects age 30-64 y with assessment of diet in 1992		as its replacement.	<p>estimated mean increase in intake of polyunsaturated fat was 5.5% of energy in men and 5.6% in women.</p> <ul style="list-style-type: none"> From 1987 to 1992, mean total blood cholesterol levels fell by 0.79 mmol/L in men and 0.82 mmol/L in women ($P < 0.001$ each). The changes in saturated and polyunsaturated fat consumption due to changes in cooking oil explained 48% of this decrease in men and 49% of the decrease in women.
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IOM indicates Institute of Medicine; NHANES, National Health and Nutrition Examination Survey; BMI, body mass index; TFA, *trans* fatty acid; FDA, US Food and Drug Administration; CHD, coronary heart disease; and CVD, cardiovascular disease.

Note: Reference numbers (eg, Powell et al, 2007³⁹⁰) appearing in this supplementary table correspond with those listed in the reference section of the statement. For the purposes of this supplementary table, these meta-analyses or systematic reviews (see "Author, y" column) are considered the primary citation. Additional studies mentioned in the primary citation may be included in the "Intervention/Exposure" and "Findings" columns. The additional studies can be accessed through the primary citation.

Supplementary Table 13. Smoking Restrictions in Communities, Worksites, Schools, and Residences

Smoking Restrictions in Communities

Author, y	Design	Population	Duration	Intervention/Evaluation	Major Findings
IOM Committee on Secondhand Smoke Exposure and Acute Coronary Events, 2009 ⁴⁰¹	Review of quasi-experimental studies (pre-/postintervention)	Multiple studies that examined smoking bans and markers of air pollution and 11 studies in the United States, Canada, and Europe that examined smoking bans and acute coronary events	Follow-up durations of individual studies after the ban ranged from 0.2 to 3.0 y	Smoking bans in public places in communities: Study designs were generally quasi-experimental, comparing rates of relevant hospitalizations in time periods before vs after the ban, with varying durations from implementation of the ban to the assessment of post-ban end points. As additional ecological controls, several studies performed parallel assessments of the coronary rates in the same time periods in a nearby locality that had not instituted a smoking ban.	<ul style="list-style-type: none"> • Many studies have consistently demonstrated substantial reductions in markers of air pollution and particulate matter in places where smoking was banned. • There was substantial evidence that these smoking bans were effective in reducing acute coronary events, with reductions ranging from ≈6% to 47%. • In studies that evaluated coronary rates separately for smokers vs nonsmokers, reductions were demonstrated in both groups, consistent with benefits of reduced exposure to secondhand smoke among nonsmokers.
Meyers et al, 2009 ⁴¹³	Systematic review and meta-analysis	11 reports from 10 study locations that examined smoking bans in public places and risk of acute coronary events (the same studies as the IOM report, above)	As above	As above	<ul style="list-style-type: none"> • Pooling all studies, the relative reduction in acute coronary events was 17% (RR=0.83; 95% CI, 0.75-0.92). • Largest RR reductions were seen among younger persons and nonsmokers. • Benefits increased over time: the reduction in RR incrementally decreased 26% for each year of observation after implementation of the ban.
Herman and Walsh, 2011 ⁴¹⁵	Quasi-experimental study (pre-/postintervention)	May 2007 statewide smoking ban in Arizona, which prohibited smoking in most enclosed public places and places of	January 2004 –May 2008	Rate of hospital admissions was evaluated before and after the ban, both overall and stratified by county-specific presence or absence of preexisting smoking bans, to separate the effects of the ban vs temporal	<ul style="list-style-type: none"> • Comparing counties with no prior bans to those with prior bans, counties with no prior bans experienced significant reductions in hospital admissions for conditions

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		employment		trends.	<p>directly affected by secondhand smoke, including acute MI (13%), angina (33%), stroke (14%), and asthma (22%).</p> <ul style="list-style-type: none"> No significant differences were seen for control conditions such as appendicitis, kidney stones, acute cholecystitis, and ulcers.
Trachsel et al, 2010 ⁴¹⁶	Quasi-experimental study (pre-/postintervention)	March 1, 2008, smoking ban in public buildings in the Swiss canton of Graubünden.	2006-2009	Rates of incident MI in the 2 y before and 2 y after the ban. Rates were evaluated both for the stable resident population and the large, transient tourist population to evaluate longer-term vs shorter-term effects.	<ul style="list-style-type: none"> There was a 22% lower rate of incident acute MI in the year following the ban, compared with the prior 2 y. Rates of acute MI in both residents and nonresidents were lower, suggesting a short-term benefit of the smoking ban.
Naiman et al, 2010 ⁴¹⁷	Quasi-experimental study (pre-/postintervention)	Smoking ban in restaurants and related settings in Toronto, Ontario, Canada	January 1996–March 2006	The study 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 y before initial implementation of the ban, to March 2006, 2 y after the last phase was implemented. The study also evaluated control cities and control end points.	<ul style="list-style-type: none"> 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. Reductions in disease end points occurred during the ban period related to implementation in restaurant settings.
Dove et al, 2010 ⁴¹⁸	Quasi-experimental study (pre-/postintervention)	July 2004 comprehensive smoke-free workplace law in Massachusetts	1999-2006	The study evaluated rates of fatal MI before and after implementation of the ban, stratified by cities/towns with and without previous local smoking bans.	<ul style="list-style-type: none"> MI mortality rates decreased by 9.2% after implementation of the law in cities and towns with no prior local smoking ban. A smaller, not statistically significant decrease occurred in localities that did have a prior ban. The effect of the statewide ban was larger after the first 12 mo (−18.6%; $P<0.001$) than in the first year.

Smoking Restrictions in the Workplace

Author, y	Design	Population	Duration	Intervention/Evaluation	Major Findings
Fichtenberg and Glantz, 2002 ⁴²⁴	Systematic review with random effects meta-analysis of quasi-experimental studies (pre-/postintervention)	N=22,122 from 8 prospective studies, 7 sequential cross-sectional studies, 6 retrospective studies, and 5 population surveys conducted in the United States, Canada, Australia, and Germany	Durations of individual study follow-up ranged from 1 to 24 mo	The included studies measured changes in smoking behavior that accompanied the implementation of smoke-free regulation in individual workplaces. Differences in consumption (per smoker and per employee) and prevalence before and after workplaces became smoke-free (in workplace studies) and between comparable samples with and without regulations (in population studies) were calculated.	<ul style="list-style-type: none"> • Implementation of totally smoke-free workplaces was associated with pooled reductions in absolute smoking prevalence of 3.8% (95% CI, 2.8%, 4.7%) and daily cigarette use among smokers of 3.1 cigarettes (95% CI, 2.4, 3.8) • The combined effects of stopping smoking and lower consumption per continuing smoker equaled 1.3 (range 0.2-1.8) fewer cigarettes smoked per day per employee, a 29% (95% CI, 11%, 53%) relative reduction. • Studies having either self-reported (N=3) or biochemical (N=3) measures of secondhand smoke all found significant reductions in environmental tobacco smoke exposure after policy implementation.
Bell et al, 2009 ⁴²⁶	Systematic review of cross-sectional (n=12), cohort (n=3), and quasi-experimental (n=1) studies	N=16 studies in workers in the United States (n=8), Australia (n=3), Ireland (n=3), Finland (n=1), and Scotland (n=1)	Included studies were published between 1990 and 2007.	Workplace smoking bans were the exposure of interest. In this review, the authors tried to study effect modification of the smoke-free policy on smoking indexes by certain key demographic variables.	<ul style="list-style-type: none"> • No differences were seen by age or sex in 2 studies finding a positive association between strong antismoking policies and quitting in the prior 6 mo (OR=1.51; 95% CI, 1.1, 1.7)⁴²⁷ and a decrease in daily cigarette consumption (-5.2 cigarettes per day) after 5 mo and an increase of 1.7 cigarettes per day at 6 mo to 2 y after workplace smoking bans.⁴²⁸ • Farrelly et al⁴²⁹ and Heloma and Jaakkola⁴³⁰ showed that a complete smoking ban was associated with slightly larger reduced prevalence of smoking in men relative to women, whereas Kinne et al⁴³¹ showed that men, but not

					<p>women, whose workplace had smoking restrictions smoked fewer cigarettes on workdays and nonwork days.</p> <ul style="list-style-type: none"> Farrelly et al⁴²⁹ also showed that workers with a college degree showed a larger decline in smoking prevalence (28% reduction) than those without a high school education (13.7% reduction). Gritz et al⁴³² showed that white collar workers had higher quit rates than blue-collar workers in relation to smoking bans.
Hopkins et al, 2010 ⁴²⁵	Systematic review	Participants in 37 worksite studies of varying designs: prospective (n=8), retrospective (n=7), cross-sectional (n=13), and quasi-experimental (n=13), conducted in a variety of work settings in the United States (n=29), Canada (n=4), Australia (n=1), and Europe(n=2).	Included studies were published between 1980 and June 2005.	Adoption of a smoke-free policy was the exposure of interest. In 19 of the included studies, smoke-free policies were implemented either voluntarily or in response to a community-wide smoke-free law. In 18 of the studies individual workers provided information about the existing smoking policy at their workplace. Outcomes included prevalence of tobacco use, cessation of tobacco use, attempts to quit, and number of cigarettes smoked per day.	<ul style="list-style-type: none"> In 22 studies that reported on prevalence, the median absolute change/difference in prevalence of tobacco use associated with smoke-free policy was a decrease of 3.4 percentage points (interquartile interval: -6.3 to -1.4). This difference was significant in 10 studies. In 6 studies that provided data to evaluate self-reported quit attempts, the median absolute change/difference was 4.1 percentage points higher (interquartile interval: -0.7 to +6.8). In 23 studies that assessed the impact of smoke-free policies on cessation, the median change/difference in tobacco quit rates was 6.4 percentage points higher (interquartile interval: 2.0-9.7). This result was significant in 8 studies. In 8 studies that provided multivariate-adjusted ORs for cessation comparing exposure to worksite smoke-free policy vs no smoke-free policy, OR ranged from 1.21 (95% CI,

					<p>1.00, 1.45) to 1.92 (95% CI, 1.11, 3.32).</p> <ul style="list-style-type: none"> In 18 studies that reported on number of cigarettes smoked per day, a smoke-free policy was associated with a median change/difference of 2.2 fewer cigarettes per day (interquartile interval: -1.7 to -3.3).
Mizoue et al, 2000 ⁴³⁶	Observational, cross-sectional	N=1040 employees of a municipal office in Japan	Not stated	A health survey using a self-administered questionnaire was conducted among a random sample of employees already subjected to 1 of 3 policies: a workroom ban, a work area ban with a smoking area inside the workroom, and time limits on smoking and prohibition of smoking during meetings (minimum restriction). Smoking behavior characteristics and desire to change smoking were compared among these policies, with adjustment for age.	<ul style="list-style-type: none"> A 12% lower prevalence of smoking and a 17% higher proportion of ex-smokers were found in workplaces with a workroom ban than in those with minimum restrictions. Among current smokers the workroom ban was significantly associated with a lower consumption of cigarettes (mean difference from minimum restrictions, 4.1 cigarettes per day; $P < 0.001$). The proportion of heavy smokers who consumed >25 cigarettes per day was 32% lower among smokers subject to a workroom ban compared with those working under minimum restrictions.
Farkas et al, 2000 ⁴³⁹	Observational, cross-sectional	N=17,185 teenagers, age 15-17 y, in the Current Population Surveys conducted by the US Census Bureau	1992-1993 and 1995-1996	Smoking behavior and household and workplace smoking restrictions were assessed using standardized questionnaires. These responses were designated as smoke-free, partial ban, and no smoking restrictions, respectively.	<ul style="list-style-type: none"> Compared with those in workplaces with no smoking restrictions, adolescents who worked in smoke-free settings were less likely to be smokers (OR=0.68; 95% CI, 0.51, 0.90).
Siahpush et al, 2003 ⁴⁶⁴	Observational, cross-sectional	N=2526 current smokers and successful quitters age 14+ y in the 1998 Australian National Drug Strategy Household Survey	1998	Smoking behavior of participants was ascertained by a mixture of interviews and self-administered questionnaires. Participants also answered questions on the presence of a smoking ban at home, school, or the workplace. Associations were examined by multivariate logistic	<ul style="list-style-type: none"> Workplace smoking bans were not significantly associated with odds of smoking cessation.

				regression analysis.	
Skeer et al, 2005 ⁴⁴⁰	Observational, cross-sectional	N=3650 Massachusetts adults who were employed primarily at a single worksite outside the home that was not mainly outdoors	January–June 2002	Participants were obtained by random-digital dialing of Massachusetts households and asked about their smoking status, hours of exposure to tobacco smoke at work, and their worksite smoking policy. A multivariate logistic regression model was created to assess exposure to secondhand smoke in the workplace by workplace smoking policy, adjusting for potential confounding variables	<ul style="list-style-type: none"> • Employees who worked in places where smoking was permitted had 10.3 higher odds (95% CI, 6.7, 15.9) of being exposed to secondhand smoke, and those who worked in places with designated smoking areas had 2.9 higher odds of being exposed to secondhand smoke (95% CI, 2.4, 3.5), compared with employees in smoke-free worksites. • Compared with smoke-free worksites, employees who worked in places with designated smoking areas were exposed to secondhand smoke 1.7 times longer (95% CI, 1.4, 2.2) and those who worked in places with no restrictions on smoking were exposed 6.34 times longer (95% CI, 4.37, 9.21).
Shelley et al, 2007 ⁴⁶⁵	Observational, cross-sectional	N=1472 Asians (1071 nonsmokers and 401 current smokers), age 18–74 y, living in 2 communities in New York City	November 2002–August 2003	Smoking behavior, health status, and household and workplace smoking restrictions were assessed using standardized questionnaires.	<ul style="list-style-type: none"> • A smoking ban at work only was not associated with a higher likelihood of reporting good/excellent health (OR=1.13; 95% CI, 0.56, 2.31).
Osypuk et al, 2009 ⁴³⁷	Observational, cross-sectional	N=85,784 US indoor workers who participated in the 2001–2002 TUS of the CPS conducted by the US Census Bureau	2001–2002	Survey participants were asked about their individual smoking habits and smoking policies at their workplace. Workplace smoking was modeled as a dichotomous variable (smoke-free vs non–smoke-free) where non–smoke-free workplaces included sites with designated smoking areas and no smoking restrictions. The association between smoke-free workplaces and current smoking was compared among immigrants and those born in the United States after covariate adjustment.	<ul style="list-style-type: none"> • Employment in a workplace that was not smoke-free was associated with higher odds of current smoking among all survey participants, OR=1.34 (95% CI, 1.27, 1.41). • Stratified analysis showed that US-born participants working in non–smoke-free workplaces were 1.36 times more likely to be current smokers (OR=1.36; 95% CI, 1.29, 1.44) compared with those working in smoke-free workplaces. The association was potentially

					weaker among immigrants (OR=1.15; 95% CI, 0.97, 1.35).
Friedrich et al, 2009 ⁴³⁸	Observational, cross-sectional	N=1627 employees of larger companies (>20 employees) in the canton of Zurich, Switzerland	2007	Questionnaire data about the prevalence of tobacco prevention usage, tobacco prevention measures, and the stages of change with respect to introduction of tobacco prevention measures were obtained from human resources managers in included companies. Multivariable regression was used to evaluate the relation between worksite tobacco prevention measures and policies and relevant outcomes such as percentage of smokers in the workforce and environmental smoke-related problems.	<ul style="list-style-type: none"> • Greater restrictiveness in smoke-free policies was inversely associated with percentage of smokers in the workforce and with environmental tobacco smoke-related problems (environmental tobacco smoke exposure and complaints) after ordinal regression analysis • Compared with companies that banned smoking indoors and outdoors, workers in companies with no policy were 3.77 times more likely and those in companies with designated smoking areas were 2.75 times more likely to report environmental tobacco smoke-related complaints. • No statistical difference was found in environmental tobacco smoke-related complaints between companies with indoor smoking bans alone and those with both outdoor and indoor smoking bans.
Ma et al, 2010 ⁴⁴¹	Observational, cross-sectional	N=2698 workers, age 18-69 y, in 6 counties in China	2004	Face-to-face interviews collected data on demographic characteristics, smoking behaviors, secondhand smoke exposure, and worksite smoking policy. Multivariate-adjusted models evaluated the relation between worksite smoking restriction policies and secondhand smoke exposure among nonsmokers, intention to quit among smokers, and cigarettes smoked.	<ul style="list-style-type: none"> • Nonsmokers in workplaces with an unrestricted smoking policy were 3.7 times more likely (OR=3.7; 95% CI, 1.3, 10.1) to be exposed to secondhand smoke compared with nonsmokers in smoke-free workplaces. • Significant associations were not seen for intention to quit or cigarettes smoked.
Longo et al, 2001 ⁴³⁵	Quasi-experimental study, comparing current or former smokers in hospitals that	N=1033 current or former smokers in 26 randomly selected	Follow-up ranged from 6 mo to 9 y, depending on when	The Joint Commission on Accreditation of Healthcare Organizations mandated smoke-free	<ul style="list-style-type: none"> • At each of the time periods examined, the post-ban quit ratio for the hospital

	implemented a smoke-free policy vs those in non-smoke-free control workplaces in the same communities	smoke-free hospitals in 21 states (intervention group) and 816 current or former smokers in workplaces without smoke-free policies who lived in the same communities (comparison group)	the smoking ban was implemented in each hospital (varying between hospitals from 1987 to 1994).	hospitals in the United States in 1993. Hospital and other community (control) employees were surveyed beginning in 1994 using a questionnaire and were resurveyed twice to assess their smoking status prospectively (until 1996). The main outcome measures were the proportions of smokers who quit after the ban (quit ratio) and the relapse rate. Between-group comparisons were conducted using the Cochran-Mantel-Haenszel statistic for general association, stratified Cox proportional hazards models, and other appropriate statistical tools.	employees was higher than that for the community employees. <ul style="list-style-type: none"> • For employees whose workplace smoking bans were implemented at least 7 y before the survey, 25.6% of smokers quit post-ban, compared with 14.2% for employees in non-smoke-free workplaces ($P=0.02$). • After adjusting for a variety of factors, time to quitting smoking was shorter for hospital employees ($P<0.001$), with an overall RR of quitting of 2.3. • Relapse rates were similar in both groups.
Osinubi et al, 2004 ⁴⁴²	Quasi-experimental study (pre-/postintervention)	N=128 employees of the New Jersey Insurance Manufacturers Group enrolled in a tobacco-dependence treatment program	1999-2000	The insurance group extended its smoke-free indoor policy to a smoke-free indoor and outdoor policy. Data on smoking habits of 101 employees enrolled in a tobacco-dependence treatment program in the group with target quit dates set before implementation of the ban were compared with those of 27 workers enrolled after the ban was implemented. In-person follow-ups were conducted with participants at 2 wk after their target quit dates, and quit status was verified with exhaled carbon monoxide. Quit status at 6 mo was assessed by self-report or telephone interviews.	<ul style="list-style-type: none"> • Post-ban participants had higher quit rates than pre-ban participants (52.4% vs 43.0%) after 6 mo. • Post-ban participants were 80% less likely to relapse than pre-ban participants. • Nonquitters decreased their consumption by 6.6 cigarettes per day (39.1% decrease).
Bauer et al 2005 ⁴³³	Quasi-experimental study (pre-/postintervention)	N=1967 employed persons, age 25-64 y at baseline, enrolled in COMMIT in 20 US and Canadian cities	8 y, 1993-2001	Data on personal and demographic characteristics, tobacco use behaviors, and restrictiveness of worksite smoking policies were obtained from trial participants who worked primarily indoors using telephone interviews done in 1993 and 2001. Multivariate models were constructed to examine the role of changes in worksite smoking policies	<ul style="list-style-type: none"> • People who worked in environments that changed to or maintained smoke-free policies between 1993 and 2001 were 1.9 times more likely than people whose worksites did not do so to have stopped smoking (OR=1.92; 95% CI, 1.11, 3.32).

				over time (and other factors) in determining smoking behaviors.	<ul style="list-style-type: none"> Continuing smokers in these environments decreased their average daily consumption by 2.57 cigarettes. People working in environments that had smoke-free policies in place in both 1993 and 2001 were 2.3 times more likely (OR=2.29; 95% CI, 1.08, 4.45) than people not working in such environments to quit by 2001, and continuing smokers reported a decline in average daily consumption of 3.85 cigarettes. No significant change was observed in the likelihood of quitting in people working in environments with designated smoking areas compared with those working in environments that allowed smoking, but workers in such environments consumed 2.22 significantly fewer cigarettes per day.
Wheeler et al, 2007 ⁴³⁴	Quasi-experimental study (pre-/postintervention)	N=1400 workers at the University of Arkansas for Medical Sciences University Hospital and Arkansas Children's Hospital	2003-2005	The hospitals implemented smoke-free campuses in 2003. Smoking behavior and exposure to secondhand smoke was assessed in 1400 of the approximately 9000 employees at random 3 mo before implementation of the ban and 10 mo after implementation, using sequential cross-sectional anonymous surveys.	<ul style="list-style-type: none"> Prevalence of smoking among employees declined from 9.6% before to 2.6% after implementation of the ban ($P<0.05$). Significantly fewer employees reported that they had to walk through cigarette smoke on campus after the ban than before (18% vs 43%, $P<0.001$).
Smoking Restrictions on School Campuses					
Author, y	Design	Population	Duration	Intervention/Evaluation	Major Findings
Sellstrom et al, 2006 ⁴⁴⁴	Systematic review	17 cross-sectional or longitudinal studies performed in high-income countries	Search conducted between August and October 2003; time range of articles not	The study aimed to evaluate the relation between the school environment and various child outcomes. Smoking behavior was 1	<ul style="list-style-type: none"> In the 3 studies that evaluated smoking as an outcome, smoking was more prevalent in schools without

		involving youth age <18 y and with hierarchically structured data	stated	outcome of interest.	antismoking policies. <ul style="list-style-type: none"> The odds of being a smoker in a school without an antismoking policy was 1.2 to 2.77 times higher than in a school with a smoking policy. 	
Downloaded from http://circ.ahajournals.org/ at Universite de Lausanne - CODUL on September 18, 2012	Siahpush et al, 2003 ⁴⁶⁴	Observational, cross-sectional	N=2526 current smokers and successful quitters age 14+ y in the 1998 Australian National Drug Strategy Household Survey	1998	Smoking behavior of participants was ascertained by a mixture of interviews and self-administered questionnaires. Participants also answered questions on the presence of a smoking ban at home, school, or the workplace. Associations were examined by multivariate logistic regression analysis.	<ul style="list-style-type: none"> Campus smoking bans were not significantly associated with odds of cessation.
	Borders et al, 2005 ⁴⁴⁵	Observational, cross-sectional	N=13,041 undergraduate students at 12 4-y colleges and universities in Texas	Not reported	A web-based survey covering past and current tobacco use was completed by students in participating schools. Campus smoking policies and regulations, including those on restriction of tobacco distribution, prohibition of sales, and restrictions on advertising were obtained from school administrators. Multivariate logistic regression evaluated the association between these school policies and probability of smoking.	<ul style="list-style-type: none"> College-level policies such as prohibition of tobacco sales on campus, prohibition of smoking in residential halls, restricted tobacco distribution, smoking restricted to 6 m from entrances, and clearly identified nonsmoking areas were each not significantly associated with self-reported smoking.
	Barnett et al, 2007 ⁴⁴⁶	Observational, cross-sectional	N=763 students age 13 y and 768 students age 16 y in 57 schools in Quebec, Canada	1999	Student smoking behaviors and other key individual variables were obtained from students by self-reported and parent-completed questionnaires. School-level data on smoking policies were obtained from school principals. Multilevel modeling evaluated relations between school policies and student smoking.	<ul style="list-style-type: none"> School policies targeted at student smoking or indoor smoking by staff were not significantly associated with students' cigarette consumption. Female students age 13 y attending schools that allowed staff to smoke outdoors were 4.8 times more likely (OR=4.8; 95% CI, 1.1, 21.1) to be daily smokers than those attending schools where teachers were not permitted to smoke outdoors.
	Piontek et al, 2008 ⁴⁴⁷	Observational, cross-sectional	N=2510 secondary school students age 10-15 y and N=843	Not reported	Student smoking behavior and students' perception of their school's antismoking policy were assessed	<ul style="list-style-type: none"> Absence of smoking bans for students was associated with higher odds of being a current

		students age 16-21 y enrolled in 40 schools in Bavaria, Germany		using self-administered questionnaires. Logistic regression examined school context variables, including rules on smoking as predictors of current adolescent smoking.	<p>smoker in the younger age group only (OR=1.62; 95% CI, 1.03-2.53).</p> <ul style="list-style-type: none"> • Among older students, the presence of teachers who smoked on school grounds was associated with a higher likelihood of smoking (OR=1.97; 95% CI, 1.18-3.29).
Boris et al, 2009 ⁴⁴⁸	Observational, cross-sectional	N=1041 teachers and N=4763 9th grade students in 20 schools in 5 districts in southern Louisiana	Spring 2000	Cross-sectional data on smoking behaviors were collected from teachers. Participating students completed the Healthy Habits Survey, which included information on smoking behavior at the end of their 1st semester in high school (to determine if short-term exposure to differing school policy affected adolescent behavior). Logistic regression methods were used to assess the relation between school policy and student smoking prevalence.	<ul style="list-style-type: none"> • No significant difference was observed for teacher smoking (11% vs 13%, $P=0.42$) or student smoking (24.6% vs 25.2%, $P=0.75$) at schools with a no-use vs restricted-use policy.
Murnaghan et al, 2009 ⁴⁴⁹	Observational, sequential cross-sectional	N=1537 10th grade students enrolled in all 10 English-speaking schools in Prince Edward Island, Canada followed up over 3 waves of data collection	1999-2001	Repeated cross-sectional smoking behavior data were collected from a census sample of all 10 schools using the SHAPES tobacco module over 3 y. In year 1, none of the schools had policies banning smoking on school property or participated in provincially directed school-based smoking prevention programs. In year 2, 4 of the schools had introduced a policy banning smoking on school property and the other 6 schools had implemented provincially directed school-based smoking prevention programs. In year 3, all 10 schools had introduced a policy banning smoking on school property and implemented the provincially directed school-based smoking prevention programs. Logistic regression analysis examined the relation between school and	<ul style="list-style-type: none"> • The presence of a school tobacco ban was not significantly associated with reduced odds of smoking after multivariate adjustment.

				environmental factors and smoking in 12th grade students.	
Lovato et al, 2010 ²¹⁰	Observational, cross-sectional	N=22,681 students in grades 10 and 11 in 77 schools in 5 Canadian provinces	2003-2004	Student smoking behaviors were assessed using the SHAPES questionnaire. Written school antismoking policies were examined and scored to quantify their “smoking policy intent,” and interviews were conducted with school officials to ascertain the degree of policy enforcement. School properties were also observed and tobacco control bylaws obtained from each school’s municipality. Data on community-level variables were obtained from the Canadian census data records. Multilevel generalized linear models evaluated the relation between key individual-, school-, or community-level variables and student smoking.	<ul style="list-style-type: none"> Students attending schools with stronger policies prohibiting tobacco use were less likely to smoke (OR=0.92; 95% CI, 0.88-0.97).
Apel et al, 1997 ⁴⁵⁰	Quasi-experimental evaluation (pre-/postintervention)	N=915 female and N=308 male students at the School of Education, University of Koln, Germany	1995	The university announced a new policy limiting smoking to designated areas. Ashtrays were also placed at each designated area and removed from all other areas that had been declared smoke-free. Approximately every 10th student was interviewed with a questionnaire. The effect of the new policy was then assessed.	<ul style="list-style-type: none"> Of the students interviewed, 36% were current smokers. Of smokers, 28% of male smokers and 30% of female smokers reported smoking less 1 mo after the policy was implemented.
Etter et al, 1999 ⁴⁵¹	Quasi-experimental evaluation (pre-/postintervention)	N=1856 staff and students of the University of Geneva, Switzerland	September 1995–July 1996	A smoking restriction policy was implemented at the university in March 1996. Smoking was prohibited in 4 faculty buildings of the university except in limited areas with display of posters and distribution of leaflets about the no-smoking program. No intervention was implemented in some other faculty buildings, considered comparison buildings. Surveys were conducted 3-4 mo before and 3-4 mo after implementation of the policy.	<ul style="list-style-type: none"> The proportion of smokers who made at least 1 attempt to quit in the 4 mo after implementation almost doubled in the intervention group before vs after implementation (2.0% to 3.8%, $P=0.003$) but remained unchanged in the comparison group (1.8%). The proportion of active smokers was lower, but not significantly so, in the intervention (24.8%) vs

					<p>comparison (27.2%) groups at 4 mo after the intervention.</p> <ul style="list-style-type: none"> • Among participants who were smokers both at baseline and at follow-up, the number of cigarettes smoked within university buildings did not change significantly in the intervention group (5.5 cigarettes per day at baseline vs 5.7 at follow-up; $P=0.14$) but decreased significantly in the comparison group (5.5 at baseline vs 5.0 at follow-up, $P=0.035$). • There was no difference in self-reported exposure to environmental tobacco smoke between the 2 groups. • More members of the intervention group (28%) reported less annoyance because of environmental tobacco smoke than the comparison group (14%) ($P=0.001$).
Stronger Enforcement of Schools' Anti-Tobacco Policies					
Wakefield et al, 2000 ⁴⁵²	Observational, cross-sectional	N=17,287 students, grades 9-12, age 14-17 y, obtained by a 3-stage sampling procedure of US counties	Spring 1996	Smoking behavior and household and school smoking restrictions were assessed using standardized questionnaires.	<ul style="list-style-type: none"> • School smoking bans were associated with a greater likelihood of being in an earlier stage of smoking uptake (OR=0.89; 95% CI, 0.85, 0.99) and lower 30-d prevalence of smoking (OR=0.86; 95% CI, 0.77, 0.94) only when the ban was strongly enforced, as measured by instances when teenagers perceived that most or all students obeyed the rule.
Adams et al, 2009 ⁴⁵³	Observational, cross-sectional	N=16,561 students, grades 7-12, at 20 middle and high schools in northern and central Illinois and participating	2007	Data on students' personal and observed smoking habits were obtained by questionnaire. Phone interviews were conducted with school administrators and staff who	<ul style="list-style-type: none"> • Schools with a higher enforcement variable had less current tobacco use by minors (OR=0.83; 95% CI, 0.70-

		in the Youth Tobacco Access Project, a large 5-y intervention study of youth tobacco use funded by the National Cancer Institute		were most knowledgeable about enforcement of the school tobacco policy. Comprehensiveness of school tobacco policies, including applicability, restrictions, and repercussions, was rated. Random effects regression with a 2-level hierarchical model examined school enforcement, observations of minors using tobacco on school grounds, and youth smoking status.	0.99). <ul style="list-style-type: none"> Schools with higher enforcement of tobacco policies had fewer observations of tobacco use on school grounds. For each additional unit of enforcement, the odds that youth saw minors using tobacco on the school grounds decreased by ≈ 0.5. Comprehensiveness of school tobacco policies was not significantly related to current tobacco use by students.
Lippman-Kreda et al, 2009 ⁴⁵⁴	Observational, cross-sectional	N=21,281 middle and high school students (primarily grades 8 and 11) in 255 schools who participated in the 2006 Oregon Health Teens Survey	2006	Students were asked about school tobacco policies and whether the policies were strictly enforced, as well as about their individual smoking behavior. The percentage of students who perceived the rule against tobacco use as strictly enforced was calculated in each school. By quartiles, schools with perceived low levels of strictly enforced antismoking policy were compared with schools with higher levels of perceived enforcement against student smoking.	<ul style="list-style-type: none"> After covariate adjustment, students at schools with high enforcement had 0.62 times the odds of any cigarette smoking and 0.46 times the odds of daily cigarette smoking compared with students in schools with low enforcement of antismoking policy ($P < 0.05$ each).
Sabiston et al, 2009 ⁴⁵⁵	Observational, cross-sectional	N=24,213 students, grades 10-11, from 81 schools in 5 Canadian provinces	2003-2004	Student smoking behaviors were assessed using the SHAPES questionnaire. Written policies were collected from schools, interviews with school administrators were conducted, and school properties were observed to assess multiple dimensions of the school tobacco policy. A multilevel logistic regression model assessed the relations between social smoking indicators, school policy characteristics, and student smoking behavior.	<ul style="list-style-type: none"> Students were less likely to be smokers in schools with stronger prohibition (OR=0.83; 95% CI, 0.72, 0.95) compared with weaker prohibition. Students' perceptions of school tobacco context were associated with a greater likelihood of smoking (OR=1.26; 95% CI, 1.20, 1.33).
Evans-Whipp et al, 2010 ⁴⁵⁶	Observational, cross-sectional	N=3466 students, grades 6, 8 and 10, from 285 schools in the International Youth	2003	Students completed questionnaires about their personal smoking behaviors and smoking behaviors occurring on school property.	<ul style="list-style-type: none"> Peer smoking on school grounds was lower in schools with a strict enforcement of policy (OR=0.45; 95% CI,

		Development Study in Washington state, the United States, and Victoria, Australia		Selected school staff from each school completed surveys, and the comprehensiveness of each school's smoking policy was rated. Random effects logistic regression evaluated the relation of specific school policy components with smoking outcomes.	0.25-0.82; $P=0.009$). <ul style="list-style-type: none"> There was no clear evidence that a comprehensive smoking ban, harsh penalties, remedial penalties, harm minimization policy, or abstinence policy had any significant relation to smoking outcomes.
Lovato et al, 2007 ⁴⁵⁷	Observational, cross-sectional	N=22,318 students in grades 10 and 11 in 81 randomly sampled schools in 5 districts in Canada	Not reported	Student smoking behaviors were assessed using the SHAPES tobacco module, and a senior school administrator with extensive knowledge of each school's tobacco policy was also recruited to complete a questionnaire about the implementation of the school smoking policy. Written tobacco policies were also collected from each school and each corresponding school district board. Multiple linear regression was conducted to examine policy implementation and students' perception of policy enforcement as predictors of school smoking prevalence and smoking behaviors occurring on and off school property.	<ul style="list-style-type: none"> Students' perceptions of policy enforcement were correlated with school smoking prevalence ($R^2=0.36$) and location of tobacco use ($R^2=0.23-0.63$). Policy intention and implementation subscales did not significantly correlate with school smoking prevalence but were moderately correlated with tobacco use on school property ($R^2=0.21-0.27$).
Lovato et al, 2010 ²¹⁰	Observational, cross-sectional	N=22,681 students in grades 10 and 11 in 77 schools in 5 Canadian provinces	2003-2004	Student smoking behaviors were assessed using the SHAPES questionnaire. Written school antismoking policies were examined and scored to quantify their "smoking policy intent," and interviews were conducted with school officials to ascertain the degree of policy enforcement. School properties were also observed and tobacco control bylaws obtained from each school's municipality. Data on community-level variables were obtained from the Canadian census data records. Multilevel generalized linear models evaluated the relation between key individual-, school-, or community-level variables and student smoking.	<ul style="list-style-type: none"> Students in schools with stronger enforcement of antismoking policies were more likely to smoke (OR=1.20; 95% CI, 1.07, 1.35).
Lovato et al 2010 ⁴⁵⁸	Observational, cross-sectional	N=29,553 students in grades 5-9 who	2004-2005	Student smoking behaviors were assessed using the SHAPES	<ul style="list-style-type: none"> Neither smoking policy intent variables nor strict

		participated in the Canadian Youth Smoking Survey		questionnaire. Each school's written tobacco policy was examined, scored, and coded, with higher scores representing stronger policies. Enforcement of school policies was assessed by interviewing school staff most knowledgeable about the anti-smoking policy. Negative binomial regression analysis models examined the relation between school policy characteristics and school smoking prevalence. Multilevel logistic regression evaluated the relations between school-level variables and individual smoking status.	enforcement of anti-tobacco policies were significant predictors of individual smoking status.
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Residence-Based Restrictions on Smoking

Author, y	Design	Population	Duration	Intervention/Evaluation	Major Findings
Mills et al, 2009 ⁴⁵⁹	Systematic review of cross-sectional (n=16) and longitudinal (n=7) studies	Adults in the United States (n=20 studies), Canada (n=2 studies), Australia (n=2 studies), and United Kingdom (n=1 study)	Studies published between January 1990 and November 2008	Home smoking restrictions were assessed using a variety of different questions in the included studies. Complete or partial home smoking bans were evaluated and typically compared with no restrictions. Outcome measures included smoking prevalence, smoking cessation, daily cigarette consumption by smokers, and relapse after smoking cessation.	<ul style="list-style-type: none"> • Of 2 studies that evaluated smoking prevalence, 2 found significantly lower prevalence of smokers in persons living in homes with smoking restrictions compared with homes without smoking restrictions. • Of 14 studies that assessed daily cigarette consumption, 13 found significantly lower daily cigarette consumption in smokers living in homes with smoking restrictions compared with homes without restrictions. One study found null results. The 3 longitudinal studies that reported significantly lower consumption showed a reduction in daily cigarette use of ≈ 2 cigarettes per day. • Of 13 studies that assessed quitting, 12 showed that smokers living in homes with smoking restrictions were more likely to quit compared with those living in homes

					<p>with no smoking restrictions. One study reported null results. Point estimates for OR of abstinence ranged from 1.32 to 3.89 in the various studies.</p> <ul style="list-style-type: none"> All 5 studies that reported relapse showed that smokers living in smoke-free homes were less likely to relapse after quitting, compared with those living in homes without smoking restrictions. In a longitudinal study, Hyland et al found that those living in a smoke-free home at baseline were less likely to be smoking 4 y later compared with those who allowed smoking in their homes (OR=0.6; 95% CI, 0.4, 0.8).
Emory et al, 2010 ⁴⁶⁰	Systematic review of longitudinal (n=2) and cross-sectional studies (n=16)	Children age <18 y in the United States (n=16 studies), Ukraine (n=1 study), Finland (n=1 study), and Australia (n=1 study)	<ul style="list-style-type: none"> Variable individual study duration Studies published between January 1990 and January 2010 were included. 	<ul style="list-style-type: none"> In 7 of the included studies, smoking restrictions at home were separated into 3 categories: complete, partial, and no smoking restrictions. Among the studies, 11 used a dichotomous exposure, in which completely smoke-free homes were compared with all others. Outcomes examined in the various studies were heterogeneous and included smoking initiation, status or transitions on the smoking uptake continuum, current smoking defined as smoking in the past 30 d, cigarette consumption among current smokers, intent to smoke, and smoking cessation among youth-ever smokers. Included studies adjusted for relevant covariates. 	<ul style="list-style-type: none"> Both longitudinal studies showed positive association between home smoking restriction and at least 1 index of improved smoking behavior among adolescents. One of these longitudinal studies (Klein et al) showed that adolescents with a home smoking ban were 12% less likely to have smoked in the past month (OR= 0.88; 95% CI, 0.80, 0.96) compared with those without home smoking bans. In the other longitudinal study (Albers et al), having a smoke free home was not significantly related to progression to established smoking. Not having a smoke-free home was associated with transition from nonsmoking to experimentation for children who lived with nonsmokers (OR=1.89; 95% CI, 1.30, 2.74)

					<p>but not for children who lived with smokers.</p> <ul style="list-style-type: none"> • Of the 17 cross-sectional studies, 14 showed at least some marginal positive association between home smoking restriction and adolescent smoking behavior. For example, Rissell et al 2008 found that students with clear rules about not smoking were 33% less likely to be current smokers (OR= 0.67; 95% CI, 0.49, 0.90) than those without clear rules. Rainio et al (2008) showed that odds of being cigarette experimenters (as opposed to never-users) were 2-fold higher in children with no home smoking restrictions vs those in smoke-free homes.
Kabir et al, 2010 ⁴⁶¹	Systematic review of cross-sectional studies (n=8), longitudinal (n=1), quasi-experimental (n=1), and randomized trial (n=1)	Children age 0-17 y (mean age 12-14 y) in studies in the United States (n=5 studies), Europe (n=5 studies), Australia (n=1 study), and Latin America, Asia, or the Middle East (n=1 study)	Studies published between January 2000 and April 2010	The study assessed the relation of voluntary home smoking restrictions with secondhand smoke exposure in children. Studies used either self-reported or biochemical measures (urinary cotinine, hair cotinine: creatinine ratio) to assess secondhand smoke exposure.	<ul style="list-style-type: none"> • Children living in homes with smoking bans had significantly lower odds of secondhand smoke exposure compared with those living in homes with no smoking bans. • Children living in homes with smoking restrictions had significantly less biochemical concentration of secondhand smoke (>50% less) than those living in homes with no smoking restrictions.
Pizacani et al, 2004 ⁴⁶²	Observational, prospective	N=1133 adult smokers identified from a 1997 telephone survey in Oregon, including 583 assessed during follow-up	1997-1999, median duration of follow-up 21.3 mo	A standardized questionnaire on tobacco attitudes and practices was administered by telephone, including level of household smoking restrictions, eg, full home ban, partial home ban, and no home smoking ban. Of the 1133 smokers identified at baseline, 583 were interviewed at follow-up to assess quitting activities, quit attempts, time until relapse, and smoking cessation.	<ul style="list-style-type: none"> • A full ban at baseline was associated with higher odds of a subsequent quit attempt (OR=2.0; 95% CI, 1.0, 3.9). • Among respondents in the preparation stage at baseline (intention to quit in the next month with a quit attempt in the previous year), a full ban was associated with higher odds of being in cessation for at least 7 d during follow-up

					(OR=4.4; 95% CI, 1.1, 18.7) and a lower relapse rate (HR=0.5; 95% CI, 0.2, 0.9). <ul style="list-style-type: none"> • These associations were not seen among smokers in precontemplation (no intention to quit) or contemplation (intention to quit within the next 6 mo) stages.
Farkas et al, 2000 ⁴³⁹	Observational, cross-sectional	N=17,185 adolescents, age 15-17 y, in the CPS conducted by the US Census Bureau	1992-1993, and 1995-1996	Smoking behavior and household and workplace smoking restrictions were assessed using standardized questionnaires. These responses were designated as smoke-free, partial ban, and no smoking restrictions, respectively.	<ul style="list-style-type: none"> • Compared with those in households with no smoking restrictions, adolescents who lived in smoke-free households were less likely to be smokers (OR=0.74; 95% CI, 0.62, 0.88). • Among ever-smokers, adolescents were more likely to be former smokers if they lived in smoke-free homes (OR=1.80; 95% CI, 1.23, 2.65).
Wakefield et al, 2000 ⁴⁵²	Observational, cross-sectional	N=17,287 students, grades 9-12, age 14-17 y, obtained by a 3-stage sampling procedure of US counties	Spring 1996	Smoking behavior and household and school smoking restrictions were assessed using standardized questionnaires.	<ul style="list-style-type: none"> • Restrictions on smoking at home were associated with a greater likelihood of being in an earlier stage of smoking uptake ($P<0.05$) and a lower 30-d prevalence of smoking (OR=0.79; 95% CI, 0.67, 0.91).
Wechsler et al, 2001 ⁴⁶³	Observational, cross-sectional	N=14,138 students enrolled in 119 US colleges and participating in the Harvard School of Public Health Alcohol Survey	Spring 1999	Smoking behavior and household and school smoking restrictions were assessed using standardized questionnaires. Multiple logistic regression was used to model association of current cigarette use in the past 30 d with types of housing after adjusting for smoking history and other variables.	<ul style="list-style-type: none"> • Current smoking was lower among residents of smoke-free housing compared with residents of unrestricted housing (21.0% vs 30.6%, $P<0.0001$).
Siahpush et al, 2003 ⁴⁶⁴	Observational, cross-sectional	N=2526 current smokers and successful quitters age 14+ y in the 1998 Australian National Drug Strategy Household Survey	1998	Smoking behavior of participants was ascertained by a mixture of interviews and self-administered questionnaires. Participants also answered questions on the presence of a smoking ban in their homes, schools, or workplaces.	<ul style="list-style-type: none"> • The odds of having quit smoking were 4.5 times greater for respondents who lived in households where smoking was not permitted than for those in households with no smoking restrictions

				Associations were examined by multivariate logistic regression analysis.	(OR 4.5; 95% CI, 3.1, 6.6).
Shelley et al, 2007 ⁴⁶⁵	Observational, cross-sectional	N=1472 Asians (1071 nonsmokers and 401 current smokers), age 18-74 y, living in 2 communities in New York City	November 2002–August 2003	Smoking behavior, health status, and household and workplace smoking restrictions were assessed using standardized questionnaires.	<ul style="list-style-type: none"> Among nonsmokers, compared with no smoking restrictions, respondents who had a total smoking ban at home only were more likely to report excellent/good health (OR=1.90; $P<0.05$); as were respondents who had a total smoking ban both at home and work (OR=2.61; $P<0.01$).
Schultz et al, 2010 ⁴⁶⁶	Observational, cross-sectional	N=29,243 students, grades 5-9, age 11-15 y, from randomly sampled public and private schools in 10 provinces in Canada and participating in the Canadian Youth Smoking Survey	2004-2005	Participants completed questionnaires on smoking behavior and home smoking restrictions, including total ban, some restrictions, and no restrictions. Susceptibility to smoking was categorized into levels of smoking experience and intention: nonsusceptible nonsmoker, susceptible nonsmoker, and experimenter/smoker.	<ul style="list-style-type: none"> Respondents living in homes with no smoking bans were more likely (OR=1.70; 95% CI, 1.31, 2.21) to be smokers or experimenters compared with those living in homes with smoking bans For nonsmokers, the odds of being susceptible to smoking increased with absence of a total household smoking ban.
Myung et al, 2010 ⁴⁶⁷	Observational, cross-sectional	N=2545 Asian male smokers age >18 y living in California	2003-2004	Data on smoking status, intention to quit smoking, and household smoking restrictions were obtained from the California Korean American Tobacco Use Survey. Multivariate adjusted logistic regression model was used to study the association between household smoking restriction and intention to quit.	<ul style="list-style-type: none"> Having an intention to quit smoking in those living in homes with complete or partial smoking restrictions was 2.5 times higher than for those with no restriction on smoking in their homes (OR=2.54; 95% CI, 1.22, 2.58).
Ayers et al, 2010 ⁴⁶⁸	Observational, cross-sectional	N=500 adult Koreans living in Seoul, Korea and N=2830 persons of Korean ancestry living in California	2002	Telephone interviews were conducted with randomly selected persons to obtain information about the kind of smoking restriction that exists in their home, estimate the number of cigarettes they and their “most exposed” child were exposed to, and obtain information about other important covariates. Logistic regression models were constructed to evaluate the association between home smoking restrictions and secondhand smoke	<ul style="list-style-type: none"> Smoking restrictions were inversely associated with home secondhand smoke exposure. The predicted probability of any secondhand smoke exposure in Koreans without any home smoking restriction was 0.5 (95% CI, 0.45, 0.56) compared with 0.1 (95% CI, 0.17, 0.33) in Koreans with complete home smoking ban. The predicted probability of

				exposure and predicted probabilities were reported.	any secondhand smoke exposure in persons of Korean ancestry living in California without any home smoking restriction was 0.62 (95% CI, 0.52, 0.70) compared with 0.03 (95% CI, 0.02, 0.04) in those with a complete home smoking ban.
Fu et al, 2010 ⁴⁶⁹	Observational, cross-sectional	N=291 American Indians obtained from a cohort of smokers participating in the Minnesota Health Care Programs' nicotine replacement treatment program	2005-2006	Administrative records obtained at baseline and follow-up survey data obtained after 8 mo of nicotine replacement therapy were used to obtain data on smoking behavior, type of smoking ban at home, and other demographics. Multivariate analysis assessed the relation between presence of complete home smoking ban and 7-d point prevalence abstinence.	<ul style="list-style-type: none"> Complete smoking ban was associated with a greater likelihood of smoking abstinence in the past week, compared with no ban and partial ban (OR=3.57; 95% CI, 1.52, 8.40).

IOM indicates Institute of Medicine; RR, relative risk; CI, confidence interval; MI, myocardial infarction; OR, odds ratio; TUS, Tobacco Use Supplement; HR, hazard ratio; CPS, current population surveys; COMMIT, Community Intervention Trial for Smoking Cessation; and SHAPES, School Health Action, Planning and Evaluation System.

Note: Reference numbers (eg, Meyers et al, 2009⁴¹³) appearing in this supplementary table correspond with those listed in the reference section of the statement. For the purposes of this supplementary table, these meta-analyses or systematic reviews (see "Author, y" column) are considered the primary citation. Additional studies mentioned in the primary citation may be included in the "Intervention/Exposure" and "Findings" columns. The additional studies can be accessed through the primary citation.

Supplementary Table 14. Examples of Major Surveillance Surveys for Diet, Physical Activity, and Tobacco Use in the United States

Survey	Description	Methodology	Frequency	What Is Measured
<p>National Health and Nutrition Examination Survey (NHANES) http://www.cdc.gov/nchs/nhanes.htm National Center for Health Statistics*</p>	<p>A program of studies that assesses the health and nutritional status of adults and children in the United States</p>	<p>A nationally representative sample of ≈5000 persons located in counties across the country is examined every year. Fifteen counties are visited annually. NHANES incorporates both a physical examination and an interview.</p>	<p>Ongoing</p>	<p>The NHANES interview includes demographic, socioeconomic, dietary, and health-related questions. The examination component consists of medical, dental, and physiological measurements, as well as laboratory tests.</p>
<p>Youth Risk Behavioral Surveillance System (YRBSS) http://www.cdc.gov/HealthyYouth/yrbs/index.htm CDC and state, territorial, and local education and health agencies and tribal governments*</p>	<p>Monitors priority health-risk behaviors and prevalence of obesity and asthma among youth and young adults</p>	<p>Includes a national school-based survey and district surveys</p>	<p>Every 2 y since 1991</p>	<p>YRBSS monitors 6 categories of priority health risk:</p> <ul style="list-style-type: none"> • Behaviors that contribute to unintentional injuries and violence • Tobacco use • Alcohol and other drug use • Sexual behaviors that contribute to unintended pregnancy and sexually transmitted diseases • Unhealthy dietary behaviors • Physical inactivity <p>In addition, YRBSS monitors the prevalence of obesity and asthma.</p>
<p>Behavioral Risk Factor Surveillance System (BRFSS) http://www.cdc.gov/brfss/ CDC, states, territories, and tribal governments*</p>	<p>A state-based system of health surveys that collects information on health risk behaviors, preventive health practices, and healthcare access primarily related to chronic disease and injury</p>	<p>Currently data are collected monthly in all 50 states, the District of Columbia, Puerto Rico, the US Virgin Islands, and Guam. More than 350,000 adults are interviewed by telephone each year.</p>	<p>Annually since 1984</p>	<p>BRFSS collects data on behaviors that are associated with preventable chronic diseases, injuries, and infectious diseases. States use BRFSS data to identify emerging health problems, establish and track health objectives, and develop and evaluate public health policies and programs. Many states also use BRFSS data to support health-related legislative efforts.</p>
<p>Household Food Acquisition and Purchase Survey (FoodAPS) http://www.ers.usda.gov/Briefing/DietQuality/food_aps.htm USDA Economic Research Service*</p>	<p>A nationally representative survey of household food purchases and acquisitions</p>	<p>Detailed information will be collected about foods purchased for consumption at home and away from home as well as foods acquired through food and nutrition assistance programs (both public and private). The survey will collect information from up to 3500 low-income and 1500 higher-income households.</p>	<p>Full-scale implementation of the study is expected in 2012.</p>	<p>FoodAPS will provide data about household food choices.</p> <ul style="list-style-type: none"> • Quantities, prices, and expenditures for all at-home and away-from-home foods and beverages bought and acquired from all sources • Nutritional value of foods bought and acquired • Eating occasions by household members

Downloaded from http://www.ers.usda.gov/Briefing/CPIFoodAndExpenditures/qfahp.html		Methodology is still being finalized.		<ul style="list-style-type: none"> Household characteristics, including income, program participation, nonfood expenditures, food security, health status, and diet and nutrition knowledge Household access to food, including location of purchase and distance to outlets
<p>Quarterly Food-at-Home Price Database (QFAHPD)</p> <p>http://www.ers.usda.gov/Briefing/CPIFoodAndExpenditures/qfahp.html</p> <p>USDA Economic Research Service*</p>	Provides food price data to support research on the economic determinants of diet quality and health outcomes. Contains regional and market-level quarterly prices across all 48 contiguous states.	The database is constructed from Nielsen Homescan data and includes quarterly observations on the mean price of 52 food categories for 35 market groups covering the contiguous United States.	1999-2006	The food categories created by QFAHPD correspond with the 2005 Dietary Guidelines for Americans and capture price premiums for convenience and processing. Prices are presented in dollars per 100 g of food as purchased by consumers.
<p>School Health Profiles (Profiles)</p> <p>http://www.cdc.gov/healthyouth/profiles/index.htm</p> <p>states, territories, tribal governments, and school districts*</p>	Provides data on health policies and activities at schools for states and large urban school districts	A representative sample of public middle schools and high schools in a state, territory, tribal government, or school district collected with self-administered, mailed questionnaires	Every 2 y since 1994	Profiles school health education requirements and content, physical education requirements, school health policies related to HIV infection/AIDS, prevention of tobacco use, nutrition, asthma management activities, and family and community involvement in school health programs
<p>School Health Policies and Practices Study (SHPPS)</p> <p>http://www.cdc.gov/HealthyYouth/shpps/index.htm</p> <p>SHPPS - CDC* September 18, 2012</p>	Provides national data on 8 components of school health at the state, school district, school, and classroom levels	Information collected includes all states, a nationally representative sample of school districts, and a nationally representative sample of public and private elementary schools, middle schools, and high schools. Computer-assisted personal interviews, Web-based surveys, and self-administered, mailed questionnaires are used.	Every 6 y since 1994	SHPPS studies health education, physical education and activity, health services, mental health and social services, nutrition services, healthy and safe school environment, faculty and staff health promotion, and family and community involvement.
<p>National Youth Tobacco Survey (NYTS)</p> <p>http://www.cdc.gov/tobacco/data_statistics/surveys/NYTS/index.htm</p>	A school-based survey of students in grades 6-12 that provides national data on long-term, intermediate, and short-term indicators key to the design, implementation, and evaluation of comprehensive tobacco prevention and control programs. The NYTS also serves	<ul style="list-style-type: none"> Both public and private schools eligible for inclusion Multistage design*; schools randomly selected, with probability proportional to enrollment size <p>*Classrooms are chosen</p>	Every 2 or 3 y since 1999	The NYTS was designed to examine correlates of tobacco use such as demographics, minors' access to tobacco, and exposure to secondhand smoke. The NYTS provides nationally representative data about middle and high school youths' tobacco-related

<p>CDC, states, territories, and tribal governments*</p>	<p>as a baseline for comparing progress toward meeting selected Healthy People 2010 goals for reducing tobacco use among youth.</p>	<p>randomly within selected schools, and all students in selected classes are eligible to participate.</p> <ul style="list-style-type: none"> • Anonymous and self-administered questionnaire • Only 1 class period required to administer questionnaire. • State-level data collected, but data can be analyzed at the local level. 		<p>beliefs, attitudes, behaviors, and exposure to pro- and anti-tobacco influences.</p>
<p>Global Youth Tobacco Surveillance (GYTS) http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5701a1.htm WHO, CDC, Canadian Public Health Association, individual countries*</p>	<p>A school-based survey designed to enhance the capacity of countries to monitor tobacco use among youth and to guide the implementation and evaluation of tobacco prevention and control programs. The GYTS uses a standard methodology for constructing the sampling frame, selecting schools and classes, preparing questionnaires, following consistent field procedures, and using consistent data management procedures for data processing and analysis. Information generated from the GYTS can be used to stimulate the development of tobacco control programs and can serve as a means to assess progress in meeting program goals.</p>	<p>GYTS is composed of 56 “core” questions. The questionnaire also allows countries to insert their own country-specific questions.</p>	<p>Ongoing</p>	<ul style="list-style-type: none"> • Knowledge and attitudes of young people toward cigarette smoking • Prevalence of cigarette smoking and other tobacco use among young people • Role of the media and advertising in young people’s use of cigarettes • Access to cigarettes • Tobacco-related school curriculum • Environmental tobacco smoke • Cessation of cigarette smoking
<p>Tobacco Marketing Surveillance Project—Trinkets and Trash http://www.trinketsandtrash.org/ University of Medicine and Dentistry of New Jersey*</p>	<p>Tobacco marketing surveillance project and archive</p>	<p>Monitors tobacco industry marketing in magazines, direct mail, email, websites, and other channels</p>	<p>Ongoing</p>	<p>Trinkets and Trash makes images and information available through its website.</p>
<p>American Time Use Survey (ATUS) http://www.bls.gov/tus/ Bureau of Labor Statistics; US Census Bureau*</p>	<p>Provides nationally representative estimates of how, where, and with whom Americans spend their time and is the only federal survey providing data on the full range of nonmarket activities, from child care to volunteering. ATUS data files are used by researchers to study a broad range of issues; the data files include information collected from</p>	<p>Data are collected through telephone interviews. Census Bureau interviewers use computer-assisted telephone interviewing. Households without telephones can also be selected for the ATUS sample. In a letter about the survey, the Bureau of Labor Statistics asks respondents in these households to call a toll-free</p>	<p>Annually since 2003</p>	<p>Age; sex; race; activity start time, stop time, duration, and location; family income; school enrollment; educational attainment; marital status; employment status; usual hours of work; multiple job status; full- or part-time work; occupation; body weight; geographic location/region of the country; eating and health module</p>

<p>Downloaded from http://ajphaphapubs.aaphapubs.org/ at University of Arizona on September 18, 2014</p>	<p>>98,000 interviews conducted from 2003 to 2009. Data files can be linked to data files from the Current Population Survey, expanding the context in which time-use data can be analyzed. ATUS data are being used to examine eating and drinking patterns and how they relate to a person's overall health; how Americans use food assistance programs; and how different groups of Americans spend their leisure time, such as watching television, socializing, and exercising.</p>	<p>number to complete the interview. Respondents are only interviewed once.</p>		
<p>Demographic and Health Surveys (DHS) http://www.measuredhs.com/</p> <p>One implementing agency, usually a bona fide governmental, nongovernmental, or private sector organization such as a national statistical office, a family planning organization, a ministry of health, a university, a government research group, or a private research group. Involvement of ministries of health is becoming more important because of the increased health content of DHS surveys and the need to have access to specialized staff who can collect biological specimens such as blood samples.*</p>	<p>Provides data for a wide range of monitoring and impact evaluation indicators in the areas of population, health, and nutrition.</p>	<p>Standard DHS surveys have large sample sizes (usually between 5000 and 30,000 households) and typically are conducted every 5 y to allow comparisons over time.</p> <p>Interim DHS surveys focus on collection of information on key performance monitoring indicators but may not include data for all impact evaluation measures (such as mortality rates). These surveys are conducted between rounds of DHS surveys and have shorter questionnaires than DHS surveys. Although nationally representative, these surveys have smaller samples than DHS surveys (2000-3000 households).</p>	<p>Every 5 y</p>	<p>Anemia, child health, education, family planning, fertility, fertility preferences, gender/domestic violence, HIV prevalence, knowledge, attitudes, and behavior, household and respondent characteristics, infant/child mortality, malaria, maternal health, maternal mortality, nutrition, wealth/SES, and women's empowerment.</p>
<p>National Health Interview Survey (NHIS) http://www.cdc.gov/nchs/nhis.htm</p>	<p>Monitors the health of the nation on a broad range of health topics, including health status, healthcare access, and progress toward achieving national health objectives</p>	<p>The NHIS is a large-scale household interview survey of a statistically representative sample of the US civilian non-institutionalized population. Interviewers visit 35,000-40,000 households across the country and collect data on about 75,000-</p>	<p>Annually since 1957</p>	<p>Demographic variables, SES, general health, health conditions, health behaviors, medical care/access, household information, and geography</p>

<p>US Census Bureau, National Center for Health Statistics*</p>		<p>100,000 individuals. The questionnaire consists of 2 main parts: a core set of questions that remain basically unchanged from year to year and supplemental questions that change from year to year and that collect additional data pertaining to current issues of national importance. About 20 min of an average NHIS interview is devoted to supplemental questions. Federal agencies and private nonprofit organizations may sponsor supplements. NHIS analyses on a variety of topics are published through <i>Vital and Health Statistics Series Reports, National Health Statistics Reports, NCHS Data Briefs, and Health E-Stats</i>.</p>		
<p>Early Childhood Longitudinal Program (ECLS-B) http://nces.ed.gov/ecls/birth.asp US Department of Education, National Center for Education Statistics*</p>	<p>ECLS was designed to provide decision makers, researchers, child care providers, teachers, and parents with detailed information about children's early life experiences. ECLS-B, the birth cohort of ECLS, looks at children's health, development, care, and education during the formative years from birth through kindergarten entry.</p>	<p>ECLS-B collects information from children, parents, child care providers, teachers, and schools. It is a nationally representative sample of children born in 1998 and 2001. The children participating in the study came from diverse socioeconomic and racial/ethnic backgrounds with oversamples of Asian and Pacific Islander children, American Indian and Alaska Native children, Chinese children, twins, and low and very low birth weight children. ECLS-B is a longitudinal study.</p>	<p>Ongoing from 1998</p>	<p>Cognitive assessment, child development, school readiness, early school experience. ECLS provides national data on children's status at birth and at various points thereafter; children's transitions to nonparental care, early education programs, and school; and children's experiences and growth through 8th grade. ECLS also provides data to analyze the relations among a wide range of family, school, community, and individual variables with children's development, early learning, and performance in school.</p>
<p>National Collaborative on Childhood Obesity Research (NCCOR) Measures Registry http://www.nccor.org/measures National Collaborative on Childhood Obesity Research*</p>	<p>Free, searchable online registry was designed to provide measures and resources for use in childhood obesity research. The purpose of the registry is to promote consistent use of common measures and research methods across childhood obesity prevention and research at the individual, community, and population levels. Measures are defined broadly as tools and methodologies to assess individual diet,</p>	<p>The Measures Registry was developed by a collaborative team of NCCOR members, contractors, and academic experts who searched bibliographic resources for peer-reviewed articles in 4 domains: (1) individual dietary behavior, (2) individual physical activity behavior, (3) food environment, and (4) physical activity environment. Selected articles deemed to contain</p>	<p>Ongoing from 2011</p>	<p>The Measures Registry includes nearly 750 measures in 4 domains. Types of measures in the Registry include questionnaires, instruments, diaries, logs, electronic devices, direct observation of people or environments, protocols, and analytic techniques. Details about each measure include validity, reliability, protocols for use, and settings, geographic areas, and populations in which the measure has</p>

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physical activity, and the environments in which these behaviors occur.

measures in these domains were then summarized for entry into the searchable database. Data abstraction form, search parameters, and coding decisions for describing measures are available on the website.

been used. Users can search for measures and details about how to use them, find measures in development, link to other measures registries and related resources, and submit new measures for inclusion.

CDC indicates Centers for Disease Control and Prevention; USDA, US Dept of Agriculture; HIV, human immunodeficiency virus; AIDS, acquired immune deficiency syndrome; WHO, World Health Organization; CPS, current population surveys; and SES, socioeconomic status.
*Ownership of data.

Supplementary Table 2. Media and Education Campaigns to Reduce Smoking

Author, y	Design	Population	Intervention/Exposure	Findings
Farrelly et al, 2005 ⁸³	Quasi-experimental comparison (pre- vs postintervention)	National US monitoring data, including ≈50,000 students in grades 8, 10, and 12	Pre- vs postevaluation of a media campaign on smoking prevalence in US youth, including a “Truth” campaign, a TV campaign, and a measure of the “dose” of exposure by market	<ul style="list-style-type: none"> The prevalence of youth smoking declined from 25.3% to 18% between 1999 and 2002. The media campaign was estimated to account for 22% of this decline.
Henriksen et al, 2006 ⁸⁴	Randomized controlled study	N=832, 9th and 10th graders, age 14-17 y	Evaluation of responses of adolescents to 5 smoking prevention ads sponsored by a tobacco company	<ul style="list-style-type: none"> Tobacco company ads were viewed as less favorable than other ads. None of the ads had an effect on intention to smoke. Company-sponsored ads engendered a more favorable response to the sponsoring company.
Sutfin et al 2008 ⁸⁵	Cross-sectional between subjects, randomized experimental design	N=488 high school students, some smokers and some nonsmokers	Exposure to 3 approaches to antismoking ad: <ol style="list-style-type: none"> Endangering others Negative life circumstances Industry manipulation 	<ul style="list-style-type: none"> Negative life circumstances were associated with lower intention to smoke. Response differed by smoking status. Smokers liked ads with more negative thoughts less.
US Surgeon General’s Report, 2000 ⁷⁶	Review, nonsystematic	10 studies, ranging from N=654 to N=6716 Intervention compared with comparison group	Educational anti-tobacco strategies	<ul style="list-style-type: none"> Education conducted in conjunction with community and healthcare system-based strategies can postpone or prevent smoking onset in 20-40% of adolescents.
CDC, 2007 ⁷⁷	Review of health communication intervention best practices for comprehensive tobacco control programs.	Multiple states	Review of effects of paid television, radio, billboard, print, and web-based advertising to reduce tobacco use	<ul style="list-style-type: none"> Countermarketing and media must have sufficient reach, frequency, and duration to be successful. Ads should reach 75%-85% of the target audience each quarter. A campaign should run at least 6 mo to increase awareness, 12-18 mo to have an impact on attitudes, and 18-24 mo to influence behavior.
Davis et al, 2008 ⁷⁹	Review, systematic	Publications from 1970 to May 2007, including 10 controlled field experiments (26 publications) in children and 19 controlled field experiments (39 publications) in adults	Media approaches to tobacco control: <ol style="list-style-type: none"> Mass media Marketing communication (ie, sponsorship) Consumer marketing (ie, packaging) Stakeholder marketing (ie, health warnings) 	<ul style="list-style-type: none"> Media communications play a key role in knowledge, attitudes, and behaviors related to tobacco. Cigarettes are one of the most heavily marketed products in the United States, and there is a causal relationship between tobacco advertising and increased tobacco use. Mass media campaigns should be designed to discourage tobacco use, curb smoking initiation, and encourage cessation. Best results occur when mass media is combined with other strategies. Advertising that includes strong negative messages about health is most effective.
Wakefield et al, 2010 ⁸¹	Review, nonsystematic	Studies of antismoking media campaigns,	Mass media campaigns for smoking cessation	<ul style="list-style-type: none"> Mass media campaigns were associated with declines in smoking initiation in adolescents and increases in adults

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		including 25 controlled field experiments (youth); 40 controlled field experiments (adults); 57 population-based state/national media campaigns; and 11 time-series studies with controls (adults)		<p>quitting.</p> <ul style="list-style-type: none"> Smoking prevention is more likely when mass media efforts are combined with school or community programs. In adults, mass media campaigns work best when combined with other control strategies, but study design often makes it difficult to establish independent effects. The dose of exposure to ad campaigns is important: more exposure improves efficacy.
Tynan et al, 2010 ⁸⁰	Review, nonsystematic	Children and adults	Multiple	<ul style="list-style-type: none"> Sustained media campaigns combined with other interventions <ul style="list-style-type: none"> Increase negative attitudes about smoking Decrease smoking initiation among youth Promote smoking cessation
Pennant et al, 2010 ⁸²	Systematic review of multicomponent CVD prevention programs that included a media-based approach and were published between January 1970 and July 2008	36 relevant community intervention programs (international) using controlled before-after comparisons in adults	Multicomponent prevention programs all included a media-based approach, with (1) screening and (2) individual and group intervention. Interventions were delivered at the workplace, schools, or other locations.	<ul style="list-style-type: none"> Net absolute reduction of smoking prevalence of 1.7% across studies (statistical significance not provided)

CDC indicates Centers for Disease Control and Prevention, and CVD, cardiovascular disease.

Note: Reference numbers (eg, Farrelly et al, 2005⁴⁸³) appearing in this supplementary table correspond with those listed in the reference section of the statement. For the purposes of this supplementary table, these meta-analyses or systematic reviews (see "Author, y" column) are considered the primary citation. Additional studies mentioned in the primary citation may be included in the "Intervention/Exposure" and "Findings" columns. The additional studies can be accessed through the primary citation.

Supplementary Table 3. Nutrient and Front-of-Pack Labels

Observational Studies of Consumer Behavior

Author, y	Design	Population	Duration	Intervention/Evaluation	Major Findings
Neuhaus et al, 1999 ⁸⁹	Observational, cross-sectional	N=1450 adult residents of Washington state	September 1995–September 1996	The questionnaire assessed use of nutrition labels, fat-related diet habits, fruit and vegetable consumption, diet-related psychosocial factors, health behavior, and demographic characteristics.	<ul style="list-style-type: none"> • Use of nutrition labels was significantly higher among women, residents age <35 y, and residents with more than a high school education. • When controlled for demographic factors, the strongest predictors of label use were belief in the importance of eating a low-fat diet, belief in an association between diet and cancer, and being in the maintenance stage of change for adopting a low-fat diet. • Label use was significantly associated with lower fat intake and, after adjusting for all demographic, psychosocial, and behavioral variables, explained 6% of the variance in fat intake ($P<0.001$). • Label use was not associated with fruit and vegetable consumption.
Weaver and Finke, 2003 ⁹³	Observational, cross-sectional	N=5765 respondents age 20+ y who completed both the CSFII and the DHKS	1994-1996	Self-reported data from a population-based cross-sectional survey. This study modeled total consumption of added sugar. Respondents' consumption of these added sugars was originally measured in teaspoons. As a dependent variable in this model, added sugar consumption was measured as a percentage of food density so that persons with different caloric needs and intakes could be compared more accurately. The results indicate which persons are receiving a larger proportion of daily energy intake from sugar.	<ul style="list-style-type: none"> • The average proportion of food energy from added sugars for the entire sample was 13.2%. • Regular use of sugar information on nutrition panels was associated with a significantly lower density of added sugar. • Persons who “always” used labels for sugar information consumed 1.1% less of their total energy from added sugars, compared with all other individuals ($P<0.05$).
Satia et al, 2005 ⁹¹	Observational, cross-sectional	N=658 blacks age 20-70 y	Not reported	Self-reported data from a population-based cross-sectional survey. An 11-page questionnaire assessed nutrition label use, fruit and vegetable consumption, total and saturated fat intakes, fat-related dietary behaviors, diet-related psychosocial factors, and demographic and behavioral characteristics. Mean age was 44±12 y, 41% were men, 37% were college	<ul style="list-style-type: none"> • 78% of respondents read nutrition labels when they purchased packaged foods. • Nutrition label use was significantly higher among participants who were women, older, educated beyond high school, and obese ($P<0.05$). • After adjusting for demographic characteristics, the strongest psychosocial predictors of nutrition label use were healthful eating self-efficacy, strong belief in a diet-cancer relationship, and

				graduates, and 75% were overweight/obese.	<p>trying to lose weight.</p> <ul style="list-style-type: none"> • Respondents who used labels usually/often had higher consumption of fruits and vegetables (mean 3.0 vs 2.1 servings per day, $P<0.0001$). • Respondents who usually/often read grams of fat information had lower total fat intake compared with those who rarely/never read this information (mean 29.1 vs 34.8 g/d, $P<0.0001$).
Lewis et al, 2009 ⁹²	Observational, cross-sectional	N=5603 US adults age 18+ y in the NHANES survey	2005-2006	A survey was conducted to examine use of label information among persons with and without chronic disease. Participants were classified into 5 disease categories: hypertension, hypercholesterolemia, diabetes/at risk of diabetes, overweight, and heart disease. Data were collected via 17 questions about awareness of federal nutrition information and food label use. Two 24-h dietary recall interviews also were given.	<ul style="list-style-type: none"> • Subjects with chronic diseases were more aware of nutritional recommendations, checked more often for specific nutrients, and used nutrition information on food labels more often than did participants without such diseases. • However, label behavior use was inconsistently associated with dietary guideline compliance. Therefore, people with chronic disease generally reported better nutrition awareness than those without, but this did not translate into better eating behaviors.
Grimes et al, 2009 ⁹⁰	Observational, cross-sectional	N=474 subjects surveyed in shopping centers within metropolitan Melbourne, Australia; 65% were female; 64% were the family's main shopper	Survey instrument to assess consumers' salt knowledge	Current labeling regulations in Australia require food products to display the sodium content of the food per serving and per 100 g within the nutrition information panel. Salt content is not provided (Sanz, 2007a) and many consumers may lack the knowledge to convert sodium into salt levels to accurately interpret sodium information. This study examined consumers' ability to interpret nutrition information about salt labeled on food products. Researchers approached passing shoppers and invited them to take part in the study by completing a questionnaire.	<ul style="list-style-type: none"> • 88% of participants knew of the relation between salt intake and high blood pressure. • 65% of participants were unable to correctly identify the relation between salt and sodium. • 69% reported reading the sodium content of food products when shopping. Sodium label use was significantly related to shoppers' concern about the amount of salt in their diet and the belief that their health could improve by lowering their salt intake. • ≈50% of shoppers were unable to accurately use labeled sodium information to select low-salt options.
Post et al, 2010 ⁹⁴	Observational, cross-sectional	N=3748 US adults age 20+ y and with chronic disease in the NHANES survey	2005-2006	The purpose of this study was to assess whether patients with chronic disease who were advised by a healthcare professional to change their diet read nutrition labels and did so more frequently than patients who have not been so advised and whether these patients have a more healthful diet. Data were collected using both survey questions and 24-h dietary recall data.	<ul style="list-style-type: none"> • Among patients with chronic disease, the odds of reading food labels when told by their doctor or another healthcare professional to reduce calories or weight was 50% higher than in those without physician intervention (OR=1.50; 95% CI, 1.12-2.00). • Those who read food labels consumed lower daily energy (2058 vs 2251 kcal; $P=0.006$), saturated fat (26.8 vs 29.2 g; $P=0.04$), carbohydrates (240 vs 267 g; $P=0.003$), and sugars (105 vs 126 g; $P=0.001$), and more fiber (16 vs 14.5 g; $P=0.01$) than those who did not.

Ollberding et al, 2010 ⁸⁷	Observational, cross-sectional	N=4454 US adults age 18+ y in the NHANES survey	2005-2006	The purpose of this study was to describe the prevalence of food label use and the association between food label use and nutrient intake. Data on food label use were collected during the interview portion of the survey and nutrient intake was estimated using 2 24-h food recalls.	<ul style="list-style-type: none"> • 61.6% of participants reported using the Nutrition Facts panel. • 51.6% looked at the list of ingredients, 47.2% looked at serving size, and 43.8% reviewed health claims at least sometimes when deciding to purchase a food product. • There were significant differences ($P<0.05$) in food label use across all demographic characteristics examined. • When comparing food label users with nonusers, label users reported significant differences in mean nutrient intake of total energy (-164 kcal/d), total fat (-9 g/d), saturated fat (-3 g/d), cholesterol (-29 mg/d), sodium (-204 mg/d), dietary fiber ($+1.1$ g/d), and sugars (-12 g/d) ($P<0.05$ for each).
Vyth et al, 2010 ¹⁰⁴	Observational, cross-sectional	N=404 adult shoppers in 9 Dutch supermarkets over 3 wk	Not reported	Shoppers completed a validated questionnaire asking about different motivations for food choice. These motivations were related to their purchased products, which were recorded and scored for a front-of-pack Choices logo after they had finished shopping.	<ul style="list-style-type: none"> • 62% of shoppers reported familiarity with the front-of-pack logo. • Attention to “weight control” and “product information” were the motivations for food choice that were positively associated with purchasing products with the logo. • The food choice motive “hedonism” was negatively associated with purchasing products with the logo.
Grunert et al, 2010 ¹⁰²	Observational, cross-sectional	N=11,700 shoppers at major retailers in the United Kingdom (n = 2019), Sweden (n = 1858), France (n = 2337), Germany (n = 1963), Poland (n = 1800), and Hungary (n = 1804)	February 2008–February 2009	In-store observations and in-store interviews were conducted to evaluate the use of nutrition information on food labels and the understanding of GDA front-of-pack nutrition labels. Shoppers were also given questionnaires to complete at home (N=6000; response rate 50.3%). Use of labels was assessed in 6 product categories. Understanding of GDA front-of-pack nutrition labels was assessed by tasks related to conceptual understanding, substantial understanding, and health inferences. Demographics, nutrition knowledge, and interest in healthy eating were measured as potential determinants.	<ul style="list-style-type: none"> • Overall, 16.8% of shoppers looked for nutrition information. The main sources looked at were the nutrition facts, GDA labels, and ingredients lists. The main data sought were calories, fat, and sugar. • Understanding of GDA labels was high in the United Kingdom, Sweden, and Germany, and more limited in the other countries. • In regression analysis, country, interest in healthy eating, interest in nutrition knowledge, and social grade were associated with use and understanding.

Kristal et al, 2001 ⁸⁸	Observational, longitudinal cohort	N=336 men and 502 women	Baseline data were collected from October 1995 to May 1996. Follow-up surveys were conducted from October 1997 to May 1998.	This prospective population-based study examined the demographic and psychosocial predictors of adopting reduced-fat and high fruit and vegetable consumption dietary patterns over 2 y. Data came from the Washington State Cancer Risk Behavior Survey, a random-digit-dial survey of adults age 18+ y to monitor attitudes and behavior related to cancer risk and prevention.	<ul style="list-style-type: none"> • During the 2 y of follow-up, fat intake (% energy) decreased by ≈ 2 percentage points and fruit and vegetable intake increased by 0.17 servings per day ($P < 0.001$ each). • Changes were greater among women and persons who were well educated. • Persons in the maintenance stage of change and persons who believed there was a strong relation between diet and cancer made the largest dietary changes. • Use of food labels was strongly associated with reduction of fat but not with increases in consumption of fruits and vegetables.
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Interventional Studies of Consumer Behavior

Author, y	Design	Population	Duration	Intervention/Evaluation	Major Findings
Sacks et al, 2009 ¹⁰⁵	Quasi-experimental comparison (pre- vs postintervention)	Shoppers at a major UK retailer thought to be representative of the UK population	4 wk before vs 4 wk after introduction of front-of-pack labeling in 2006	In 2006, the UK Food Standards Agency recommended that UK food retailers and manufacturers place front-of-pack traffic light labels on products in a range of categories. The format consisted of 4 separate color-coded lights indicating amount of fat, saturated fat, sugar, and salt. Red indicated a high level; amber, medium level; and green, low level. This study aimed to examine the impact of labeling on food sales in a major UK supermarket. Products were analyzed in 2 major categories: chilled prepackaged "ready meals" and fresh prepackaged "sandwiches." Data were collected as percent change in sales before vs after the traffic-light labels were introduced. Product promotions, life cycle, and seasonality were taken into account.	<ul style="list-style-type: none"> • Sales of ready meals increased by 2.4% in the 4 wk after the traffic-light labels were introduced. • Sales of the selected sandwiches did not change significantly. • For both types of foods, there was no association between label coding for healthfulness and changes in product sales.
Sutherland et al, 2010 ¹⁰⁶	Quasi-experimental comparison (pre- vs postintervention)	Supermarket shoppers in Maine, New Hampshire, Vermont, Massachusetts, and northern New York	2 y Purchasing data obtained from 2006 to 2008 from a northeastern supermarket chain with 168 stores	The Guiding Stars Nutrition Navigation Program was implemented in September 2006. The program was driven by an algorithm that generates weighted scores based on points debited for <i>trans</i> fat, saturated fat, cholesterol, sodium, and added sugars and credited for vitamins and minerals, fiber, and whole grains. If a product met inclusion criteria for earning 1, 2, or 3 stars, the star icons	<ul style="list-style-type: none"> • Significant changes were seen in food purchasing immediately after implementation of the program and 1 and 2 y later. • Evaluating the same 8-mo period (January–August) each year, in 2006, 24.5% of items purchased earned a star rating; this proportion increased to 25.0% ($P < 0.001$) and 25.9% ($P < 0.0001$) at the 1- and 2-y follow-up periods, respectively.

				were displayed at the point of purchase on the UPC shelf tag. Purchasing data were examined before implementation and at 1- and 2-y follow-up periods.	<ul style="list-style-type: none"> Evaluating a 4-wk period 1 y after program implementation, consumers purchased significantly more ready-to-eat cereals with stars (eg, less added sugars and more dietary fiber) and fewer no-star, high-sugar, low-fiber cereals.
Borgmeier and Westenhoefer, 2009 ¹⁰⁸	RCT, short-term (1 session)	N=420 adults living in Hamburg, Germany	1-time exposure to 5 different experimental conditions	This study investigated which food label format enables consumers to best differentiate healthier products from less healthy ones and the impact of these food labels on planned food choices and diet quality. Five labels were evaluated: (1) a simple “healthy choice” tick, (2) a multiple traffic-light label, (3) a monochrome GDA label, (4) a color GDA label, and (5) no label. Data were collected on whether the labels influenced (1) subjects’ ability to identify the healthier food item in 28 pairwise comparisons of foods from different food groups and (2) subjects’ choice of foods from a range of different foods to compose a theoretical 1-d consumption.	<p>Task I</p> <ul style="list-style-type: none"> Compared with no label, subjects could best identify the healthier food in pairwise comparisons with use of the traffic-light label, followed by either of the GDA labels and then the tick label ($P<0.001$ across comparisons). Compared with no label, subjects’ selections of a 1-d menu did not vary significantly according to any of the types of labels in terms of energy or nutrients.
Temple et al, 2010 ¹⁰⁷	RCT, short-term (1 meal)	N=47 (24 male, 23 female) adults age 18-50 y recruited from flyers posted around the University of Buffalo	1 lunch session	Participants visited the lab for 1 session lasting ≈ 1 h. Participants were randomly assigned to 1 of 2 video groups (nutrition labeling education vs control [organic food movement]) and 1 of 2 labeling conditions (labels vs no labels). Participants watched a short educational video and then ate a buffet lunch.	<p>Subjects assigned to nutrition label groups consumed less energy ($P<0.05$):</p> <ul style="list-style-type: none"> Women in the label group consumed 500 kcal vs 700 kcal for those in the no-label group. Men in the label group consumed 600 kcal vs 1000 kcal for those in the no-label group. The educational video had no independent effects.
Fiske and Cullen, 2004 ¹⁰⁹	RCT (4 wk)	10 vending machines in teachers’ lounges in Texas elementary and middle schools	<ul style="list-style-type: none"> Assessed items sold Assessed dollar sales for items Total machine revenue 	<p>2-wk baseline assessment, 4-wk intervention</p> <ul style="list-style-type: none"> Each vending machine had 28 snack items and 5 choices of gum. Low-fat items were promoted by means of <ul style="list-style-type: none"> No intervention (control, 2 machines) Increased availability plus labels (intervention I, 4 machines). Increased availability plus labels plus signs (intervention II, 4 machines). 	<ul style="list-style-type: none"> The mean numbers of low-fat snacks sold were 2.5, 2.6, and 3.2 in the control, intervention I, and intervention II groups, respectively, but these differences did not achieve statistical significance ($P=0.08$). A significant difference in total machine revenue was not seen with either intervention.

Vyth et al, 2011 ¹¹⁰	RCT (3 wk)	N=25 worksite cafeterias (13 intervention, 12 control) in the Netherlands	<ul style="list-style-type: none"> Sales data were collected daily pre- and postintervention for 9 wk, from March to May 2009 Employees (N=368) from 1 intervention and 1 control worksite completed questionnaires pre- and postintervention. 	<ul style="list-style-type: none"> Intervention cafeterias: Choices nutrition logo added to foods Control cafeterias: same menu without the logo 	<ul style="list-style-type: none"> No significant intervention effects were found in sales of sandwiches, soups, snacks, fruit, or salads. Self-reported "intention to eat healthier" and "paying attention to product information" were positively associated with self-reported consumption of foods with the Choices logo at lunch.
Combined Interventions					
French et al, 2001 ¹¹¹	RCT	55 vending machines in 12 secondary schools and 12 worksites in Minnesota	1 y	<p>Changing Individuals' Purchase of Snacks (CHIPS) study</p> <ul style="list-style-type: none"> 55 vending machines were used, including placement of low-fat snacks in 2 designated rows of the machine. Effects of price and labeling on sales were evaluated during a 1-y intervention. Labeling conditions: none, low-fat label, low-fat label plus promotional sign Pricing conditions: equal price, 10% reduction, 25% reduction, 50% reduction 	<ul style="list-style-type: none"> Labels alone had no effect on sales. Promotional signage was associated with a very small increase in low-fat snack sales. Price reductions of 10%, 25%, and 50% on low-fat snacks were associated with significant increases in low-fat snack sales. Low-fat snack sales increased by 9%, 39%, and 93% respectively.
Lowe et al, 2010 ¹¹²	Quasi-experimental (pre- vs postintervention)	N=96 hospital employees	Worksite cafeteria purchases at lunch assessed by scanned food purchasing cards, comparing the period 3 mo before vs after interventions	<p>Group 1: environmental changes in the cafeteria, including addition of selected healthier options along with food labeling (calories, energy density, macronutrients) for all foods sold during lunch</p> <p>Group 2: environmental changes in the cafeteria plus pricing incentives and 4 1-h group sessions of nutrition education on strategies for decreasing energy density of the diet</p>	<ul style="list-style-type: none"> Comparing before vs after intervention in both groups, total lunchtime calories and percent energy from fat decreased (≈ 70 kcal and 5% energy less, respectively; $P < 0.01$ each). There were no differences between the 2 intervention groups, ie, the addition of pricing incentives and nutrition education did not appear to have any additional impact. However, the sample size was small and may have not been adequately powered after attrition of subjects.
Thorndike et al, 2011 ¹¹³	Quasi-experimental	Large hospital cafeteria in	Electronically recorded food	Foods and beverages were labeled with simple color codes (red, yellow, green)	<ul style="list-style-type: none"> After 3 mo, sales of "red" products decreased by 9.2%, including 23.1% lower sales of sugar-

	(pre- vs postintervention)	Boston, Massachusetts, plus 2 smaller comparison cafeterias in the same hospital	sales in the 3 mo before vs after the labeling change	based on USDA food pyramid guidelines in the intervention cafeteria. No changes were made in the comparison cafeterias.	sweetened beverages. Sales of “green” products increased by 4.5% ($P < 0.001$ each). <ul style="list-style-type: none"> • Total sales did not change. • No changes were seen in sales of these different foods at the 2 comparison cafeterias.
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CSFII indicates Continuing Survey of Food Intakes by Individuals; DHKS, Diet and Health Knowledge Survey; NHANES, National Health and Nutrition Examination Survey; OR, odds ratio; CI, confidence interval; GDA, guideline daily amount; UPC, universal product code; and RCT, randomized controlled trial.

Note: Reference numbers (eg, Neuhouser et al, 1999⁸³) appearing in this supplementary table correspond with those listed in the reference section of the statement. For the purposes of this supplementary table, these meta-analyses or systematic reviews (see "Author, y" column) are considered the primary citation. Additional studies mentioned in the primary citation may be included in the "Intervention/Exposure" and "Findings" columns. The additional studies can be accessed through the primary citation.

Supplementary Table 4. Menu and Other Point-of-Sale Information on Calories and Nutrients

Author, y	Study Type	Population	Intervention/Evaluation	Findings
Seymour et al 2004 ¹¹⁶	Review of interventional studies to improve diet by changes in food availability, access, pricing, or point-of-purchase information in worksites, universities, grocery stores, and restaurants	A total of 38 intervention studies in adult populations, published between 1970 and June 2003	Point-of-purchase information on foods or beverages in worksites, universities, grocery stores, and restaurants	<ul style="list-style-type: none"> • Many interventions were not thoroughly evaluated or lacked important evaluation information, and direct comparison of studies across settings was not possible. • The authors concluded that worksite and university interventions (ie, “limited access” sites in which few other choices were available) had the greatest potential for success. Interventions in grocery stores appeared least effective. • Sustainability of diet changes was not addressed in these studies.
Bassett et al, 2008 ¹¹⁴	Observational, cross-sectional	N=7318 customers from 275 randomly selected restaurants in 11 fast-food chains in New York City	The authors randomly sampled a total of 300 chain restaurants from ≈1625 eligible locations from March to June 2007. Receipts of consenting customers were collected after their purchase, along with other self-reported information about the purchase. Calories were identified from an electronic database.	<ul style="list-style-type: none"> • The mean fast-food purchase contained 827 calories, and 34% of respondents purchased foods containing ≥1000 calories. • One chain (Subway) posted point-of-purchase calorie information. In comparison with the other 10 chains, Subway customers were more likely to report seeing calorie information (4% vs 32%, $P<0.001$). • Among Subway customers, those who reported seeing calorie information purchased 52 fewer calories than did other Subway customers ($P<0.01$).
Yamamoto et al, 2005 ¹¹⁹	Quasi-experimental comparison (pre- vs postintervention)	N=106 adolescents, age 11-18 y, students enrolled in band, orchestra, or tennis	Participants were shown menus with and without calorie/fat information from McDonald’s, Denny’s, and Panda Express. First, they were shown the regular menu, and then they were asked to select a dinner item and estimate their calorie/fat consumption. Next, they were shown the menus with calorie and fat information and asked again to select a dinner item and estimate consumption.	<ul style="list-style-type: none"> • Of the 106 subjects, 75 subjects chose the same meal after the revelation of calorie/fat information. • Significant declines were shown in calories and fat in meals ordered at McDonald’s ($P=0.002$, $P=0.001$) and Panda Express ($P=0.005$, $P=0.004$), but these changes occurred in <20% of the study subjects. • Significant differences were not shown in meals ordered at Denny’s.
Chu et al, 2009 ¹¹⁷	Quasi-experimental evaluation (pre- vs postintervention)	Students purchasing food at the study dining center at Ohio State University in 2004	This study sought to determine whether the display of nutrition information at the point of selection for all entrées available in a university dining hall would alter patrons’ meal selection. A quasi-experimental design was used to test the hypotheses that (1) average energy content of entrées sold per day decreases when nutrition labels are present at point of selection, (2) entrées with the highest energy content have the greatest decrease in sales, and (3) this change can occur without any negative	<ul style="list-style-type: none"> • The average energy content of entrées sold decreased 12.4 kcal from the last day of pretreatment to the first day of the treatment period ($P=0.007$). A negative slope, small in magnitude, was observed during the treatment period (−0.3 kcal/d). At the beginning of the posttreatment period, the daily average energy content immediately began to increase. Across the posttreatment period, the daily average energy content increased at a rate of 1.5 kcal/d ($P=0.01$).

			impact on overall sales. Nutrition information was posted for 14 d, with sales tracked immediately before, during, and after the intervention.	<ul style="list-style-type: none"> • The sale of the entrées with the highest energy content significantly decreased during the treatment period compared with the pretreatment period ($P=0.007$). • The difference in total sales between the study periods was not significant and revenue remained consistent.
Elbel et al, 2009 ¹²⁰	Quasi-experimental comparison (pre- vs postintervention)	N=1156 receipts from customers in fast-food restaurants in low-income, minority communities in New York City and Newark (control) before and after institution of menu labeling in New York City	Receipts were collected from willing customers at McDonald's, Burger King, Wendy's, and KFC in New York City (14 stores) and control stores in Newark (5 stores). A set of questions was also given to participants to collect age, sex, race, education, whether food was for dining in or to go, whether calorie information was posted, whether calorie information influenced their choice, and whether calorie information caused them to purchase fewer or more calories.	<ul style="list-style-type: none"> • Postlabeling, 54% of participants in New York City reported noticing calorie information. • Participants in New York City purchased a mean of 825 calories (95% CI, 779-870) before labeling and 846 calories (95% CI, 758-889) after labeling. • Participants in Newark purchased a mean of 823 calories (95% CI, 802-890) before labeling and 826 calories (95% CI, 746-906) after labeling. • Overall, no change in calories chosen was detected.
Dumanovsky et al, 2010 ¹¹⁵	Quasi-experimental comparison (pre- vs postintervention)	N=2417 customers from 45 fast-food restaurants representing the 15 largest fast-food chains in New York City	Consumer awareness of menu calorie information was evaluated in separate cross-sectional surveys in the 3 mo before and 3 mo after enforcement of a city health code requiring fast-food chains to display food-item calories on menus/menu boards. Customers reported whether they had seen calorie information and, if so, whether it had affected their purchase. Data were weighted to the number of city locations for each chain.	<ul style="list-style-type: none"> • The percentage of customers who reported seeing calorie information rose from 38% pre- to 72% postenforcement ($P<0.001$). • Among customers who reported seeing calorie information postenforcement, 27% reported using the information, a 2-fold increase in the overall proportion of customers making calorie-informed choices (10% vs 20%, $P<.001$).
Pulos and Leng, 2010 ¹¹⁸	Quasi-experimental comparison (pre- vs postintervention)	6 full-service restaurants in Pierce County, Washington state	Restaurants added nutrition information including calories, fat, sodium, and carbohydrates to their menus for all regular items, excluding beverages and daily specials. Data on entrée sales were provided for 30 d before and 30 d after the information was added.	<ul style="list-style-type: none"> • 71% of consumers (95% CI, 65-77) reported noticing the nutrition information. • Postlabeling, entrées sold contained an average of 15 fewer calories, 1.5 g less fat, and 45 fewer milligrams of sodium. • The most frequent change after viewing nutrition information was choosing an entrée containing lower calories (20.4%, 95% CI, 15.2, 25.6) and lower fat (16.5%, 95% CI, 11.6, 21.4).
Harnack and French, 2008 ³²	RCT, short-term (1 meal)	N=594 adolescents (>16 y) and adults in the Minneapolis/St Paul metropolitan area who	Two hotel conference rooms and 1 church basement were set up as dining rooms where meals were consumed from 4:50 to 7:30 PM. Participants were shown 1 of the following 4 menus: Control menu: No calories; value pricing is in accordance with McDonald's pricing. Price menu: No calories; value pricing was removed. Price was standardized per ounce.	<ul style="list-style-type: none"> • No significant differences were found in the average number of calories consumed by the 4 groups ($P=0.25$). • Taste was rated as a very important/most important aspect by 97.6% of participants for buying fast food and 98.5% of participants for buying groceries. • Nutrition was rated as a very important/most important aspect by 58.2% of participants for buying

		regularly (once or more per week) eat at fast-food restaurants	Calorie menu: Calories were added to the value price menu. The background of the calorie column was bright yellow to draw attention to it. The average calorie needs for adults were also shown in the calories count box. Calorie plus price menu: Calories were added as in the calorie menu, value pricing was removed, and price was standardized per ounce as in the price menu.	fast food and 83.5% of participants for buying groceries. <ul style="list-style-type: none"> • 54% of participants in the calorie menu group and 59% in the calorie plus price menu group reported noticing calorie information on their menu. • However, providing calorie information at point of purchase had little effect on food selection or consumption.
Engbers et al, 2006, ¹²² 2007 ¹²³	Nonrandomized controlled trial (1 y)	N=515 office workers at 2 government worksites	Intervention worksite: Product information sheets were available near cafeteria foods, including calorie values in terms of exercise. Every 4 wk, 1 of 6 food groups was highlighted. Leaflets were available in the canteen with information on healthy food, blood pressure, and cholesterol. Control worksite: No treatment. Brief dietary questionnaire given at 3 and 12 mo.	At 1 y: <ul style="list-style-type: none"> • No significant effects on consumption of fruits, vegetables, or dietary fat

CI indicates confidence interval.

Note: Reference numbers (eg, Seymour et al, 2004¹¹⁰) appearing in this supplementary table correspond with those listed in the reference section of the statement. For the purposes of this supplementary table, these meta-analyses or systematic reviews (see "Author, y" column) are considered the primary citation. Additional studies mentioned in the primary citation may be included in the "Intervention/Exposure" and "Findings" columns. The additional studies can be accessed through the primary citation.

Supplementary Table 5. Labeling and Consumer Information on Smoking: Package Warnings and Labeling

Author, y	Design	Population	Intervention/Evaluation	Evidence and Results
Millar, 1996 ¹³⁹	Observational, cross-sectional	Adults age ≥ 20 y in selected health surveys conducted between 1977 and 1994	Differences in rates of smoking were examined by educational attainment and other self-reported characteristics.	<ul style="list-style-type: none"> • Smaller proportions of smokers with lower education recalled printed warnings about heart disease on cigarette packages. • All smokers cited the mass media as their major source of information about smoking, but those with lower education levels reported mass media less often than did smokers with higher education levels and were less likely to obtain information from books, pamphlets, or magazines. • Smokers with lower education levels reported encountering fewer smoking restrictions in their daily activities than did those with higher education levels.
Borland and Hill, 1997 ¹³²	Observational, cross-sectional		Following the introduction of new health warnings and content labeling on cigarettes and other tobacco products in Australia in 1995, surveys were conducted to evaluate whether these changes increased the noticeability of the warnings and contributed to an increase in relevant knowledge.	<ul style="list-style-type: none"> • To be effective, health warnings need to be noticed and persuasive and need to provide guidance for appropriate action. • To be noticed, health warnings need to stand out from the surrounding pack design and need to be large enough to be read easily. • To be persuasive, warnings need to be understood, believed, and judged personally relevant by the reader.
Crawford et al, 2002 ¹³⁴	Observational, cross-sectional	N=785 teenagers of white and other races/ethnicities, primarily smokers, from rural, urban, and suburban locations across the United States	The 13-site TCN, sponsored by the CDC, conducted 129 focus groups that were homogeneous for sex and ethnicity to explore adolescents' response to current and potential tobacco control policy issues.	<ul style="list-style-type: none"> • Teenagers were generally familiar with laws and rules about access and possession for minors but believed them ineffective. • They found a list of chemical names of cigarette ingredients largely meaningless but believed that disclosing and publicizing their common uses could be an effective deterrent, especially for those who were not yet smoking. • They were aware of current warning labels but considered them uninformative and irrelevant. • They were knowledgeable about prices and reported that a sharp, sudden (and large) increase could lead them to decrease their smoking patterns; however, a moderate increase would most likely result in unintended negative consequences (eg, stocking up and selling cigarettes at a profit; buying black-market cigarettes; working at a store that sells cigarettes; stealing cigarettes from stores or family members; and using other forms of tobacco or other substances, such as nicotine replacement products, alcohol, or marijuana).
Guttman and Peleg, 2003 ¹³⁷	Observational, cross-sectional	N=1000 adults, and N=200 adult smokers in Israel	The Israel Ministry of Health surveyed 1000 adults by telephone and 200 smokers in face-to-face interviews to guide its decisions about how warnings should be attributed and how to counter	<ul style="list-style-type: none"> • There was little effect from unattributed warnings. • Smokers, when presented with actual warnings, tended to favor those attributed to "medical studies." • Nonsmokers were somewhat more likely to prefer warnings attributed to the Ministry of Health, explaining that it is

			tobacco lobby opposition.	“responsible for the topic” or “has the authority.”
Health Canada 2005a; Health Canada 2005b	Observational, cross-sectional	Canadian surveys	National surveys conducted on behalf of Health Canada	<ul style="list-style-type: none"> • ≈95% of youth smokers and 75% of adult smokers reported that pictorial warnings on cigarette packs have been effective in providing important health information.
Willemsen, 2005 ¹⁴¹	Observational, cross-sectional	N=3937 Dutch adult smokers	The Dutch Continuous Survey of Smoking Habits examined the self-perceived impact of new health warnings on the attractiveness of cigarettes, smokers’ motivations to quit, and smoking behavior.	<ul style="list-style-type: none"> • 32% said they preferred to purchase a pack without the new warning labels. • 18% reported that warning labels increased their motivation to quit. • 14% became less inclined to purchase cigarettes because of the new warning labels • 10% said they smoked less. • Those who intended to quit within 6 mo were 5-6 times as likely to report smoking less due to the warnings than those who did not plan to quit. • A strong dose-response relation was observed between these effects and intention to quit.
Hammond et al, 2006 ¹⁴⁰	Observational, cross-sectional	N=9058 adult smokers from the ITC-4, including nationally representative surveys in the United States, United Kingdom, Canada, and Australia	A telephone survey was conducted to examine variations in smokers' knowledge about tobacco risks and the impact of package warnings. Respondents were asked to state whether they believed smoking caused heart disease, stroke, impotence, lung cancer in smokers, and lung cancer in nonsmokers. Respondents were also asked whether the following chemicals are found in cigarette smoke: cyanide, arsenic, and carbon monoxide.	<ul style="list-style-type: none"> • Smokers in the 4 countries exhibited significant gaps in their knowledge of the risks of smoking. • Smokers who noticed the warnings were significantly more likely to endorse health risks, including lung cancer and heart disease. • In each instance where labeling policies differed between countries, smokers living in countries with government-mandated warnings reported greater health knowledge. For example, in Canada, where package warnings include information about the risks of impotence, smokers were 2.68 (2.41-2.97) times more likely to agree that smoking causes impotence compared with smokers from the other 3 countries. • Similarly, respondents living in countries with more comprehensive warnings were more likely to cite packages as a source of health information. For example, 85% of Canadian respondents cited packages as a source of health information, in contrast to only 47% of US smokers.
Fathelrahman et al, 2009 ¹⁴²	Observational, cross-sectional	N=1919 adult male smokers in Malaysia	This study examined whether different responses among smokers toward cigarette pack warning labels could predict quit intentions and self-efficacy in quitting. Face-to-face interviews were conducted using a standardized questionnaire.	<ul style="list-style-type: none"> • The responses “more likely to quit because of the warning labels” and “stopped from having a cigarette when about to smoke one” significantly predicted all stages of change and self-efficacy independent of the other measures. • In addition, thinking about the health risks and reading the warnings more often added extra predictive capacity but only in the early stages of contemplating change.
Pollay and Dewhirst 2002 ¹⁴⁴	Observational, retrospective	Trade sources and internal US tobacco	This study evaluated the development, intent, and consequences of US tobacco industry advertising for low machine	<ul style="list-style-type: none"> • Several tactics were used by cigarette manufacturers, leading consumers to perceive filtered and low machine yield brands as safer relative to other brands.

		company documents	yield (“light”) cigarettes. Data were collected via analysis of trade sources and internal US tobacco company documents now available on various web sites created by corporations, litigation, or public health bodies.	<ul style="list-style-type: none"> • Tactics include using cosmetic (that is, ineffective) filters, loosening filters over time, using medicinal menthol, using high-tech imagery, using virtuous brand names and descriptors, adding a virtuous variant to a brand’s product line, and generating misleading data on tar and nicotine yields. • The ads were intended to reassure smokers concerned about the health risks of smoking and to present the respective products as an alternative to quitting. • Such promotional efforts were successful in getting smokers to adopt filtered and low-yield cigarette brands.
Hammond et al, 2004 ¹³⁶	Observational, longitudinal	N=616 adult smokers in Canada	The impact of graphic Canadian cigarette warning labels was assessed using a longitudinal telephone survey.	<ul style="list-style-type: none"> • Participants reported negative emotional responses to the warnings, including fear (44%) and disgust (58%). • Smokers who reported greater negative emotion were more likely to have quit, tried to quit, or reduced their smoking 3 mo later (OR=1.37; 95% CI, 1.15, 1.64). • Participants who tried to avoid the warnings (30%) were no less likely to think about the warnings or engage in cessation behavior at follow-up.
Portillo and Antonanzas, 2002 ¹⁴³	Quasi-experimental comparison (pre- vs postintervention)	N=435 students at the University of La Rioja, Spain	A questionnaire was administered both before and after students were presented with a demonstration of the health warnings on cigarette packets based on the new European Union directive. Students were surveyed on their perceptions of the principal health risks attributable to the consumption of tobacco, ie, lung cancer, respiratory diseases, and CVD.	<ul style="list-style-type: none"> • Perceptions changed significantly after exposure to the content and type of information presented on the new packaging. In general, students attributed a higher health risk to smoking after the presentation.
Hammond et al, 2007 ¹³³	Quasi-experimental comparison (pre- vs postintervention)	N=14,975 adult smokers from the ITC-4, including nationally representative surveys in the United States, United Kingdom, Canada, and Australia	The current study examined the effectiveness of health warnings on cigarette packages in 4 countries. Telephone surveys were conducted in representative cohorts of adult smokers between 2002 and 2005, before and at 3 time points after implementation of new package warnings in the United Kingdom.	<ul style="list-style-type: none"> • Large, comprehensive warnings on cigarette packages are more likely to be noticed and rated as effective by smokers. • Changes in health warnings are also associated with increased effectiveness. • Health warnings on US packages, which were last updated in 1984, were associated with the least effectiveness.
Loken and Howard-Pitney, 1988 ¹³⁵	RCT, short-term (1 session)	115 college women, including smokers and nonsmokers	This study evaluated factors that could influence subjects’ reactions to print ads for cigarettes. Subjects were shown cigarette ads that varied in 2 dimensions: showing or not showing an	<ul style="list-style-type: none"> • Ads were rated as more attractive, more persuasive, and more credible when they showed an attractive model than when they did not. • Compared with general warnings, specific warnings on ads acted as a counterinfluence to their appeal, making the ads

			attractive model and showing a general or specific warning label. Subjects were evaluated on each ad, with ratings combined into 3 dimensions: (1) attractiveness (good-bad, clever-stupid, well designed-not well designed, attractive-unattractive), (2) persuasiveness (persuasive-unpersuasive, makes me-does not make me want to buy the product), and (3) credibility (informative-uninformative, honest-dishonest).	appear less attractive and less persuasive.
Malouff et al, 1992 ¹³⁸	RCT, short-term (1 session)		The readability of label warnings was assessed with 3 standard tests. The tests focused on length of sentences, average number of syllables per word, and unfamiliarity of the words.	<ul style="list-style-type: none"> Literacy levels of the warning labels affected their readability

TCN indicates Tobacco Control Network; CDC, Centers for Disease Control and Prevention; ITC4, International Tobacco Control Four-Country Survey; OR, odds ratio; CI, confidence interval; CVD, cardiovascular disease; and RCT, randomized controlled trial.

Note: Reference numbers (eg, Seymour et al, 2004¹¹⁰) appearing in this supplementary table correspond with those listed in the reference section of the statement. For the purposes of this supplementary table, these meta-analyses or systematic reviews (see "Author, y" column) are considered the primary citation. Additional studies mentioned in the primary citation may be included in the "Intervention/Exposure" and "Findings" columns. The additional studies can be accessed through the primary citation.

Supplementary Table 6. School-Based Approaches to Improving Diet and Physical Activity

Interventions Targeting Both Diet and Physical Activity

Author, Year	Study Type	Population	Outcomes	Duration	Intervention/Exposure	Findings
Brown and Summerbell, 2009 ²²⁵	Systematic review of RCTs	RCTs evaluating school children, age kindergarten through 18 y, and published by September 2007	Effects of diet and physical activity interventions on BMI Only studies reporting a weight outcome were reviewed.	Interventions of at least 12 wk	Among 38 identified trials of school-based lifestyle interventions that focused on improving diet and/or physical activity behaviors to reduce BMI, 20 trials focused on both diet and physical activity.	Diet plus physical activity intervention vs control (20 trials): <ul style="list-style-type: none"> • Of 20 studies, 9 studies showed significant improvements in BMI z score. • In a 6-mo intervention in 5 Chilean primary schools, a program of active recess, parental involvement, health kiosks, and activities led to maintained BMI among boys in the intervention group, whereas boys in the control group had increased BMI. • In 10 US schools, the Planet Health program focused on dietary change plus reduction of sedentary behaviors, especially TV time, in 12-y-olds. The intervention reduced prevalence of obesity (OR=0.47; 95% CI, 0.24-0.93) and increased obesity remission (OR=2.16; 95% CI, 1.07-4.35) over 2 y. • In Crete, a Know Your Body program to improve cardiovascular health demonstrated long-term improvements in BMI and skin-fold measurements, including reduction in BMI of 0.7 kg/m² at 3 y (<i>P</i><0.001), and 3.7 kg/m² at 6 y (<i>P</i><0.05). • An intervention among 8-y-old children in the United States led to reduced weight gain at 2 y. The lowering of BMI z score by the intervention was seen in normal-weight (-0.29; 95% CI, -0.38, -0.21), not overweight (-0.02, 95% CI, -0.16, 0.12) children. • A 12-wk New York public school intervention in 14-y-olds to reduce diabetes risk showed improved BMI and percent body fat. • The Wellness, Academics and You (WAY) program in 9–11-y-olds showed a reduction in risk of becoming overweight in the children in the intervention group.
WHO, 2009 ³⁶	Review of RCTs	School-age children	Diet and/or physical activity	Variable	Multiple school-based interventions reviewed from 107 peer-reviewed articles on 55 interventions, mostly from North America	<ul style="list-style-type: none"> • Effective interventions for diet and/or physical activity are comprehensive and multicomponent and include <ul style="list-style-type: none"> – Curriculum on diet and/or physical activity taught by trained teachers – Supportive school environment/policies – Parental/family component – Physical activity program – Healthy food options in school cafeterias, vending machines, etc • There is also evidence for moderate additional effectiveness of the following: <ul style="list-style-type: none"> – A focused approach with other supportive activities in the

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						<p>curriculum</p> <ul style="list-style-type: none"> – A formative assessment that addresses the needs of the school and cultural contexts
Jiang et al, 2007 ²²⁸	Nonrandomized controlled trial	N=2425 children in 5 primary schools in Beijing, China	Prevalence of overweight and obesity	3 y (dates not reported)	Intervention schools: Nutrition education was aimed at both children and parents and included regular talks and printed materials on diet, physical activity, and sedentary behaviors. Overweight, obese, and nonfit children were also asked to run for 20 min per day after class, monitored by PE teachers. Control schools: no intervention	<ul style="list-style-type: none"> • After 3 y, prevalence of overweight and obesity decreased in intervention schools and increased in control schools. • Compared with controls, intervention schools had a lower prevalence of overweight (9.8 vs 14.4%; $P<0.01$) and obesity (7.9 vs 13.3%; $P<0.01$). • Dietary intake, physical activity, and other obesity-related behaviors were not assessed.
Hoelscher et al, 2010 ²³²	Nonrandomized controlled trial	30 low-income primary schools in central Texas, ≈60% Hispanic	Serial cross-sectional evaluations of ≈1000 4th grade students each year, including BMI, self-reported diet, and physical activity using the SPAN questionnaire	Spring 2007–spring 2008	CATCH BP (control): Multicomponent school intervention for diet and physical activity, including altering the school environment in the classroom, cafeteria, and PE curriculum, with additional family/home components CATCH BP + Community: The above plus additional intensive community involvement based on principles of community-based participatory research	<p>Comparison of CATCH BP + Community with CATCH BP alone:</p> <ul style="list-style-type: none"> • Diet: Percentage of students eating breakfast increased and consumption of unhealthy foods decreased ($P<0.05$ each); a trend toward greater consumption of fruits and vegetables was also seen ($P=0.07$). • Physical activity: No significant differences were seen. • Sedentary activity: less time at the computer ($P=0.003$) and trends toward less time watching TV ($P=0.10$). • Prevalence of overweight/obesity decreased by 1.3 percentage points in CATCH BP schools vs 8.3 percentage points in CATCH BP + Community schools ($P=0.05$). Similar declines were seen in boys, girls, Hispanics, and non-Hispanics.
Marcus et al, 2009 ²²⁹	RCT	N=3135 children, grades 1-4, in 10 schools in	<ul style="list-style-type: none"> • Physical activity assessed by accelerometer • BMI z score • Prevalence of 	4 school years, August 2001–June 2005	Intervention schools: STOPP—Vegetables, low-fat dairy products, and whole grains were	<ul style="list-style-type: none"> • At baseline, the prevalence of overweight plus obesity was higher in intervention vs control schools (20.3% vs 16.1%). Prevalence decreased in intervention schools (to 17.1%) and increased in control schools (to 18.9%) ($P<0.05$ for comparison of changes). • Differences in changes in mean BMI z scores were not

		Stockholm, Sweden	overweight and obesity		introduced and promoted; sweets and sweetened drinks were eliminated. Physical activity was increased by 30 min per day during school; sedentary behavior during afterschool programs was reduced.	<p>significant.</p> <ul style="list-style-type: none"> • There was a nonsignificant trend toward higher physical activity assessed by accelerometer in intervention vs control schools ($P=0.10$). • Eating habits at home were healthier in intervention vs control schools.
Hollar et al, 2010 ²²⁷	Nonrandomized controlled trial	N=2494 children age 6-13 y in 5 elementary schools in Osceola County, central Florida	<ul style="list-style-type: none"> • Systolic and diastolic BP • BMI percentiles and weight 	August 2004–June 2006	Multicomponent: 4 nonrandomly selected intervention schools (N=2029 students) received a multicomponent intervention including 10–15-min physical activity breaks during academic lessons, changes in school meals to meet US Dietary Guidelines for Americans, and changes in school curriculum to teach children, parents, and teachers about good nutrition and the benefits of physical activity. Control schools: no intervention	<p>After 2 academic years:</p> <ul style="list-style-type: none"> • Systolic BP was lower than baseline in intervention schools (≈ 1 mm Hg lower in boys and ≈ 1.5 mm Hg lower in girls), whereas no changes were seen in control schools, but these differences were not statistically significant ($P=0.30$ for boys, $P=0.15$ for girls). • Changes in diastolic BP were also not different in boys ($P=0.79$). • Girls in the intervention schools had a significant decline in diastolic BP (≈ 1.8 mm Hg lower) compared with controls ($P=0.04$). • Comparing intervention vs control schools, BMI z scores and weight z scores decreased significantly for girls (-0.03 vs 0.0, $P=0.003$ and -0.05 vs -0.03, $P=0.01$, respectively) but not for boys ($P=0.86$ and $P=0.59$).
Foster et al, 2010 ²³⁰ Lago et al, 2011 ²³¹	RCT	N=4603 students in 42 US middle schools at 7 US sites, with schools having at least 50% of children	<p>BMI, waist circumference, fasting glucose, fasting insulin</p> <p>Metabolic syndrome risk factors, fitness assessed by 20-m shuttle run, and self-reported</p>	Fall 2006 (start of 6th grade) –spring 2009 (end of 8th grade)	“HEALTHY” schools: Multicomponent intervention targeting diet, physical activity, and behavioral knowledge/skills. Changes were made in quantity and quality of foods and drinks in cafeterias,	<p>Comparison of intervention vs control schools at the end of follow-up:</p> <ul style="list-style-type: none"> • Declines in prevalence of overweight and obesity in both groups of ≈ 4 percentage points (OR=0.99; 95% CI, 0.82, 1.19, $P=0.92$) • Greater declines in BMI z score (-0.05 vs -0.01, $P=0.04$) and waist circumference >90th percentile (-8.1 vs -5.9%, $P=0.04$) • Smaller increases in fasting insulin ($+3.8$ vs 4.0, $P=0.04$) • No significant difference in fasting glucose • No significant differences in prevalence of metabolic syndrome, although low numbers (only 5% at baseline) • No significant differences in objective fitness or self-reported

		eligible for federally subsidized meals or at least 50% black or Hispanic	moderate to vigorous physical activity		vending machines, a la carte options, snack bars, school stores, fundraisers, and classroom parties. PE curriculum was revised to increase time in moderate to vigorous physical activity. Education included self-monitoring and goal setting, plus peer involvement, communication strategies, and social marketing. Control schools: no intervention	moderate to vigorous physical activity
Rosenkranz et al, 2010 ²²⁶	RCT	N=76 girls age 9-13 y in Girl Scout troops Intervention (N=3 troops, 34 girls) Standard care control: (N=4 troops, 42 girls) (Included due to similarity of this troop-based approach to school-based approaches)	<ul style="list-style-type: none"> • BMI z score • Physical activity assessed by accelerometry • Self-reported intake of fruits and vegetables and sugar-sweetened beverages, physical activity • Parental survey of intake of fruits and vegetables and sugar-sweetened beverages, family meals, physical activity, and BMI of parent, frequency of eating while 	October 2007–November 2008	Intervention: Social cognitive theory interactive health curriculum during troop meetings, led by briefly trained (2 h) troop leaders, targeting behaviors (frequent family meals, parent/child physical activity, no TV during meals, water over sugar-sweetened beverages, adding fruits and vegetables to meals, manners, and preparation/clean-up of family meals), goal setting, activity (dancing, yoga, etc), snack/recipe preparation, role-playing, and take-home projects	<ul style="list-style-type: none"> • Most effects were not significantly different from the control troops, including child BMI z score, parent BMI, and most behavioral variables. • However, girls in the intervention troops did accumulate less sedentary activity ($P=0.01$), more moderate physical activity ($P=0.004$), and more moderate to vigorous physical activity ($P<0.001$) as assessed by accelerometry.

watching TV,
family
cohesion, and
parenting style

Interventions Targeting Diet

Author, Study Type	Population	Outcomes	Duration	Intervention/Exposure	Findings
Robinson, O'Brien et al, 2009 ²³³	Children age 5-15 y	Consumption of fruits and vegetables, preferences for fruits and vegetables, and willingness to try fruits and vegetables	Variable	Garden interventions: 11 studies of garden-based educational programs (N=5 on school grounds, N=3 after school, N=3 community) Half of the studies included formal control groups; half used pre/post tests. Assessment methods included 24-h diet recalls, workbooks, surveys, interviews, and focus groups.	Garden-based nutrition education programs led to <ul style="list-style-type: none"> • In 3 of 4 studies, increased intake of fruit and vegetable intake • In 2 of 6 studies, increased preferences for fruits and vegetables • In 2 of 3 studies, increased willingness to taste fruits and vegetables (eg, spinach, carrots, peas, and broccoli in kindergarteners and 1st graders). • In 4 of 6 studies, increased nutrition knowledge, such as ability to identify food groups or recognize the health benefits of fruits and vegetables.
Parmer et al, 2009 ²³⁴	N=115 in 6 2nd grade classes, 3 groups, age 7-8 y	<ul style="list-style-type: none"> • 16-question survey on fruits and vegetables with nutrient-food matching and nutrient-job matching • Fruits and vegetables preference questionnaire with identification of fruits and vegetables and willingness to taste fruits and vegetables • Lunchroom observation: pre-/postintervention 	28 wk	School-based garden: NE+G: 1 h of nutrition education every other week; 1 h of gardening classes in the alternate weeks, including planting carrots, broccoli, spinach, and cabbage and watering, weeding, and managing pests (with adult supervision). Students then prepared a "Party Confetti Salad" from the produce they had grown. NE only: 1 h nutrition	<ul style="list-style-type: none"> • Knowledge (food matching, nutrient matching, identification of fruits and vegetables) increased in both intervention groups compared with control ($P<0.001$). Gains were $\approx 20\%$ greater in the NE+G vs NE group but not statistically significant. • Both intervention groups were more willing to try fruits and vegetables and also rated fruits and vegetables as better tasting ($P<0.001$). Gains were $\approx 50\%$ greater in the NE+G vs NE group but not statistically significant. • The NE+G group was more willing to choose vegetables at lunch than the control group was ($P<0.01$). The NE group was also more willing, but the effect was about half as large and not statistically significant. • The NE+G group ate more vegetables overall than the control group did. The NE group had no significant change.

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					education every other week Control: no treatment	
Somerset and Markwell 2009 ²³⁵	Quasi-experimental study (historical control)	Intervention in 4th to 7th graders, age 8-13 y: 4th (N=25), 5th (N=21), 6th (N=34), and 7th (N=40) Historical controls: 4 th (N=30), 5th (N=37), 6th (N=38), and 7th (N=22)	<ul style="list-style-type: none"> • Identification of fruits and vegetables survey using 3-point Likert scale • 38 questions • 1st: given 1 mo before intervention • 2nd: given in subsequent autumn 	12 mo (2 data years)	<p>School-based garden:</p> <ul style="list-style-type: none"> • Part used as an outdoor classroom • Garden-based teacher hired to incorporate garden activities into curriculum. • Children had classes on composting, propagation, planting, harvesting, and cooking. • Weekly garden activities were also planned. 	<ul style="list-style-type: none"> • Children developed a greater ability to identify fruits and vegetables, had enhanced confidence in preparation of fruits and vegetables, and had changes in perceived consumption. • Preference for whether vegetables taste good increased in 4th graders from 36% to 74%, in 5th graders from 64% to 68%, and in 6th graders from 30% to 42%. In 7th graders, preference decreased from 36% to 31%. • The proportion of children saying they liked to eat vegetables every day increased in 4th graders from 33% to 50%; in 5th graders from 47% to 65%; and in 6th graders from 26% to 35%. In 7th graders, the proportion decreased from 23% to 18%. • There was an increase in children saying yes when asked if their friends were eating “lots of vegetables”: in 5th graders from 24% to 70%, 6th graders from 11% to 32%, and 7th graders from 19% to 23%. (Results in 4th graders not reported.)
Day et al, 2009 ²⁴⁰	RCT (pilot)	Intervention schools (5): N=246 Control schools (5): N=198 Age: 4th and 5th graders	<ul style="list-style-type: none"> • KAP survey • 24-h recall • FFQ • Food Choices Scale for Children • Teacher-recorded logs 	12 wk	<p>Action Schools!</p> <ul style="list-style-type: none"> • School received classroom activities/menu for implementation • 1.5 h of training • Each teacher received (Canada) \$12.50 per month for fruit and vegetable tasting activities 	<ul style="list-style-type: none"> • Servings of fruits increased at intervention schools ($P<0.05$). • There were no effects on willingness to try new fruits and vegetables. • Percentage of fruits and vegetables tried increased from 78% to 83% in intervention schools.
Davis et al, 2009 ²³⁷	RCT	Intervention school (1): N=4800 Control school (1): N=3500 Age: high school, grades 9-12	Anonymous postintervention surveys that assessed intake of fruits and vegetables and demographics, including N=2080 intervention and N=1610 control students	Spring 2006, fall and spring 2006-2007	<p>Fresh Fruit and Vegetable Program:</p> <p>During the 2006-2007 school year, baskets of fresh fruits (apples, oranges, pears, plums, pineapple, and kiwi) and vegetables (carrots and celery with low-fat ranch</p>	<ul style="list-style-type: none"> • Only 1 in 5 students from both the intervention and control schools consumed >5 servings per day of fruits, fruit juices, or vegetables. • More intervention students consumed fruit/100% fruit juice at least twice a day (39.3% vs 27.3%; $P<0.05$). • More intervention students consumed a total of 5+ fruit juices/vegetables per day (22% vs 18.4%; $P<0.05$) and 1+ fruits day (59.1% vs 40.9%; $P<0.05$). • There were no differences in eating vegetables.

			Restricted to those with demographic info (N=1515 and N=1377)		dip) were given to each homeroom (N=180). Students could select fruits and vegetables from the baskets, and teachers were encouraged to discuss fruits and vegetables in class.	
Coyle et al, 2009 ²³⁹	Quasi-experimental (pre- vs postintervention)	N=725, including N=207 with 24-h diet recalls, from a sample of kindergarten through 12th grade students from 5 schools in Mississippi	<ul style="list-style-type: none"> Attitudes toward, familiarity, and preferences for fruits and vegetables Consumption of fruits and vegetables 	Pre- vs postintervention during the 2004-2005 school year	Fresh Fruit and Vegetable Program: A federally funded initiative provided free fresh fruit and vegetable snacks to students. During the 2004-2005 school year, the Mississippi Department of Education Child Nutrition Programs initiated a pilot program to distribute free fruits and vegetables to students in kindergarten through 12th grade during the school day.	<ul style="list-style-type: none"> Results showed greater familiarity with fruits and vegetables at all grade levels ($P<0.05$) Increased preferences for fruit were observed among 8th and 10th grade students ($P<0.01$). 8th graders also reported more positive attitudes toward eating fruits and vegetables ($P<0.01$), increased perceived self-efficacy to eat more fruit ($P<0.01$), and increased willingness to try new fruit. Student consumption of fruit in school and overall increased significantly, by 0.34 and 0.61 servings per day, respectively ($P<0.01$). In-school vegetable intake decreased ($P=0.05$), whereas overall vegetable consumption did not change.
Brown and Summerbell, 2009 ²²⁵	Systematic review of RCTs	RCTs evaluating school children, age kindergarten through 18 y, and published by September 2007	Effects of diet and physical activity interventions on BMI. Only studies reporting a weight outcome were reviewed.	Interventions of at least 12 wk	Diet policy interventions and adiposity: Among 38 identified trials of school-based lifestyle interventions that focused on improving diet and/or physical activity behaviors to reduce BMI, 3 trials focused on diet alone.	<p>Diet intervention vs control (3 trials):</p> <ul style="list-style-type: none"> Of 3 trials, 2 trials showed improvements in BMI z score. 2 UK schools (11-y-olds) tested a low-intensity 12-mo intervention to reduce intake of sugar-sweetened beverages. At 12 mo, the percentage of overweight/obese increased in the control group and was unchanged in the intervention group (mean absolute difference 7.7%; 95% CI, 2.2%, 13.1%). At 3 y, prevalence of overweight had increased in both groups, and between-group differences were no longer significant. A school in Norway (15-y-olds) evaluated whether dietary habits/school performance improved when participants ate breakfast. At 4 mo, BMI increased in the control group but not in the intervention group in both boys and girls ($P<0.05$). A school in Italy (12-y-olds) tested the efficacy of board games in providing nutrition knowledge/promoting healthy dietary behavior. There was no effect on BMI z score at 24 wk.
Foster et	RCT	N=1349	Primary:	2 y	Diet policy	<ul style="list-style-type: none"> Significantly fewer children in the intervention schools (7.5%)

al, 2008 ²³⁸		students in grades 4-6 from 10 schools (5 intervention , 5 control) in a US city in the Mid-Atlantic region with at least 50% of students eligible for free or reduced-price meals	Incidences of overweight and obesity Secondary: Prevalence and remission of overweight and obesity; BMI z score; intake of total energy, fat, and fruits and vegetables; body dissatisfaction; hours of activity and inactivity		interventions and adiposity: Schools were matched on school size and type of food service and randomly assigned to intervention or control groups. The School Nutrition Policy Initiative included the following components: school self-assessment, nutrition education, nutrition policy, social marketing, and parent outreach.	than in the control schools (14.9%) became overweight after 2 y, a 50% reduction. <ul style="list-style-type: none">• Prevalence of overweight was also lower in the intervention schools.• No differences were observed in incidence or prevalence of obesity or in remission of overweight or obesity at 2 y.
Muckelbauer et al, 2009 ²⁴¹	RCT	N=2950 2nd and 3rd graders from 32 elementary schools (17 intervention , 15 control) in socially deprived areas of Dortmund and Essen, 2 neighboring cities in Germany	<ul style="list-style-type: none"> • Daily water consumption • Risk of overweight 	1 y, August 2006–June 2007	School water Randomization was performed at the city level. Intervention included installation of 1-2 water fountains in schools, providing children with reusable water bottles, and teachers encouraging use of the water bottles. Other components were education (4 45-min classroom lessons regarding water needs of the body and the water circuit in nature) and goal setting (at 3 mo, teachers introduced a motivation unit that used a goal-setting strategy for a sustained increase in water consumption,	At the end of 1-y follow-up: <ul style="list-style-type: none"> • Daily water consumption was 1.1 glasses (200 mL) greater in the intervention group. • Compared with the control group, the odds of overweight were 31% lower in the intervention group ($P=0.04$).

					including quantitative targets and feedback). Control schools: no intervention	
Patel et al, 2011 ²⁴²	Nonrandomized intervention study (pilot)	1 intervention and 1 comparison middle school in lower-income areas of Los Angeles, California	Daily water consumption at school, based on surveys of 7th grade students (N=793) and recordings of water used in cafeterias	5 wk, with assessment at 2 mo, in 2008	School water: In the intervention school, cold filtered drinking water was provided in 19-L dispensers in the cafeteria, reusable water bottles were distributed to students and staff, and education activities promoted drinking water. The comparison school received no intervention.	At 2 months postintervention, adjusting for sociodemographic characteristics and baseline intake of water at school: <ul style="list-style-type: none"> The proportion of children drinking any water at school (adjusted OR=1.76), drinking from fountains (OR=1.45), or drinking from reusable water bottles (OR=1.99) was higher in the intervention school than in the comparison school ($P<0.01$ for each). No statistically significant differences were seen in consumption of other beverages, including sodas, sports drinks, or 100% juice.
Loughridge and Barratt, 2005 ²⁴³	Nonrandomized intervention study (pilot)	3 secondary schools in North Tyneside, United Kingdom	Average water consumption at school	3 mo	School water: Intervention schools received either cooled filter water plus active promotion or water alone. The control school received no intervention.	At the end of the 3-mo follow-up: <ul style="list-style-type: none"> The average volume of water drunk by students in the water plus promotion school was greater ($P=0.05$) than in the water-alone or control schools. The volume of soft drinks purchased by students in all 3 schools before and during the intervention did not significantly change.

Interventions Targeting Physical Activity

Author, Year	Study Type	Population	Outcomes	Duration	Intervention/Exposure	Findings
Willenber et al, 2010 ²⁴⁹	Observational, cross-sectional	23 schools, N=3006 children 12 focus groups, N=91, to identify children's ideas about what's fun and healthy	<ul style="list-style-type: none"> SOPLAY scans Focus groups: concept map, group discussion, drawing, photographic ordering 	October 2004–December 2005 Focus groups in 2005-2006	School equipment: Availability and types of playground equipment at schools	<ul style="list-style-type: none"> 44% of children engaged in sedentary behavior, 30% in MPA, and 27% in VPA. MPA was higher in schools with fixed equipment, eg, slides, monkey bars (35% vs 20%; $P<0.001$) MPA was greater where the blacktop was marked with court markings/goals (34% vs 20%; $P<0.001$); play line markings were also higher (25% vs 20%; $P=0.04$). VPA was higher when loose equipment (33% vs 20%; $P<0.001$) and supervision (29% vs 22%; $P<0.001$) were available. In focus groups, children expressed concern about blacktop surfaces due to fear of injuries and falls. Children had an overriding preference for metal surfaces to

		Age: 9-11 y				<p>wooden ones because they thought they were better for safe play and “attractive and fun” and thought that colored surface markings were better for playing.</p> <ul style="list-style-type: none"> • Children often were quick to point out that adults shouldn’t assume that older kids don’t want to play on fixed play equipment and also stated that as the school year went on, less loose equipment was available for play.
Nielsen et al, 2010 ²⁵⁰	Observational, cross-sectional	7 schools, N=417 children age 5-12 y, participating in the APPLE study	Physical activity measured by Actical accelerometer worn at the hip for 2-5 d, put on in the morning and taken off at bedtime	September –November 2004	School equipment: number of permanent play facilities in schools, such as swings, playground markings (eg, hopscotch), courts, sandpits, slides, tower forts, and monkey bars	<ul style="list-style-type: none"> • The number of play facilities in schools ranged from 14 to 35 and was positively associated with both total physical activity and time engaged in MPA/VPA. • For each additional play facility, average accelerometry counts were 3.8% higher at school ($P<0.001$) and 2.7% higher overall ($P<0.001$). • Each additional facility was also associated with 2.3% ($P=0.001$) or 4 min more vigorous activity during school hours and 3.4% ($P<0.0001$) or 9 min more MPA/VPA over the day. • Higher activity at school wasn’t compensated for by decreased activity later. • For each additional 5 play facilities, overall activity increased by 15%-20%. • The effects of play facilities were seen in both sexes and all ages.
Ridgers et al, 2010 ²⁵¹	RCT	15 UK intervention schools (N=256, 130 boys, 126 girls) 11 UK control schools (N=214, 102 boys, 112 girls) Age: elementary school	<ul style="list-style-type: none"> • Physical activity: heart rate telemetry/accelerometry • All wore a heart rate monitor. • 300 wore an accelerometer during points of measure. • BMI • Recess duration: all had morning and lunch recess, and 11 also had recess in the afternoon. 	12 mo	School equipment: <ul style="list-style-type: none"> • Intervention schools each received £20,000 (≈\$31,174 US) to change the playground environment funded by the Department for Education and Skills as part of a national sporting playground initiative. • Changes included the addition of playground markings (sports area, multiactivity area, quiet play area); physical structures, such as 	<ul style="list-style-type: none"> • During lunch recess, VPA was 1.4% greater in intervention schools compared with control schools ($P<0.05$). • Playground markings/structures increased the proportion of morning recess heart rate spent in MPA (from baseline $0.2\pm 0.1\%$ to $3.1\pm 3.1\%$) and VPA (from baseline $0.2\pm 0.1\%$ to $3.6\pm 2.1\%$) ($P<0.05$ each). • There were similar positive effects on lunch recess heart rate for both MPA (from baseline $0.2\pm 0.01\%$ to $3.0\pm 2.1\%$) and VPA (from baseline $0.2\pm 0.1\%$ to $0.9\pm 1.3\%$). • Effects were stronger at 6 mo postintervention than at 12 mo. • As age increased, physical activity during morning and lunch recess decreased.

					soccer goal posts, basketball hoops, fencing, seating; and greater supervision.	
Brown and Summerbell, 2009 ²²⁵	Systematic review of RCTs	RCTs evaluating school children, age kindergarten through 18 y	Effects of diet and physical activity interventions on BMI Only studies reporting a weight outcome were reviewed.	Interventions of at least 12 wk	Among 38 identified RCTs of school-based lifestyle interventions that focused on improving diet and/or physical activity behaviors to reduce BMI, 15 RCTs focused on physical activity alone.	Physical activity intervention vs control (15 trials): <ul style="list-style-type: none"> • 5 of 15 trials showed improvements in BMI z score. • 1 trial showed that 2 h per week of extra PE class improved BMI at 6 mo but not over longer periods. • 1 trial showed that a 12-wk, 150 min per week aerobic dance class reduced BMI (-0.8 kg/m²). • 10 of 15 trials showed no improvement (eg, 6-mo intervention promoting supportive school, 12-wk intervention encouraging walking in girls, 4-mo intervention promoting additional PE classes, 12-wk intervention with individual counseling from a school nurse; 66-session aerobic/dance/gymnastics program).
Harris et al, 2009 ²⁵⁹	Systematic review and meta-analysis of RCTs	RCTs of school-based interventions with objective data on change in BMI, published through September 2008	Effect of school-based physical activity interventions on change in BMI in children	School-based interventions of at least 6 mo	<ul style="list-style-type: none"> • 18 RCTs involving 18,141 children, primarily in elementary school • Duration of studies ranged from 6 mo to 3 y. In 15 of 18 studies, there was some type of cointervention. 	Physical activity intervention vs control (18 trials): <ul style="list-style-type: none"> • In overall pooled meta-analysis, physical activity interventions did not improve BMI compared with controls: weighted mean difference: -0.05 kg/m²; 95% CI, -0.19, 0.10. • Similarly, no consistent changes were seen in other measures of body composition. Outcome measures reported included percentage of body fat, waist circumference, waist-to-hip ratio, triceps skin-fold thickness, subscapular skin-fold thickness, total lean mass, total fat mass, and skin-fold sum. Among 10 studies evaluating 18 such measures, only 3 of the 18 measures found significant improvement with physical activity intervention, 1 demonstrated deterioration with physical activity intervention, and 14 did not show any significant change. • Only 5 trials evaluated objective measures of physical activity. Three studies used SOFIT and found more physical activity in the intervention group; 2 studies used accelerometers and found no difference in physical activity in intervention vs control groups.
Jago et al, 2009 ²⁶⁰	Quasi-experimental pilot study (pre- vs postintervention)	<ul style="list-style-type: none"> • Pilot study for the STOPP-T2D 2003 study: 6 US schools (N=585) • 2004 	Monitored heart rate as a measure of MVPA	2003-2004	2003 activity study: <ul style="list-style-type: none"> • School received \$10,000 for equipment • Specialist PE teacher provided • 56 instruction cards designed for lesson plans to result in high levels of 	2003: <ul style="list-style-type: none"> • Mean heart rate during PE ranged from 143 to 150 bpm. The percentage of class time with heart rate >130-140 bpm ranged from 66% to 76%, equivalent to ≈16 min of physical activity during a 45-min class. • For each day of the intervention, there was an increase of 0.2 bpm (<i>P</i><0.0001) in mean heart rate during PE. An increase was also seen in the percentage of time spent in activities producing a heart rate >130 bpm (<i>P</i><0.0001) and >140 bpm (<i>P</i><0.0001) of about 0.3% per day for both.

		<p>study: 7 US schools (N=1544)</p> <ul style="list-style-type: none"> • Age: 6th graders 			<p>MVPA 2004 curriculum study</p> <ul style="list-style-type: none"> • School received \$10,000 worth of equipment • 5 units: basketball, Frisbee, jump rope, soccer, team ball; 8-12 lesson plans • Master PE teacher and TA provided 	<p>2004:</p> <ul style="list-style-type: none"> • The percentage of class time with heart rate >130 bpm increased from 63% in week 3 to 72% in week 8, and with heart rate >140 bpm, from 49% in week 3 to 58% in week 8.
Kriemler et al, 2010 ²⁵⁷	RCT	<p>N=502 students in 28 1st and 5th grade elementary school classrooms from 15 schools in Switzerland</p>	<ul style="list-style-type: none"> • Body fat (sum of 4 skin folds) • Aerobic fitness (shuttle run test) • Physical activity (accelerometry on weekdays) • Quality of life • BMI, metabolic risk (average z scores of waist circumference, BP, blood glucose, inverted HDL cholesterol, and triglycerides) 	<p>1 academic year (August 2005–June 2006)</p>	<p>Multicomponent PE+activity</p> <ul style="list-style-type: none"> • Participants in both groups received 3 45-min PE classes per week. • The intervention group (16 classrooms) also received structuring of the 3 existing PE classes; 2 additional 45-min PE classes per week; daily short activity breaks (3-5 per day during academic lessons, lasting 2-5 min each); and daily physical activity homework. 	<p>After adjustment for grade, sex, baseline values, and clustering within classes:</p> <ul style="list-style-type: none"> • Children in the intervention classrooms showed a greater decrease in skin-fold thickness z score (−0.12; 95% CI, −0.21, −0.03; <i>P</i>=0.009), increase in shuttle run z score (+0.17; 95% CI, 0.01, 0.32; <i>P</i>=0.04), and total daily MPA/VPA z score (+0.44; 95% CI, 0.05, 0.82; <i>P</i>=0.03), with the latter due to increased activity during school hours (+1.19; 95% CI, 0.78, 1.60; <i>P</i><0.001). • The intervention also reduced BMI z score (−0.12; 95% CI, −0.19, −0.04; <i>P</i><0.003) and cardiovascular risk z score (−0.18; 95% CI, −0.29, −0.06; <i>P</i><0.003). • No significant differences were seen in z scores for overall daily physical activity (0.21; −0.21 to 0.63), physical quality of life (0.42; −1.23 to 2.06), or psychological quality of life (0.59; −0.85 to 2.03).
Jansen et al, 2011 ²⁶¹	RCT	<p>N=2622 children in grades 3-8 (age 6-12 y) in 20 schools in multiethnic, low-income areas in Rotterdam, Netherlands</p>	<ul style="list-style-type: none"> • BMI • Waist circumference • Fitness assessed by 20-m shuttle run 	<p>1 school year</p>	<p>Multicomponent PE+activity:</p> <ul style="list-style-type: none"> • “Lekker Fit” schools: 3 PE sessions per week by trained teacher, additional sport/play outside school hours, physical activity education • Control schools: no intervention. 	<p>Comparing intervention with control schools after 1 y:</p> <ul style="list-style-type: none"> • No significant differences overall in grades 6-8 • In grades 3-5 only: <ul style="list-style-type: none"> – Lower prevalence of overweight (OR=0.53; 95% CI, 0.36, 0.78) – Lower waist circumference (−1.29 cm; 95% CI, −2.16, −0.42) – Greater fitness (+0.57 laps; 95% CI, 0.13, 1.01)

<p>Jurg et al, 2006²⁵⁸</p>	<p>Nonrandomized controlled trial</p>	<p>N=510 students, grades 4-6, in 4 intervention and 2 control schools in Amsterdam, Netherlands</p>	<ul style="list-style-type: none"> Physical activity assessed with a questionnaire 	<p>August 2002–June 2003</p>	<p>Multicomponent, including activity breaks</p> <ul style="list-style-type: none"> JUMP-in program: Schools received an intervention including accessible school exercise activities around or within the school, structured PE by school teachers with a goal of 60+ min of MPA per day, regular breaks during usual lessons for physical activity, relaxation, and posture exercises, and parental support. Control schools: no intervention 	<ul style="list-style-type: none"> After multilevel analysis and adjustment for baseline physical habits and activities, pupils in the intervention schools were more likely to meet the guidelines (at least 60 min of MPA daily): OR 1.63; 95% CI, 1.02, 2.61. This difference was only significant among 6th grade students (OR 4.33; 95% CI, 1.82, 10.32), not 4th grade (OR 0.84; 95% CI, 0.34, 2.09) or 5th grade (OR 1.16; 95% CI, 0.48, 2.79) students.
<p>Stewart et al, 2004²⁵²</p>	<p>Intervention study but without control or pre- vs postintervention comparison</p>	<p>N=71 students in a nonrandomized sample from 3 classrooms (grades 1, 3, 5) in a school in Georgia; of the students, 88% were black, 7% Hispanic, and 5% white</p>	<ul style="list-style-type: none"> Exercise intensity in METs, estimated from step counts measured using accelerometer parameters Calculated energy expenditure 	<p>Spring 2001</p>	<p>Activity breaks</p> <ul style="list-style-type: none"> A 10-min classroom-based physical activity program implemented by teachers at least once a day in the intervention school (TAKE10!) No control 	<ul style="list-style-type: none"> During the program, exercise intensity ranged from 6.2 to 6.4 METs across all grades during activity and in the moderate to vigorous range of energy expenditure during all sessions. Average energy expenditure ranged from 25 to 37 kcal during each session and increased with grade. Change in exercise intensity or expenditure before or after the program was not assessed.
<p>Mahar et al, 2006²⁵³</p>	<p>RCT</p>	<p>N=243 students in 15 classes from</p>	<ul style="list-style-type: none"> Daily steps during school hours, measured by a pedometer 	<p>12-wk period from August–</p>	<p>Activity breaks</p> <ul style="list-style-type: none"> Intervention classes (N=135 students) received a 10-min 	<ul style="list-style-type: none"> Students in the intervention classes took more daily steps in school than those in the control classes (5587 vs 4805, +782; effect size=0.49; $P<0.05$).

		kindergarten through 4th grade in a public school in North Carolina		November (year not stated)	classroom-based physical activity program implemented by teachers. • Control classes (N=108 students): no intervention	
Liu et al, 2008 ²⁵⁴	Nonrandomized controlled trial	N=753 boys and girls age 6-12 y from 2 elementary schools in Beijing, China	<ul style="list-style-type: none"> • Duration of total physical activity per day assessed by validated 7-d questionnaire • Average energy expenditure per day calculated from activity questionnaire • BMI 	October 2004–June 2005	<p>Activity breaks</p> <ul style="list-style-type: none"> • Intervention school: a 10-min classroom-based physical activity program implemented by teachers at least once per day (Happy 10 program) • Control school: no intervention 	<ul style="list-style-type: none"> • Duration of total physical activity increased from 2.8 to 3.3 h per day in the intervention school but decreased from 4.4 to 2.9 h per day in the control school ($P<0.05$ for comparison of change). • Average energy expenditure increased from 15.0 to 18.2 kcal/kg in the intervention school but decreased from 24.3 to 14.7 kcal in the control school ($P<0.05$ for comparison of change). • Among boys, BMI increased similarly in both intervention (18.1-19.0 kg/m²) and control (18.0-18.7 kg/m²) schools ($P=NS$ for comparison of change). • Among girls, BMI decreased in the intervention (18.6-18.2 kg/m²) but increased in the control (16.4-17.1 kg/m²) school ($P<0.05$ for comparison of change).
Donnelly et al, 2009 ²⁵⁵	RCT	N=1527 students, grades 2-3, in 24 schools in Northern Kansas	<ul style="list-style-type: none"> • BMI (primary) • Daily physical activity assessed in a subset using accelerometers 	2003-2006	<p>Activity breaks</p> <ul style="list-style-type: none"> • Physical Activity Across the Curriculum: 14 intervention schools received a 90 min per week MVPA lesson delivered intermittently in the school day in addition to 60 min per week of PE. • 10 control schools received 60 min per week of PE. 	<ul style="list-style-type: none"> • There was no significant change in BMI or BMI percentile between the intervention and control schools. End BMI: 19.9 vs 20.0; change in BMI: 2.0±1.9 vs 2.0±1.9, $P=0.83$. • Intervention schools had higher mean accelerometer counts (851 vs 744 over 4 d, $P=0.007$) due to greater activity during both school hours and on weekends and more time spent in MVPA (98 vs 72 min over 4 d, $P=0.001$) • In post hoc observational analyses, intervention schools complying with 75+ min per week of intervention (N=9) had a smaller increase in BMI than intervention schools with <75 min per week of intervention (N=5). Change in BMI: 1.8±1.8 vs 2.4±2.0, $P=0.02$. • The significance of change in BMI in compliant intervention schools (1.8±1.8) vs control schools (2.0±1.9) was not reported but did not appear to be statistically significant.
Katz et al, 2010 ²⁵⁶	RCT	N=1214 students grades 2-4 at 5 schools in Missouri	<ul style="list-style-type: none"> • BMI • Maximal oxygen consumption • Measured abdominal strength, upper body strength, back extensor strength, and 	September 2007–April 2008	<p>Activity breaks</p> <ul style="list-style-type: none"> • Students in 3 intervention schools (N=655) received a range of multiple structured physical activity breaks, implemented by teachers during times when students 	<ul style="list-style-type: none"> • Over 1 academic year, students in the intervention group had a significantly greater increase in BMI than controls (median BMI change 0.3 vs 0.1; $P=0.02$) and a trend toward a greater BMI z score ($P=0.07$) Lean muscle mass was not assessed. • • The intervention group showed greater improvements in median abdominal strength (curl-ups: +9.0 vs 0.0; $P<0.01$), upper-body strength (90-degree push-ups: +2.0 vs 0.0; $P<0.01$), and trunk extension (trunk lifts: +1.0, IQR 0.0, 3.0, vs 1.0, IQR 0.0, 2.0;

			flexibility		were not concentrating maximally in class. <ul style="list-style-type: none"> • Students in 2 control schools (N=559) received no intervention. 	<i>P</i> <0.01). <ul style="list-style-type: none"> • No significant differences were seen in flexibility or maximal O₂ consumption.
Mendoza et al, 2009 ²⁶⁶	Nonrandomized controlled trial	3 urban, socioeconomically disadvantaged public elementary schools (1 intervention vs 2 controls) in Seattle, Washington, kindergarten to 5th grade (age 5-11 y)	Evaluated change in walking vs all other forms of transport to school, assessed by serial cross-sectional surveys (n≈650 each) at baseline and 1-y follow-up	1 y	Walking school bus <ul style="list-style-type: none"> • Part-time coordinator • Parent volunteers 	<ul style="list-style-type: none"> • At baseline, the proportions of students walking to school did not differ at the intervention (20±2%) vs control (15±2%) schools (<i>P</i>=0.39). • At 1 y, more students walked to school at the intervention (25±2%) vs control (7±1%) schools (<i>P</i>=0.001). • No significant changes were seen in the percentage of students riding in a car or taking the school bus at baseline or 1 y (all <i>P</i>>0.05).
Heelan et al, 2009 ²⁶⁵	Nonrandomized controlled trial	2 intervention schools (N=464) 1 control school (N=227) Age: elementary school	<ul style="list-style-type: none"> • Trial assessed how children got to school (walking, biking, riding in car/bus) for 1 wk 3 times per year. • A subset (N=201) received objective activity measures. • BMI, skin-fold thickness, and percentage of body fat were measured twice per year. 	2 y	Walking school bus <ul style="list-style-type: none"> • Children walked to school in groups with set stops along the way. • Adults were present as “bus drivers” for supervision. • Walk stops were within a 1.6-km radius of the school. • 8 routes were created for the 2 participating schools. • Participants walked an average of 1.04 km each way. 	<ul style="list-style-type: none"> • After 2 y, 36% of children at the intervention schools actively commuted at least 50% of the time (meeting the HP 2010 goal) vs 26% of children at the control school (<i>P</i><0.05). • In the subset with objective measures, the effects were greater: 71% of intervention participants met the HP 2010 goal compared with 25% of control participants. • Over 2 y, there were no statistically significant differences in BMI, BMI <i>z</i> score, or percentage of body fat between children at the intervention and control schools. • In observational analyses, there was a significant difference in change in BMI over 2 y between frequent walkers (ΔBMI=0.80 kg/m²) vs passive commuters (ΔBMI=1.57 kg/m²), <i>P</i><0.05. • Frequent walkers vs passive commuters also had a smaller increase in sum of skin folds (2.40±5.80 vs 5.55±4.66) and percentage of body fat (1.55%±3.84% vs 3.72%±3.31).

RCT indicates randomized controlled trial; BMI, body mass index; OR, odds ratio; CI, confidence interval; WHO, World Health Organization; SPAN, School Physical Activity and Nutrition; PE, physical education; CATCH BP, Coordinated Approach to Child Health–Blood Pressure; STOPP, Stockholm Obesity Prevention Program; BP, blood pressure;

NE, nutrition education; NE+G, nutrition education plus gardening; KAP, Knowledge, Attitude, and Practice; FFQ, food frequency questionnaire; SOPLAY, System for Observing Play and Leisure Activity in Youth; VPA, vigorous physical activity; MPA, moderate physical activity; APPLE, A Pilot Programme for Lifestyle and Exercise; SOFIT, System for Observing Fitness Instruction Time; STOPP-T2D, Studies to Treat or Prevent Pediatric Type 2 Diabetes; MVPA, moderate to vigorous physical activity; PE, physical education; bpm, beats per minute; HDL, high-density lipoprotein; METs, metabolic equivalents; NS, not significant; IQR, interquartile range; and HP 2010, Healthy People 2010.

Note: Reference numbers (eg, Brown and Summerbell, 2009²¹⁸) appearing in this supplementary table correspond with those listed in the reference section of the statement. For the purposes of this supplementary table, these meta-analyses or systematic reviews (see "Author, y" column) are considered the primary citation. Additional studies mentioned in the primary citation may be included in the "Intervention/Exposure" and "Findings" columns. The additional studies can be accessed through the primary citation.

Supplementary Table 7. Studies of School Vending Machines

Author, y	Design	Population	Outcomes	Duration	Intervention/Exposure	Findings
Nickelson et al, 2010 ²⁴⁴	Observational, cross-sectional	8 public middle schools N=4049 Age: 6th-8th grades	<ul style="list-style-type: none"> • Self-reported parental limits on soft drink intake • School vending machine soft drink purchases • Soft drink consumption 	Survey taken during 1 class period	YRBSS <ul style="list-style-type: none"> • Observed 7 items from YRBSS in relation to purchases of soft drinks from school vending machines and consumption of soft drinks at school/home • Examined survey question about parental limits on consumption of soft drinks • Measured age, sex, race/ethnicity, milk, and fruit juice intake 	<ul style="list-style-type: none"> • 67% of students reported consuming no soft drinks per day. • 54% of students reported no parental limits on consumption, 33% reported a limit of 1 soft drink per day, and 14% reported a limit of 2-3 soft drinks per day. • The greatest number of purchasers of soft drinks from school vending machines were students who reported a parental limit of 2-3 soft drinks per day (29%) or no parental limit (27%) ($P<0.001$). • Students with the lowest soft drink purchases from school vending machines (20%) reported a parental limit of 1 soft drink per day ($P<0.001$).
Park et al, 2010 ²⁴⁶	Observational, cross-sectional	73 Florida public middle schools N=4322 Age: 6th-8th grades	<ul style="list-style-type: none"> • Use of school vending machines • Consuming snacks/caloric beverages in place of lunch 	Spring 2003	Florida Youth Physical Activity and Nutrition Survey <ul style="list-style-type: none"> • Statewide, self-reported school-based survey for middle school students to monitor attitudes, behaviors, physical activity, and nutrition knowledge • Developed by Florida Dept of Health • Survey examined vending machine types and items offered • Items were grouped into healthier and less healthy snacks and beverages. 	<ul style="list-style-type: none"> • 99% of students reported the presence of a vending machine serving snacks, 89% reported a beverage vending machine, and 88% reported having both. • 70% reported buying less healthy snacks and 69% reported buying less healthy beverages. • In schools with a beverage vending machine, more students (19%) selected snacks/beverages instead of lunch than in schools without beverage vending machines (7%) ($P<0.05$). • Students in schools with a beverage machine had a higher risk for buying lunch from the vending machine (adjusted OR=3.5; 95% CI, 2.2-5.7). • Students who bought snacks/beverages from the vending machines instead of school lunch ≥ 3 days per week more often purchased less healthy snacks.
Thompson et al, 2010 ²⁴⁵	Observational, cross-sectional	Public school students N=869	<ul style="list-style-type: none"> • Access to school vending machines • Food purchases and dietary intakes 	Given May–June 2005	Youth Styles Survey <ul style="list-style-type: none"> • Consumer mail panel survey as part of Styles survey • Survey inquired about school 	<ul style="list-style-type: none"> • 58.7% of students reported that access to school vending machines was restricted to certain hours. The majority of these students reported not making any purchases from the vending machine ($P<0.05$). • Students who bought food from the

					vending machine access, purchasing behaviors, school rules about vending machines, individual dietary intakes, and purchase of pizza/fried foods from the school cafeteria.	vending machine ≥ 3 days per week were more likely to have unrestricted access to vending machines (OR=1.71; 95% CI, 1.13-2.59), drink soda (OR=3.21; 95% CI, 1.87-5.51), and eat chocolate/candy (OR=2.71; 95% CI, 1.34-5.46) at least 1 or more times per day. <ul style="list-style-type: none"> Students who bought lunch 1-2 times per week were more likely to buy fried foods/pizza from the school cafeteria (OR=2.43; 95% CI, 1.69-3.49); those buying food >3 times per week were even more likely to buy fried foods/pizza (OR=5.05; 95% CI, 3.10-8.22).
Fiske and Cullen, 2004 ¹⁰⁹	RCT	10 vending machines in teachers' lounges in Texas elementary and middle schools	<ul style="list-style-type: none"> Assessed items sold Assessed dollar sales for items Total machine revenue 	2-wk baseline assessment; 4-wk intervention	Teacher vending machines: <ul style="list-style-type: none"> Each machine had 28 snack items and 5 choices of gum. Low-fat items were promoted by <ul style="list-style-type: none"> Labels (intervention I, 4 machines) Labels plus signs (intervention II, 4 machines) No intervention (control, 2 machines) 	<ul style="list-style-type: none"> Intervention I resulted in a trend toward a small increase in sales of low-fat items ($P=0.08$). Intervention II resulted in more target foods sold, without a significant effect on total dollar sales ($P=0.11$). A significant difference in total machine revenue was not seen in either intervention.
Gorton et al, 2010 ²⁴⁷	Quasi-experimental (pre- vs postintervention)	14 vending machines at 2 hospital sites N=835 at baseline; N=611 at follow-up (Included here although worksite-based)	<ul style="list-style-type: none"> Web-based staff surveys: 1 preintervention and 1 midway through intervention Sales data pre- vs postintervention 	March–May 2007 and March–May 2008	Hospital vending machines: <ul style="list-style-type: none"> Intervention to provide at least 50% more healthy choices in vending machines (defined as <800 kJ, <1.5 g saturated fat per 100 g, <450 mg per 100 g nonconfectionery items), and 50% other choices (<800 kJ) 	<ul style="list-style-type: none"> Preintervention: 16% of staff used vending machines ≥ 1 time per day, 51% said they tried to choose healthier items, and 84% reported they never or infrequently used vending machines. Mid intervention: no significant changes. End intervention: no significant changes. 15% used vending machines >1 time per day, 53% said they tried to choose healthier items, and 85% reported they never or infrequently used vending machines. 87% of staff who frequented vending machines reported noticing that healthier snacks were available. 54% of staff who frequented vending machines reported changing their choices, with 31% doing so to make healthier choices. Postintervention, average purchase: 40% lower kJ, 32% lower total fat, and 41%

						lower saturated fat
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YRBSS indicates Youth Risk Behavior Surveillance System; OR, odds ratio; CI, confidence interval; and RCT, randomized controlled trial.

Note: Reference numbers (eg, Nickelson et al, 2010²³⁸) appearing in this supplementary table correspond with those listed in the reference section of the statement. For the purposes of this supplementary table, these meta-analyses or systematic reviews (see "Author, y" column) are considered the primary citation. Additional studies mentioned in the primary citation may be included in the "Intervention/Exposure" and "Findings" columns. The additional studies can be accessed through the primary citation.

Supplementary Table 8. Workplace-Based Approaches to Improve Diet and Physical Activity.

Diet and Physical Activity

Author, y	Design	Population	Outcomes	Intervention/Exposure	Findings
Engbers et al, 2005 ¹²¹	Systematic review of controlled trials (with or without randomization) evaluating workplace environmental modifications to improve diet, physical activity, or other health indicators	Healthy employees in manufacturing, education, service, state agencies, health care, sales (insurance, computer, food), and telecommunications	<ul style="list-style-type: none"> • Knowledge or behaviors related to diet, physical activity, or other health indicators • Follow-up in all trials identified ranged from 3 mo to 2.4 y. 	<p>All trials included worksite interventions to improve diets:</p> <ul style="list-style-type: none"> • Glasgow et al, Emmones et al, Sorenson et al, and Hebert et al used point-of-purchase food labeling, but how the labeling was used was not specified. • Kronefeld et al, Beresford et al, Glasgow et al, Pegus et al, Sorenson et al, and Emmons et al expanded the availability of healthy products/enhanced visibility of healthy food; most distributed posters and bulletins. • Glasgow et al, Pegus et al, Sorenson et al, and Emmons et al implemented healthy food options in vending machines. <p>All interventions were multicomponent, combining environmental changes with education, counseling, and distribution of info (brochures, kick-off events, flyers, etc).</p>	<ul style="list-style-type: none"> • Glasgow et al: 2 studies, same intervention, 1995—no effects on dietary intake, tobacco use, and cholesterol levels; 1997—no effect on cholesterol levels, significant decrease in fat intake, significant increase in self-reported exercise • Emmons et al: significant increase in exercise behavior and consumption of fruits and vegetables • Sorenson et al: 2 studies— <ul style="list-style-type: none"> – Treatwell 1992: no significant changes in fiber intake, significant decrease in dietary fat – Treatwell 5-day 1999: worksite plus family—significant increase in fruit and vegetable intake compared with worksite intervention and control • Sorenson et al: Working Well Trial 1996—significant increase in fruits and vegetables consumption, insignificant decrease in smoking • Sorenson et al: Well Works Trial 1998—significant decrease in fat intake, significant increase in fruit and vegetable consumption and fiber, no effect on smoking; 2002—no significant changes between conditions on fruit and vegetable intake, smoking cessation rates higher in 1 intervention condition • Hebert et al: identical subjects to Sorenson 1992, increase in vegetable consumption, decrease in ground/processed meat consumption, high correlation between priori intervention targets and behavior • Kronefeld et al: increase in consumption of chicken, few other changes in dietary habits; increase in exercise in both intervention and control groups; decrease in number of smokers in intervention group • Beresford et al: larger increase in fruit and vegetable intake in intervention than in control sites (both significant) • Pegus et al: significant increase in knowledge of cardiac risk factors, diet, and BP management;

					<p>improvements in exercise, diet, nutrition, smoking, BMI, BP, and cholesterol but no significant differences from control</p> <ul style="list-style-type: none"> • Braeckman et al: no change in cholesterol levels, significant increase in nutrition knowledge, significant decrease in total energy and fat intake, increase in BMI in intervention group • Strong evidence on effectiveness of worksite dietary interventions to alter fruit, vegetable, and fat intake • Many studies of lower quality: only 4 of 13 trials overall could be qualified as high quality; outcome measures were often self-reported; none of the studies described randomization process <p>Physical activity</p> <ul style="list-style-type: none"> • See entry in the next section of this Table, below.
Anderson et al, 2009 ²⁶⁷	Systematic review of RCTs of worksite interventions on diet and/or physical activity for adults	RCTs in worksites	Any adiposity-related outcomes, including weight, BMI, or body fat	<p>US Task Force on Community Preventive Services review of diet and/or physical activity interventions at worksites:</p> <ul style="list-style-type: none"> • Most studies combined informational and behavioral strategies to influence diet and physical activity. • Fewer studies modified the work environment (eg, cafeteria, exercise facilities) to promote healthy choices. 	<p>At 6–12-mo follow-up, the overall pooled effect estimate showed</p> <ul style="list-style-type: none"> • Weight reduction of 1.26 kg (95% CI, -4.6, -1.0) based on 9 RCTs • BMI reduction of 0.5 kg/m² (95% CI, -0.8, -0.2) based on 6 RCTs • Heterogeneity not identified by sex or worksite settings.
Groeneveld et al, 2010 ²⁶⁸	Systematic review of RCTs that targeted workers; aimed at improving diet and/or physical activity; and measured CVD risk factors	31 RCTs identified	Body weight, body fat, BP, blood lipids, and/or blood glucose	<p>Diversity of interventions identified, including counseling, group education, and exercise. Of the 31 trials, 18 were judged to be of high quality.</p> <p>.</p>	<ul style="list-style-type: none"> • Strong evidence was found for a beneficial effect on body fat. • Among higher-risk populations, there was also strong evidence for a beneficial effect on body weight. • Due to inconsistencies in results between studies, there was no evidence for the effectiveness of interventions on the remaining outcomes.
Engbers et al, 2006, 2007 ^{122,123}	Controlled trial	N=452 and 515 office workers at 2 government	<ul style="list-style-type: none"> • Brief dietary questionnaire • BMI, waist/hip circumference, skin-fold 	<p>Food Steps Trial: 1-y intervention:</p> <ul style="list-style-type: none"> • Diet: Product information sheets placed near foods, indicating calorie values in terms of exercise. 	<p>Dietary habits:</p> <ul style="list-style-type: none"> • No significant effects on consumption of fruits, vegetables, or dietary fat <p>Physical activity:</p> <ul style="list-style-type: none"> • Not reported

		worksites	thickness, BP, cholesterol levels <ul style="list-style-type: none"> Measures at 3 and 12 mo 	Every 4 wk, 1 of 6 food groups was highlighted. Leaflets with information on healthy food, BP, and cholesterol were left in the canteen. <ul style="list-style-type: none"> Activity: Focus on increasing use of stairs by point-of-decision prompts on ground floor elevator doors; use of footprint graphics on the floor to lead employees to stairwells; motivational quotes, poems, and exercise facts posted on the windows between floors; and slim mirrors on every other staircase floor Control group: no treatment 	Physiologic risk factors, among those with a BMI ≥ 23 : <ul style="list-style-type: none"> At 1 y, there were no significant differences in anthropometric measures between groups. When compared with controls, the intervention group had significant favorable changes in total cholesterol (women only); HDL cholesterol (men only); and the total-HDL ratio. When compared with controls, BP was actually significantly increased in the intervention group (+5 mm Hg, $P < 0.001$).
Lowe et al, 2010 ¹¹²	Quasi-experimental (pre-/postintervention)	N=96 hospital employees	Worksite cafeteria lunch purchases as assessed by scanned purchasing cards, comparing 3 mo before vs after the intervention	<ul style="list-style-type: none"> Group 1: Environmental changes in the cafeteria, including addition of selected healthier options along with food labeling (calories, energy density, macronutrients) for all foods sold during lunch Group 2: Environmental changes in the cafeteria plus pricing incentives and 4 1-h group sessions of nutrition education on strategies for decreasing energy density of the diet 	<ul style="list-style-type: none"> In a comparison of before vs after the intervention, total calories and percent energy from fat at lunch decreased (≈ 70 less kcal and 5% less energy, respectively; $P < 0.01$ each). There were no differences between the 2 intervention groups, ie, the addition of pricing incentives and nutrition education did not appear to have any additional impact. However, the sample size was small and may have not been adequately powered after attrition of subjects.

Physical Activity

Author, y	Design	Population	Outcomes	Intervention/Exposure	Findings
Engbers et al, 2005 ¹²¹	Systematic review of controlled trials (with or without randomization) evaluating workplace environmental modifications to improve diet, physical activity, or other health	Healthy employees in manufacturing, education, service, state agencies, health care, sales (insurance, computer, food), and	<ul style="list-style-type: none"> Knowledge or behaviors related to diet, physical activity, or other health indicators Follow-up in all trials identified ranged from 3 mo to 2.4 y. 	3 trials included worksite interventions to increase physical activity: <ul style="list-style-type: none"> Walking track on factory grounds Posters and bulletin boards to encourage use of stairs New or upgrading of worksite fitness facilities, plus route for walking during lunchtime All interventions were multicomponent, combining environmental changes with education, counseling, and distribution of information	Physical activity <ul style="list-style-type: none"> Adding a worksite walking track did not significantly improve CVD risk factors. Improvements were seen in both intervention and control groups. Posters and bulletins for stairs did not significantly increase activity. Exercise improved in both intervention and control groups. Adding or upgrading worksite fitness facilities significantly increased physical activity. Studies were generally of lower quality, with self-reported outcomes and no clear description of randomization procedures.

	indicators	telecommu nications		(brochures, kick-off events, flyers, etc).	Diet See entry in prior section of this Table, above.
Engbers et al, 2007 ²⁶⁹	Observational, cross-sectional	N=186 office workers with BMI ≥ 23 at 2 government agencies	<ul style="list-style-type: none"> • Self-reported stair use: how often stairs were used, how many floors covered • Objective measures using detection device, chip card 	<p>Worksite 1</p> <ul style="list-style-type: none"> • 6-story building, staircases visible and located directly next to elevator <p>Worksite 2</p> <ul style="list-style-type: none"> • 12-story city hall building, tighter security, stairs not accessible from 1st floor, stairs hidden <p>(Baseline data from Food Steps Trial)</p>	<ul style="list-style-type: none"> • Worksite 1: Men and normal-weight employees used stairs more often and covered more floors than did women and overweight employees, respectively. • Worksite 1: Men had significantly higher values on objective stair-use frequency ($P=0.002$) and objective number of floors covered ($P<0.001$) compared with worksite 2. • No significant differences were found between worksite 1 and 2 for women.
Schwetschenau et al, 2008 ²⁷²	Observational, cross-sectional	N=88 employees of a Midwestern company	Membership in and use of workplace fitness centers	Survey of worksite employees to assess perceived barriers to using worksite fitness centers	<ul style="list-style-type: none"> • The perception that the fitness center had inadequate exercise facilities was associated with a lower likelihood of membership. • Among members, embarrassment about exercising in front of colleagues was associated with lower frequency of use.
Schwartz et al, 2009 ²⁷¹	Observational, cross-sectional	N=293 employed adults in Montgomery County, Maryland	<ul style="list-style-type: none"> • Accelerometer determined steps per weekday • Self-reported walking home from work 	8 built-environment characteristics near workplace (presence of sidewalks, crosswalks/pedestrian signals, cul-de-sacs, bicycle or pedestrian trails, trees along streets, no litter, four-way intersections, too much traffic) and 4 workplace policies (presence of exercise facilities, exercise programs, showers, and lockers)	<ul style="list-style-type: none"> • No built-environment characteristic near the workplace was significantly associated with measured amounts of weekday walking. • Some built-environment characteristics were positively associated with self-reported walking home from work, including the presence of sidewalks, crosswalks, and pedestrian signals near the workplace. • All 4 workplace policies were positively associated with weekday walking ($P<0.05$).
Nicoll et al, 2009 ²⁷⁰	Quasi-experimental	N=299 office building employees in Texas	<ul style="list-style-type: none"> • Stair use from infrared monitors and card readers • Survey of stair use and attitudes and behaviors toward physical activity. 	<ul style="list-style-type: none"> • Natural experiment: 1 bank of skip-stop elevators, which stop only at every 3rd floor, requiring users to take stairs to other floors, with nearby stairs made open and appealing • Control: Traditional elevator core and fire exit stairwell on the other side of the building 	<ul style="list-style-type: none"> • The open stair near the skip-stop elevator was used 33 times more than the enclosed fire stair in traditional core (117,619 entries for skip-stop stairs, 3570 entries for traditional stairs). • Initial attitudes toward skip stop: 32% satisfied, 32% neutral, and 35% dissatisfied • Attitudes 22 mo later: 48% satisfied, 27% neutral, and 25% dissatisfied • 73% of employees used stairs daily.
Pedersen et al, 2009 ²⁷³	RCT	N=549 employees in Denmark	<ul style="list-style-type: none"> • Self-reported physical activity. • Physical fitness by maximal muscle strength, maximal O_2 	<p>Resistance training:</p> <ul style="list-style-type: none"> • Allotted 1 h per week during work for intervention activities • Traditional dynamic strengthening exercises with dumbbells and isometric exercises <p>General physical exercise:</p>	<p>After 1 y:</p> <ul style="list-style-type: none"> • There were no changes in self-reported physical activity. • Both interventions decreased percentage of body fat (mean decrease 2.2%, $P<0.01$) and systolic BP (mean decrease 6.4 mm Hg, $P<0.001$). • There were also small increases ($\approx 10\%$) in muscle

			uptake <ul style="list-style-type: none"> • Heart rate • BMI • Percent body fat • BP 	<ul style="list-style-type: none"> • Allotted 1 h per week during work for intervention activities • Steppers placed at copy machine, punch bags placed in the hall, Nordic walking group sessions, step counters, and 8-min exercise CD • Employees also encouraged to increase physical activity during leisure time Control: <ul style="list-style-type: none"> • Information on health-enhancing activities except for physical activity, with formation of discussion groups • Allotted 1 h per week during work hours for intervention activities 	strength and maximal O ₂ uptake. <ul style="list-style-type: none"> • There were no significant differences in BMI or productivity.
Gilson et al, 2007 ²⁷⁴	RCT	N=64 university employees in the United Kingdom (58 women, 6 men)	<ul style="list-style-type: none"> • Pedometer step counts assessed at 1, 5, and 10 wk • Percentage of body fat • Waist circumference • BP 	Intervention group 1: <ul style="list-style-type: none"> • Designated campus walking routes • At least 15 min of continuous brisk walking every workday • Weekly emails for 10 wk Intervention group 2: <ul style="list-style-type: none"> • Incorporating walking into daily tasks • Accumulation of step counts, “walk and talk” • Weekly emails for 10 wk Control: no treatment	At 10 wk: <ul style="list-style-type: none"> • Steps decreased in control group and increased in both treatment groups, with a net difference of about 1800 steps per day ($P<0.002$). • There were small, nonsignificant changes in other health variables.

Comprehensive Worksite Wellness Programs

Author, y	Design	Population	Outcomes	Intervention/Exposure	Findings
Pelletier 2001, 2005, 2009 ²⁷⁵⁻²⁷⁷	Systematic reviews of RCTs and quasi-experimental studies that evaluated both clinical and cost outcomes	Published studies from the United States, including 15 from 1998-2000, 12 from 2000-2004, and 16 from 2004-	<ul style="list-style-type: none"> • Clinical outcomes • Cost outcomes 	Comprehensive worksite wellness programs, defined as programs that provided ongoing health promotion and disease prevention that integrates specific components into a coherent, ongoing program and is consistent with corporate objectives.	Evidence from 1998-2000 (15 studies): <ul style="list-style-type: none"> • Many methodologic limitations were identified. • Overall data indicate benefits for both clinical and cost outcomes, in particular for facets of programs that identify and provide individualized risk reduction for high-risk employees. Evidence from 2000-2004 (12 studies): <ul style="list-style-type: none"> • Methodologic limitations continue and are perhaps even worse. • In the context of these important limitations, these studies provide additional evidence of benefits for both clinical and cost outcomes.

		2008			Evidence from 2004-2008 (16 studies): <ul style="list-style-type: none"> Nearly all studies were quasi-experimental; only 1 RCT was identified. Overall conclusions are unchanged from prior reviews.
Cahill et al, 2008 ²⁸²	Systematic review of controlled workplace interventions for smoking cessation	51 studies published through 2008	<ul style="list-style-type: none"> Smoking cessation attempts Smoking cessation 	Randomized and quasi-RCTs allocating individuals, workplaces, or companies to intervention or control conditions to promote smoking cessation. Most studies randomized individuals at the workplace (rather than randomizing workplace-level interventions) to various interventions, including group therapy, individual counseling, self-help materials, nicotine replacement therapy, and social support.	Due to heterogeneity in study methods, formal meta-analysis was not performed. Qualitative impressions of the authors were summarized. Among 37 studies of individual-level interventions: <ul style="list-style-type: none"> Group programs, individual counseling, and nicotine replacement therapy each increased cessation rates in comparison with no treatment or minimal intervention controls. Self-help materials were less effective. Among 16 studies of workplace-level interventions: <ul style="list-style-type: none"> Strong evidence was not seen that comprehensive programs reduced prevalence of smoking. Incentive schemes increased cessation attempts, but there was less evidence that they increased the rate of actual quitting.
Calderon et al, 2008 ²⁷⁸	Quasi-experimental (pre- vs postintervention)	N=366 employees, average age 49 y, 75% male	2- and 5-mo changes from baseline in CVD risk factors over 3 y of the program	Kennedy Space Center Cardiovascular Disease Risk Reduction Program: A worksite program to identify employees with high cholesterol from voluntary monthly screening visits and target their CVD risk factors through health education phone counseling. Phone counseling consists of reviewing lab values with participants, discussing dietary fat intake frequency using an intake questionnaire, and promoting increase in exercise frequency.	At 2 mo: <ul style="list-style-type: none"> Decreases in systolic BP ($P=0.03$); diastolic BP ($P=0.002$); total cholesterol, LDL cholesterol, and dietary fat intake ($P<0.001$ each); and increase in exercise frequency ($P=0.04$) At 5 mo: <ul style="list-style-type: none"> Decreases in triglycerides ($P=0.05$) and total cholesterol, LDL cholesterol, and dietary fat intake ($P<0.001$ each)
Chung et al, 2009 ²⁷⁹	Quasi-experimental (pre- vs postintervention)	N=343 Chrysler employees, age >18 y	<ul style="list-style-type: none"> Smoking status Physical activity HDL, LDL, total cholesterol BP Diabetes Overall estimated Framingham risk 	<ul style="list-style-type: none"> Intervention: 18-mo approach to improve CVD risk: <ul style="list-style-type: none"> Employees were stratified into 3 risk categories: low (no CVD), moderate (treated and controlled CVD), or high (newly diagnosed CVD). All received more targeted education/individualized intervention than general employees, including meeting with a nurse, receiving a starter 	Compared with baseline, postintervention: <ul style="list-style-type: none"> Smoking decreased by 14%. 36% of participants lost weight. Mean BMI decreased slightly from 28.4 to 28.2 ($P=0.04$). Mean systolic and diastolic BP decreased by 6.7 mm Hg ($P<0.0001$) and 1.1 mm Hg ($P=0.02$), respectively. Mean total cholesterol/HDL-C ratio was lower ($P=0.02$). Predicted RR of CVD was 12.7% lower ($P=0.01$)

				<p>kit, and focusing on realistic and measurable goals to reduce risk.</p> <ul style="list-style-type: none"> – Moderate-/high-risk employees also received additional progress meetings and small-group educational sessions. • Control: All employees received general education, a CVD risk profile assessment and BMI calculator, general seminars on CVD topics, information in company newsletters, a toll-free number for questions, and physical activity guidelines. 	<ul style="list-style-type: none"> • At baseline, 68.5% were low risk, 21.6% were moderate risk, and 9.9% were high risk. At conclusion, 71.1% were low risk, 21.6% were moderate risk, and 7.3% were high risk, for an overall RR reduction of 12.7% ($P=0.01$). • The proportion of subjects who reported being active for 30-60 min most days of the week increased from 0.5% to 57%. • 86% planned to maintain lifestyle changes. • 95% thought it was important for employers to offer a workplace health promotion program.
Milani and Lavie, 2009 ²⁸⁰	RCT	N=308 employees and N=31 spouses, randomized to active intervention (N=185) vs usual care (N=154)	<ul style="list-style-type: none"> • 6-mo changes in risk factors • Total medical claim costs the year before and the year after intervention • Cost-effectiveness. 	<p>Intervention: 6-mo worksite health intervention using cardiac rehabilitation and exercise training staff, consisting of worksite health education, nutritional counseling, smoking cessation counseling, physical activity promotion, selected physician referral, and other health counseling</p>	<ul style="list-style-type: none"> • Improvements were seen in body fat (-9%; $P=0.001$), HDL-C ($+13\%$; $P=0.0001$), diastolic BP (-2%; $P=0.01$), health habits (-60%; $P=0.0001$), total health risk (-25%; $P=0.0001$), quality of life ($+10\%$; $P=0.001$), and other symptoms (depression -33%, anxiety -32%, somatization -33%, hostility -47%; all $P<0.001$). • Of employees categorized as high risk at baseline, 57% were converted to low-risk status. • Average employee annual claim costs decreased 48% ($P=0.002$) for the 12 mo after the intervention, whereas control employees' costs remained unchanged (-16%; $P=NS$). • Compared with the costs of intervention, the savings represented a 6-fold return on investment.
Racette et al, 2009 ²⁸¹	RCT	N=151 employees age >18 at worksites within a large medical center in St Louis, Missouri	<p>At 6 mo and 1 y:</p> <ul style="list-style-type: none"> • Diet • Fitness • BMI, body composition • BP • Blood lipids • Overall estimated Framingham risk 	<p>Intervention:</p> <ul style="list-style-type: none"> • Personal health report • Transtheoretical Model of Behavior Change • Pedometers, weekly healthy snack cart, on-site Weight Watchers meetings, on-site group exercise program, monthly lunchtime seminars, monthly newsletters, walking maps, team competitions, participation cards, participation rewards • Registered dietitian available weekly <p>Control:</p> <ul style="list-style-type: none"> • Personal health report 	<p>In the intervention group:</p> <ul style="list-style-type: none"> • Increased daily servings of fruits and vegetables from 4.7 at baseline to 7.8 at 6 mo and 7 at 1 y ($P<0.01$); smaller improvements in control (4.3 at baseline, 5.3 at 6 mo, 5.1 at 1 y) • Decreased intake of saturated fat, fatty meats, and fried foods at 6 mo and 1 y ($P<0.001$) • Increased daily physical activity ($P<0.001$) as shown in an increase in walking/moderate activities ($P<0.01$) • Percentage of employees in lowest Framingham risk category increased from 40% to 57% at 1 y ($P<0.01$); no significant change in control. • At 1 y, percentage with metabolic syndrome decreased from 38% to 25% in intervention ($P=0.02$) and 29% to 18% in control ($P=0.07$).

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BP indicates blood pressure; BMI, body mass index; RCT, randomized controlled trial; CI, confidence interval; CVD, cardiovascular disease; HDL, high-density lipoprotein; HDL-C, high-density lipoprotein cholesterol; LDL, low-density lipoprotein; RR, relative risk; and NS, not significant

Note: Reference numbers (eg, Engbers et al, 2005¹²¹) appearing in this supplementary table correspond with those listed in the reference section of the statement. For the purposes of this supplementary table, these meta-analyses or systematic reviews (see "Author, y" column) are considered the primary citation. Additional studies mentioned in the primary citation may be included in the "Intervention/Exposure" and "Findings" columns. The additional studies can be accessed through the primary citation.

Supplementary Table 9. Local Environmental Change to Improve Diet (Community Settings)

Accessibility to Supermarkets, Grocery Stores, and Convenience Stores

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Author, y	Design	Population	Duration	Intervention/Evaluation	Major Findings
Morland et al, 2002 ²⁸⁴	Observational, cross-sectional	N=2392 black and 8231 white participants, age 49-73 y, in the ARIC cohort	1993-95, 1999	This study evaluated the relation between local food environment and intakes of selected foods and nutrients. The food environment was characterized by the number of supermarkets, grocery stores, full-service restaurants, and fast-food restaurants located in the residence census tract of participants (Maryland, North Carolina, Mississippi, and Minnesota), based on data from local health departments and state departments of agriculture in 1999. Dietary intakes were estimated by a semiquantitative FFQ in 1993-1995. Evaluated dietary metrics included daily consumption of ≥ 2 servings of fruits, ≥ 3 servings of vegetables, ≤ 300 mg of cholesterol, $\leq 30\%$ of calories from total fat, and $\leq 10\%$ of calories from saturated fat.	<ul style="list-style-type: none"> • 31% of white but only 8% of black participants lived in a census tract with 1 or more supermarkets. On average, there were 5 times as many supermarkets in census tracts where whites lived. <p>After adjustment for income, education, and other types of food stores and places:</p> <ul style="list-style-type: none"> • The presence of a neighborhood supermarket was associated with meeting dietary metrics for fruits and vegetables (RR=1.54; 95% CI, 1.11, 2.12), total fat (RR=1.22; 95% CI, 1.03, 1.44), and saturated fat (RR=1.30; 95% CI, 1.07, 1.56) among blacks and with meeting the dietary metric for total fat (RR=1.09; 95% CI, 1.01, 1.18) among whites. • Among blacks only, each additional supermarket in the census tract was associated with 0.41 higher daily servings of fruits and vegetables (95% CI, 0.13, 0.76). • See the separate section in this Table (below) for findings related to fast-food and full-service restaurants.
Laraia et al, 2004 ²⁸⁵	Observational, cross-sectional	N=918 women in the PIN study in North Carolina	1995-1999	This study examined the relation between distance to the closest supermarket or convenience store and diet quality index for pregnancy. Data on food stores were obtained from the USDA 2000 inspection registry and geocoded. Data on dietary intakes (percentage of recommended servings of grains, vegetables, and fruits, percentage of RDA of folate and iron, AI of calcium, percentage of calories from fat, and a meal pattern score) were obtained from a validated FFQ and used to construct a diet quality index.	<p>After adjustment for individual factors (age, race, marital status, income, and education) and distance to other food retail outlets:</p> <ul style="list-style-type: none"> • Women living >6.4 km from a supermarket were more likely to fall into the lowest diet quality tertile compared with women living ≤ 3.2 km from a supermarket (OR=2.16; 95% CI, 1.2, 4.0). • Each 1.6 km closer to the nearest convenience store was associated with better diet, ie, lower probability of being in the lowest diet quality tertile (34% at

					3.2 km, 38% at 6.4 km, and 42% at 9.6 km).
Rose et al, 2004 ²⁸⁷	Observational, cross-sectional	N=963, national sample of US participants in the Food Stamp program	1996-1997	This study evaluated the relation between access to food stores and fruit and vegetable consumption. By using self-reported supermarket shopping, travel time, and car ownership, a 3-level supermarket access variable was created, including little access, moderate access, and easy access. Weekly household fruit and vegetable consumption was estimated by 2 at-home interviews.	After adjustment for urbanization, household income and size, race, schooling, single-parent status, and employment status of the respondent: <ul style="list-style-type: none"> Distance to the nearest supermarket was inversely associated with fruit consumption. Those who lived >8 km from the nearest supermarket consumed 62 g less fruit (95% CI, -7, -117), with a nonsignificant trend toward 36 g less vegetables (95% CI, -108, 35) per adult equivalent per day than those living closer to the store. Overall "easy access" to a supermarket was associated with consuming 84 g more fruit (95% CI, 5, 162) and a nonsignificant trend toward 48 g more vegetables (95% CI, -57, 153) per adult equivalent per day, compared with little access.
Sturm et al, 2005 ¹⁷³	Observational, longitudinal	N=6918 participants, age 7 y, in the ECLS-K in 59 metropolitan areas in 37 states	4 y, 1998-2002	This study evaluated the relation between density of grocery stores, convenience stores, fast-food restaurants, and full-service restaurants in a child's neighborhood (home and school ZIP codes) and changes in BMI. Individual-level data were obtained from the cohort. Data on per capita numbers of grocery stores, convenience stores, full-service restaurants, fast-food restaurants, ratio of grocery stores to convenience stores, and ratio of full-service restaurants to fast-food restaurants in the residence ZIP code were obtained from the US Census Bureau 1999 ZIP Code Business Patterns files.	After adjusting for BMI, birth weight, family income, sex, mother's education, and race/ethnicity: <ul style="list-style-type: none"> BMI change over 3 y was not significantly associated with density of grocery or convenience stores. See the separate section in this Table (below) for findings related to fast-food and full-service restaurants.
Inagami et al, 2006 ³⁰⁰	Observational, cross-sectional	N=2144 participants in the Los Angeles Family and Neighborhood Study	2000-2002	This study examined the relation between distance to and characteristics of the grocery store where people shop and BMI. Data on neighborhood and grocery store characteristics, including	After adjustment for age, gender, education, race/ethnicity, employment, marital status, income, and neighborhood socioeconomic characteristics: <ul style="list-style-type: none"> Living ≥ 2.82 km from a grocery store

				percentage living below the poverty line, percentage of households headed by a woman, male unemployment rate, and percentage of families receiving public assistance were obtained from the 2000 US Census and used to create a neighborhood disadvantage score. BMI was calculated from self-reported height and weight.	was associated with higher BMI (+0.78, $P<0.05$). <ul style="list-style-type: none"> BMI was also higher in individuals who chose to shop in grocery stores in more disadvantaged neighborhoods than in their own residential neighborhood ($P<0.01$).
Morland et al, 2006 ²⁹⁰	Observational, cross-sectional	N=10,763 participants, age 49-73 y, in the ARIC cohort living in 207 areas of Mississippi, North Carolina, Maryland, and Minnesota	1993-95, 1999	This study evaluated the relation between the presence of supermarkets, grocery stores, and convenience stores in an individual's residential census tract and prevalence of obesity and other CVD risk factors. Food store data were obtained from local health departments and state departments of agriculture in 1999. BMI was calculated from weight and height measurements collected in 1993.	After adjustment for age, gender, race/ethnicity, income, education, physical activity, and all types of food stores and places simultaneously: <ul style="list-style-type: none"> The presence of supermarkets was associated with a lower prevalence of overweight (OR=0.94; 95% CI, 0.90, 0.98) and obesity (OR=0.83; 95% CI, 0.75, 0.92). No association was found between the presence of grocery stores and overweight (OR=1.03; 95% CI, 1.00, 1.07) or obesity (OR=1.06; 95% CI, 0.99, 1.16). The presence of convenience stores was associated with a higher prevalence of overweight (OR=1.06; 95% CI, 1.02, 1.10) and obesity (OR=1.16; 95% CI, 1.05, 1.27). No significant associations were found between the presence of supermarkets, grocery stores, or convenience stores and prevalence of diabetes, high cholesterol, or hypertension.
Jago et al, 2007 ²⁸⁸	Observational, cross-sectional	N=204 Boy Scouts, age 10-14 y, recruited from 36 troops within the greater Houston, Texas area	2003	This study evaluated the relation between distance to food and restaurant outlets and fruit and vegetable consumption. A buffer with a 1.6-km radius was created around each participant's home, and by using council public health records, distance to the nearest food establishment was calculated. An FFQ was used to assess fruit and vegetable consumption. Vegetables were evaluated in 2 groups,	After adjustment for BMI, age, parental education, and ethnicity: <ul style="list-style-type: none"> No significant associations were seen between distance to supermarkets or warehouse clubs and fruit and vegetable consumption. Living closer to a convenience store was associated with lower consumption of fruit and juice ($P=0.002$), low-fat vegetables ($P=0.006$), and high-fat vegetables ($P=0.001$).

				including “high-fat” vegetables (potatoes, french fries, coleslaw) and other (“low-fat”) vegetables.	<ul style="list-style-type: none"> • See the separate section in this Table (below) for findings related to fast-food and full-service restaurants.
Wang et al, 2007 ²⁹⁴	Observational, multiple cross-sectional	N=5795 participants, age 25-74 y, in the Stanford Heart Disease Prevention Program surveys	1979-1990	This study assessed the relation between various types of food stores and BMI. Data on distance to and density of chain supermarkets, grocery stores, ethnic markets, convenience stores, and fast-food restaurants were obtained from the California State Board of Equalization and telephone business directories for the relevant years. Data on BMI and other individual factors were obtained from 5 cross-sectional surveys conducted between 1979 and 1990.	<p>After adjustment for age, gender, ethnicity, SES, smoking, physical activity, and nutrition knowledge:</p> <ul style="list-style-type: none"> • Among women only, closer proximity to supermarkets and ethnic markets was associated with lower BMI ($P<0.05$ each). No associations were seen in men. • Proximity to grocery stores and convenience stores and density of each of these types of stores were not significantly associated with BMI. • See the separate section in this Table (below) for findings related to fast-food restaurants.
Lopez, 2007 ²⁹¹	Observational, cross-sectional	N=15,358 participants in the Massachusetts BRFSS	1998-2002	This study examined the relation between neighborhood presence of a supermarket and fast-food density and obesity. ZIP code level data were obtained from the 2000 US Census and the 2001 County Business Patterns. BMI was calculated based on self-reported height and weight.	<p>After adjusting for age, sex, race/ethnicity, education, income, smoking status, population density, median income, establishment density, and employment density:</p> <ul style="list-style-type: none"> • The presence of a supermarket was associated with lower risk of obesity (OR=0.89; 95% CI, 0.82, 0.98). • See the separate section in this Table (below) for findings related to fast-food restaurants.
Owens et al, 2007 ²⁹²	Observational, cross-sectional	N=73,079 8th and 10th grade students in the nationwide US Monitoring and Future study	1997-2003	This study examined the relation between per capita availability of chain supermarkets, nonchain supermarkets, convenience stores, and grocery stores and weight status among children. Individual-level data came from the study, and food store data were obtained from Dun and Bradstreet business lists. BMI was calculated from self-reported weight and height.	<p>After adjusting for age, gender, race/ethnicity, grade, parents’ education, neighborhood designation (rural, urban), student income, weekly hours of work by the student, mother’s employment status (part-time or full-time), presence of restaurants and fast-food restaurants, prices of fast food and fruits and vegetables, and neighborhood per capita income:</p> <ul style="list-style-type: none"> • The density of chain supermarkets per 10,000 capita was inversely associated with BMI ($\beta=-0.1093$, $P<0.01$) and overweight ($\beta=-0.0059$, $P<0.05$). • Greater density of convenience stores was associated with higher BMI ($\beta=0.0295$,

					<p>$P < 0.05$) and overweight ($\beta = 0.0015$, $P < 0.05$).</p> <ul style="list-style-type: none"> The association between supermarket availability and weight was larger for black children ($\beta = -0.3187$, $P < 0.01$) vs white ($\beta = -0.0959$, $P < 0.01$) or Hispanic children ($\beta = -0.0898$, $P < 0.1$). No association was found between the availability of nonchain supermarkets and grocery stores and BMI.
Liu et al, 2007 ²⁹³	Observational, cross-sectional	N=7334 children, age 3-18 y, who visited for child-wellness care in 7 urban primary care clinics in Marion County, Indiana	2000	This study evaluated the relation between proximity of home to a supermarket, grocery store, convenience store, and fast-food restaurant and prevalence of overweight (BMI >95th percentile). Data on food establishments and categorization were obtained from hygiene grading conducted by the Marion County Health Department. Data from the 2000 US Census were used to classify participants' residence as high (≥ 695 persons/km ²) or low (<695 persons/km ²) population density.	<p>After adjusting for age, race, gender, and median family income of the neighborhood:</p> <ul style="list-style-type: none"> Greater distance to the nearest supermarket was associated with higher-risk overweight only in children living in lower-population density regions (OR: 1.04; $P = 0.03$). No significant associations were seen between distance to the nearest grocery store or convenience store and prevalence of overweight in either high or low population density neighborhoods. See the separate section in this Table (below) for findings related to fast-food restaurants.
Moore et al, 2008 ²⁸⁶	Observational, cross-sectional	N=2384 adults, age 45-84 y, in the MESA cohort	2004	This study assessed the relation between local food environment and diet quality. Food environment was characterized by density of supermarkets within 1.6 km of home, participants' reports of the availability of healthy foods in the neighborhood, and a measure of the availability of healthy foods created by aggregating the perceptions of non-MESA participants living in the participants' neighborhoods. Supermarket data were obtained from InfoUSA (Papillion, Nebraska). An FFQ was used to develop 2 dietary measures, including the AHEI and the empirically derived FPM diet pattern. A healthy diet was defined as scoring in the top quintile of AHEI or the bottom quintile of FPM.	<p>After adjustment for age, sex, race, and per capita income:</p> <ul style="list-style-type: none"> Living in a neighborhood with no supermarkets within 1.6 km of home compared with living in the neighborhood with >2.2 supermarkets near home was associated with a 25% lower probability of having a healthy diet based on AHEI (RR=0.75; 95% CI, 0.59-0.95) and a 46% lower probability of having a healthy diet based on FPM (RR=0.54; 95% CI, 0.42, 0.70). On the basis of participant or informant reports, living in a neighborhood with the lowest availability of healthy food was associated with 22%-35% lower probability of having a healthy diet by either diet pattern ($P < 0.05$), compared with living in a neighborhood with the

					highest availability of healthy food.
Wang et al, 2008 ²⁸³	Observational, overall cross-sectional trends	N=5779 participants, age 25-74 y, in the Stanford Heart Disease Prevention Program surveys	1981-1990	This study examined the overall trends in number and density of neighborhood food stores, food consumption behavior, and prevalence of overweight. Individual-level data came from participants in 1 of 4 cross-sectional surveys between 1981 and 1990 in 4 mid-sized cities in California. Food store data came from the California State Board of Equalization and telephone business directories for the same years. Diet was assessed by a limited interviewer-administered 24-h recall. Notably, only overall analyses (the whole region combined), rather than neighborhood-level analyses, were performed.	<ul style="list-style-type: none"> • From 1981 to 1990, the total number and density of stores per neighborhood selling sweets, pizza, and fast food each increased ($P < 0.05$ for each). • Overall increases in the number and/or density of stores that sold sweets, doughnut shops, small grocery stores, and convenience stores paralleled overall increases in the percentage of participants reporting consumption of sweets and other prepared foods. • Overall increases in fast-food restaurants did not correspond with an increase in the overall percentage of participants reporting consumption of fried foods, which showed decreases of 32% for women and 20% for men. • The percentage of overweight participants increased 13% in women and 7% in men.
Murakami et al, 2009 ³⁰¹	Observational, cross-sectional	N=990 female students age 18-22 y studying dietetics at 15 institutions in Japan	2006-2007	Neighborhood food-store availability and individual food intake were evaluated in a group of young Japanese women. The number of all food stores serving different types of foods within a 1-km mesh-block of residence was derived from the census of commerce. Dietary intake was estimated using a validated, self-administered diet-history questionnaire.	<p>After adjustment for household SES, geographic variables, and frequency of eating out:</p> <ul style="list-style-type: none"> • Neighborhood store availability (density) for confectioneries and bread was positively associated with intake of confectioneries and bread. • No significant independent association was seen between neighborhood store availability for the other foods examined, including meat, fish, fruits and vegetables, or rice.
Rundle et al, 2009 ²⁹⁶	Observational, cross-sectional	N=13,102 adults living in New York City	2000-2002	Geocoding was used to assess the density of healthy food outlets (supermarkets, fruit and vegetable markets, natural food stores) within 0.8 km of home. BMI was measured.	<p>After adjustment for age, sex, race/ethnicity, education, neighborhood sociodemographic characteristics, and population density:</p> <ul style="list-style-type: none"> • Greater density of healthy food outlets was associated with lower BMI. • Comparing quintile 5 vs 1 (median density 11 vs 0 stores/km²), the adjusted BMI difference was 0.8 kg/m² ($P = 0.003$), the prevalence ratio of overweight was 0.94 (95% CI, 0.88, 1.01), and the prevalence ratio of obesity was 0.87 (0.78, 0.97).

Jilcott et al, 2011 ²⁹⁷	Observational, cross-sectional	3106 counties in all 50 states	2007-2009 market/store data, 2006-2008 BRFSS data	The USDA ERS Food Environment Atlas was used to map per capita farmers' markets, grocery stores/supermarkets, and supercenters in each county. County prevalence of adult obesity was also obtained from the Atlas, based on BRFSS. Results were stratified by whether the county was rural (no cities with >50,000 residents) or metropolitan (all others).	After adjustment for county-level race, age, median income, and natural amenities (topography, climate, water access): <ul style="list-style-type: none"> • Per capita density of grocery stores/supermarkets was inversely associated with obesity, especially in metro counties in which each 24.3/100,000 greater stores was associated with 0.59% lower obesity ($P<0.001$). • Per capita density of supercenters was inversely associated with obesity: per each 1.7/100,000 greater stores, obesity prevalence was 0.08% lower ($P=0.004$). • When all 3 types of outlets were considered together, densities of grocery stores/supermarkets and supercenters but not farmers' markets, were independently associated with lower obesity.
Chen et al, 2010 ²⁹⁵	Simulation study	N=3550 residents in 5 poor neighborhoods of Marion County, Indiana, from the Marion County Health Department Obesity Needs Assessment Survey	2005	This study simulated the effect on BMI of a policy to increase the number of new chain grocery stores in 5 poor neighborhoods. Data on participants' weight, shopping and eating habits, use of trails and recreation areas, and geographic identifiers came from the survey, and data on chain grocers came from the Marion County Health Department's health safety inspection records. The effect on BMI of introducing new chain grocery stores in previously underserved neighborhoods was estimated from a prior non-peer-reviewed analysis by the authors on observed links between grocery stores and BMI.	<ul style="list-style-type: none"> • The addition of 5 new grocery stores in this county would favorably affect the BMI of ≈ 302 residents by changing the number of such stores within 1.6 km of residents' homes. • Persons living closest to the new stores would be affected most. • Among these 302 affected residents, the simulated increase in access to grocery stores was predicted to decrease BMI by 0.43 kg/m^2 ($P<0.05$).
Boone-Heinonen et al, 2011 ²⁸⁹	Observational, longitudinal	N=5115 young US adults, age 18-30, in the CARDIA cohort	1985-1986 to 2000-2001	This prospective study examined the relation of neighborhood fast-food chain, supermarket, and grocery store density (counts per population) with fast-food intake, diet quality, and fruit and vegetable intake, using linked time-varying GIS within 1, 1-3, 3-5, and 5-8 km of home.	After adjustment for individual sociodemographic factors, neighborhood poverty, and sex: <ul style="list-style-type: none"> • Supermarket and grocery store density were generally unrelated to diet quality or fruit and vegetable intake. • See the separate section in this Table (below) for findings related to fast-food

					restaurants.
Leung et al, 2011 ²⁹⁹	Observational, longitudinal	N=353 girls, age 6-7 y, recruited from a health maintenance organization in Northern California	2005-2008	This prospective study examined the relation of neighborhood food stores with 3-y risk of overweight/obesity and change in BMI. Per capita density of food stores was identified from 2006 data from InfoUSA, a commercial database. Stores were classified according to industry codes into 9 separate categories, including convenience stores, drug stores, fast-food outlets, farmers' markets, full-service restaurants, small grocery stores, specialty stores, specific food store venues, and supermarkets. Neighborhoods were assessed at 0.4- and 1.6-km buffers around homes. BMI was measured.	<p>After adjustment for baseline BMI/weight and family sociodemographics:</p> <ul style="list-style-type: none"> • Among the 9 types of stores evaluated within a 0.4-km buffer, availability of convenience stores was associated with higher risk of overweight/obesity (OR=3.38; 95% CI, 1.07, 10.7) and an increase in BMI z score ($\beta=0.13$; 95% CI, 0.00, 0.25). No other significant associations were seen. • Among the 9 types of stores evaluated within a 1.6-km buffer, availability of farmers' markets was inversely associated with overweight/obesity (OR=0.22; 95% CI, 0.05, 1.06) but not with change in BMI z score ($P>0.10$). No other significant relations were seen.

Accessibility to Fast-Food and Full-Service Restaurants

Author, y	Design	Population	Duration	Intervention/Evaluation	Major Findings
Morland et al, 2002 ²⁸⁴	Observational, cross-sectional	N=2392 black and 8231 white participants, age 49-73 y, in the ARIC cohort	1993-1995, 1999	This study evaluated the relation between local food environment and intakes of selected foods and nutrients. Food environment was characterized by the number of supermarkets, grocery stores, full-service restaurants, and fast-food restaurants located in the residence census tract of participants (Maryland, North Carolina, Mississippi, and Minnesota), based on data from local health departments and state departments of agriculture in 1999. Dietary intakes were estimated by semiquantitative FFQ in 1993-1995. Evaluated dietary metrics included daily consumption of ≥ 2 servings of fruits, ≥ 3 servings of vegetables, ≤ 300 mg of cholesterol, $\leq 30\%$ energy from total fat, and $\leq 10\%$ energy from saturated fat.	<ul style="list-style-type: none"> • Fast-food restaurants were evenly dispersed across neighborhoods. • No significant associations were seen between the presence of fast-food or full-service restaurants and these dietary metrics in either blacks or whites. • See the separate section in this Table (above) for findings related to supermarkets and grocery stores.
Burdette et al, 2004 ³⁰³	Observational, cross-sectional	N=7020 low-income preschool children,	2001	This study evaluated the relation between proximity of residence to fast-	<ul style="list-style-type: none"> • The distance (mean\pmSD) to the nearest fast-food restaurant was similar in

		age 3-6 y, enrolled in the WIC program in Cincinnati, Ohio		food restaurants and prevalence of overweight (BMI \geq 95th percentile). Height and weight were measured at the most recent WIC visit. Fast-food restaurant locations were obtained from US Yellow Page listings. ArcView was used to geocode residence and fast-food restaurants.	overweight (1.12 \pm 0.64 km) vs nonoverweight (1.10 \pm 0.61 km) children ($P=0.91$). <ul style="list-style-type: none"> 56.0% of overweight children lived in a neighborhood with a fast-food restaurant, whereas 55.5% of nonoverweight children lived in a neighborhood with a fast-food restaurant ($P=0.84$).
Simmons et al, 2005 ³⁰⁴	Observational, cross-sectional	N=1454 residents of randomly selected households in Australia	2001-2003	This study examined the relation between availability of take-out and fast-food restaurants and obesity. Restaurants were mapped through direct observation and use of the local telephone directory. The per capita density of local take-out and dine-in fast-food restaurants (number per 1000 population) was calculated using the 2001 census population in each town. BMI was calculated from measured height and weight. The food environment was assessed separately for regional centers, large rural towns, and small rural towns.	<ul style="list-style-type: none"> No significant associations were found between the density of take-out and dine-in fast-food restaurants and prevalence of obesity.
Jeffery et al, 2006 ³⁰⁵	Observational, cross-sectional	N=1033 Minnesota residents from a random digit-dial telephone survey	Not provided	This study evaluated the relation between living or working near various types of restaurants and BMI. GIS methodology was used to calculate the total number of restaurants and the number of fast-food restaurants within 0.8, 1.6, and 3.2 km of home and work. BMI was determined by self-reported height and weight.	After adjustment for age and education: <ul style="list-style-type: none"> A significant inverse relation was observed between the number of fast-food, non-fast-food, and total restaurants within 3.2 km of work and BMI in men (fast food: $\beta\beta=-0.029$, $P=0.008$; non-fast food: $\beta\beta=-0.022$, $P=0.01$; total: $\beta\beta=-0.005$, $P=0.01$) but not women. No significant relations were seen between the number of restaurants near home and BMI in men or women.
Jago et al, 2007 ²⁸⁸	Observational, cross-sectional	N=204 Boy Scouts, age 10-14 y, recruited from 36 troops within the greater Houston, Texas area	2003	This study evaluated the relation between distance to food and restaurant outlets and fruit and vegetable consumption. A buffer with a 1.6-km radius was created around each participant's home, and council public health records were used to calculate distance to the nearest food establishment. An FFQ was used to assess consumption of	After adjustment for BMI, age, parental education, and ethnicity: <ul style="list-style-type: none"> Living closer to a fast-food restaurant was associated with higher consumption of high-fat vegetables ($P=0.003$) and fruit and juice ($P=0.006$). No significant associations were seen between distance to cafeterias or full-service restaurants and fruit and vegetable consumption.

				fruits, juice, and vegetables. Vegetables were evaluated in 2 groups, including “higher-fat” vegetables (potatoes, french fries, and coleslaw) and other (“lower-fat”) vegetables.	<ul style="list-style-type: none"> • See the separate section in this Table (above) for findings related to supermarkets and convenience stores. 	
Downloaded from http://circ.ahajournals.org/ at Universite de Lausanne - CDU on September 18, 2012	Wang et al, 2007 ²⁹⁴	Observational, multiple cross-sectional	N=5795 participants, age 25-74 y, in the Stanford Heart Disease Prevention Program surveys	1979-1990	This study assessed the relation between various types of food stores and BMI. Data on distance to and density of chain supermarkets, grocery stores, ethnic markets, convenience stores, and fast-food restaurants were obtained from the California State Board of Equalization and telephone business directories for the relevant years. Data on BMI and other individual factors were obtained from 5 cross-sectional surveys conducted between 1979 and 1990.	<p>After adjustment for age, gender, ethnicity, SES, smoking, physical activity, and nutrition knowledge:</p> <ul style="list-style-type: none"> • Proximity to and density of fast-food restaurants were not significantly associated with BMI. • See the separate section in this Table (above) for findings related to supermarkets, ethnic markets, grocery stores, and convenience stores.
	Lopez, 2007 ²⁹¹	Observational, cross-sectional	N=15,358 participants in the Massachusetts BRFSS	1998-2002	This study examined the relation between fast-food density (stores per square kilometer) and presence of a supermarket in the neighborhood and obesity. ZIP code level data were obtained from the 2000 US Census and the 2001 County Business Patterns. BMI was calculated based on self-reported height and weight.	<p>After adjusting for age, sex, race/ethnicity, education, income, smoking status, population density, median income, establishment density, and employment density:</p> <ul style="list-style-type: none"> • Fast-food density was not associated with obesity (OR=1.00; 95% CI, 0.92, 1.01). • See the separate section in this Table (above) for findings related to supermarkets.
	Liu et al, 2007 ²⁹³	Observational, cross-sectional	N=7334 children, age 3-18 y, visited for child-wellness care in 7 urban primary care clinics in Marion County, Indiana	2000	This study evaluated the relation between proximity of home to a supermarket, grocery store, convenience store, and fast-food restaurant and prevalence of overweight (BMI >95th percentile). Data on food establishments and categorization were obtained from hygiene grading conducted by the Marion County Health Dept. The 2000 US Census data were used to classify participants' residences as high population density (≥ 695 persons/km ²), or low population density (<695 persons/km ²).	<p>After adjusting for age, race, gender, and median family income of the neighborhood:</p> <ul style="list-style-type: none"> • No significant associations were seen between distance to the nearest fast-food restaurant and prevalence of overweight in either high or low population density neighborhoods. • See the separate section in this Table (above) for findings related to supermarkets, grocery stores, and convenience stores.
	Mehta and Chang,	Observational, cross-sectional	N=714,054 US adults in the BRFSS,	2006-2007	This study examined the relation between restaurant environment and	After adjustment for age, age-squared, gender, race/ethnicity, education, smoking status,

<p>2008³⁰⁶</p>		<p>a nationally representative sample of the noninstitutionalized adult population age 18+ y</p>		<p>BMI across counties in the United States. Restaurant environment was measured by per capita fast-food and full-service restaurant density (number per 10,000 individuals) and ratio of fast-food to full-service restaurants. Individual data came from the 2002-2006 BRFSS. Restaurant data came from the 2002 US Economic Census.</p>	<p>household income, and county-level variables (population size, median household income, percentage of adults with a high school diploma):</p> <ul style="list-style-type: none"> • Higher BMI was seen with higher fast-food restaurant density ($\beta=0.09$; 95% CI, 0.02-0.16; $P<0.05$) and a higher ratio of fast-food to full-service restaurants ($\beta=0.20$; 95% CI, 0.12-0.27; $P<0.001$). • Lower BMI was seen with higher density of total restaurants ($\beta=-0.22$; 95% CI, -0.30-0.14; $P<0.001$) and full-service restaurants ($\beta=-0.32$; 95% CI, -0.40-0.24; $P<0.001$). • Higher risk of being obese was associated with density of fast-food restaurants (OR=1.05; 95% CI, 1.02-1.08) and a higher ratio of fast-food to full-service restaurants (OR=1.08; 95% CI, 1.05-1.1) were associated with. • Lower risk of being obese was associated with higher density of total restaurants (OR=0.94; 95% CI, 0.91-0.96) and full-service restaurants (OR=0.89; 95% CI, 0.87-0.92).
<p>Spence et al, 2009³⁰⁸</p>	<p>Observational, cross-sectional</p>	<p>N=2900 participants, age 18+ y, in Edmonton, Canada, in the Population Health Survey</p>	<p>2002</p>	<p>This study examined the relation between relative availability of and distance to different types of neighborhood food retail stores and obesity. Data on food outlets came from the Health Inspection division of Capital Health and the Alberta First Business Directory. An RFEI was calculated based on the ratio of the number of fast-food restaurants plus convenience stores divided by the number of grocery stores. Buffers of 800 m and 1600 m were evaluated around participants' postal codes. BMI was calculated from self-reported height and weight.</p>	<p>After adjustment for age, sex, education, and neighborhood SES index:</p> <ul style="list-style-type: none"> • RFEI within 800 m of home was associated with obesity: residents of areas with the lowest RFEI (<3.0) had a lower prevalence of obesity than residents in areas with the highest RFEI (5.0+) (OR=0.75; 95% CI, 0.59, 0.94).
<p>Li et al, 2009³⁰⁹</p>	<p>Observational, cross-sectional</p>	<p>N=1221 adults, age 50-75 y, in a regionally</p>	<p>2006-2007</p>	<p>This study examined the relation between fast-food restaurant density and individual-level behaviors and</p>	<p>After adjustment for age, gender, education, household income, employment status, home ownership, alcohol and tobacco use, fruit and</p>

		representative sample of 120 neighborhoods in Portland, Oregon		obesity. BMI, eating-out behavior, eating self-efficacy, fried food consumption, fruit and vegetable intake, physical activity, and sociodemographic characteristics were assessed at in-person interviews. Fast-food restaurant data came from commercial business data at InfoUSA.	vegetable intake, fried food consumption, and neighborhood characteristics (land-use mix, residential density, median household income, percentage of non-Hispanic black residents, percentage of Hispanic residents): <ul style="list-style-type: none"> Residents of high-density fast-food restaurant neighborhoods who also regularly visited fast-food or buffet restaurants (1-2 times per week) were more likely to be obese than those living in low-density fast-food restaurant neighborhoods (OR=1.9; 95% CI, 1.01-3.5, $P<0.05$). Compared with low-density fast-food restaurant neighborhoods, residents of high-density fast-food restaurant neighborhoods were more likely to report low self-efficacy in eating healthy food (OR=1.21; 95% CI, 1.06, 1.39, $P<0.005$) and to not meet recommended levels of physical activity (OR=1.79; 95% CI, 1.01, 3.19, $P<0.05$).
Currie et al, 2009 ³⁰⁷	Observational, cross-sectional	3.06 million 9th grade children in California public schools; and pregnant women in Michigan, New Jersey, and Texas	Children Study: 1999 and 2001-2007 Pregnant Woman Study: 1989-2003	This study evaluated the relation between fast-food restaurants and obesity among 9th grade children and pregnant women. Data on children came from the California public schools; data on schools (percentage black, white, Hispanic, and Asian; percentage immigrant; pupil/teacher ratios; fraction eligible for free lunch, etc) came from the National Center for Education Statistics Common Core of Data. Data on census block of the school (median earnings, percentage with a high-school degree, percentage unemployed, percentage urban) came from the 2000 US Census. Data on pregnant women came from Vital Statistics birth data in 3 states, with restaurant data from the NETS Database. Availability of fast-food or other restaurants was assessed within 0.16, 0.4, and 0.8 km of either the school or the mother's residence.	After adjusting for school-level variables, census block variables, and year effects: <ul style="list-style-type: none"> Among 9th grade children, the presence of a fast-food restaurant within 0.16 km of a school was associated with a 5.2% higher risk of obesity. Among pregnant women, the density of fast-food restaurants within a 0.8-km radius of home was associated with a 2.5% higher probability of gaining >20 kg during pregnancy.

Davis et al, 2009 ³¹²	Observational, cross-sectional	N=529,367 middle school and high school students in the California Healthy Kids Survey	2002-2005	This study evaluated the relation between proximity of fast-food restaurants to schools and obesity among middle school and high school students in California. Individual-level data came from the survey, school data came from the California Department of Education, and data on fast-food restaurants came from Microsoft Streets and Trips, with restaurant brands classified as “top limited-service restaurants” by Technomic Inc.	After adjustment for student-level characteristics (age, gender, grade, race/ethnicity, physical activity), school-level characteristics (school type, percentage of students eligible for free or reduced-price meals, school enrollment, indicators for school location types), county indicators, and survey wave: <ul style="list-style-type: none"> Students with a fast-food restaurant within 0.8 km of their school were more likely to be overweight (OR=1.06; 95% CI, 1.02, 1.10, $P<0.01$) and obese (OR=1.07; 95% CI, 1.02, 1.12, $P<0.01$). After further adjustment for the presence of nearby gas stations, motels, and grocery stores, attending a school within 0.8 km of a fast-food restaurant was associated with a 0.13-unit increase in BMI (95% CI, 0.05, 0.20, $P<0.01$).
Richardson et al, 2011 ³⁰²	Observational, cross-sectional	N=13,150 young US adults, age 18-28 y, in the nationally representative National Longitudinal Study of Adolescent Health	2001-2002	This study evaluated the relation of neighborhood fast-food availability and frequency of self-reported fast-food consumption.	After adjustment for individual and neighborhood characteristics: <ul style="list-style-type: none"> No significant association was seen in rural, low-density urban, or high-density urban areas.
Sturm et al, 2005 ¹⁷³	Observational, longitudinal	N=6918 participants, age 7 y, in the ECLS-K in 59 metropolitan areas in 37 states	4 y, 1998-2002	This study evaluated the relation between density of grocery stores, convenience stores, fast-food restaurants, and full-service restaurants in a child’s neighborhood (home and school ZIP codes) and changes in BMI. Individual-level data were obtained from the cohort. Data on per capita numbers of grocery stores, convenience stores, full-service restaurants, fast-food restaurants, ratio of grocery stores to convenience stores, and ratio of full-service restaurants to fast-food restaurants in the residence ZIP code were obtained from the US Census Bureau's 1999 ZIP Code Business Patterns files.	After adjusting for BMI, birth weight, family income, sex, mother's education, and race/ethnicity: <ul style="list-style-type: none"> The per capita number of fast-food restaurants was associated with a nonsignificant trend toward faster BMI gain ($P<0.10$). BMI change over 3 y was not significantly associated with density of full-service restaurants. See the separate section in this Table (above) for findings related to grocery stores and convenience stores.

Li et al, 2009 ³¹⁰	Observational, longitudinal	N=1145 adults, age 50-75 y, in a regionally representative sample of 120 neighborhoods in Portland, Oregon	2006-2007 to 2007-2008 (1 y)	This prospective study examined the relation of fast-food restaurant density and individual-level behaviors with obesity, including weight and waist circumference. Data on fast-food restaurants came from InfoUSA. Covariates included neighborhood characteristics (residential density, median household income, percentage of non-Hispanic black residents, percentage of Hispanic residents) and individual characteristics (age, gender, education, household income, race/ethnicity, tobacco use, employment status, health status, baseline values of BMI, weight, and waist circumference). Anthropometrics were objectively measured at baseline and follow-up.	After adjustment for neighborhood and individual characteristics: <ul style="list-style-type: none"> Residents of high-density fast-food neighborhoods who made weekly visits to fast-food restaurants experienced more increase in weight (+1.40 kg, $P<0.05$) and waist circumference (2.06 cm, $P<0.05$) over time, compared with residents of low-density fast-food neighborhoods or those who did not make weekly visits to fast-food restaurants.
Boone-Heinonen et al, 2011 ²⁸⁹	Observational, longitudinal	N=5115 young US adults, age 18-30, in the CARDIA cohort	1985-1986 to 2000-2001	This prospective study examined the relation of neighborhood fast-food chain, supermarket, and grocery store density (counts per population) with fast-food intake, diet quality, and fruit and vegetable intake, using linked time-varying GIS within 1, 1-3, 3-5, and 5-8 km of home.	After adjustment for individual sociodemographic factors, neighborhood poverty, and sex: <ul style="list-style-type: none"> Fast-food store density was associated with fast-food consumption among low-income respondents, especially at 1-3 km among men. See the separate section in this Table (above) for findings related to supermarkets and grocery stores.
Leung et al, 2011 ²⁹⁹	Observational, longitudinal	N=353 girls, age 6-7 y, recruited from a health maintenance organization in Northern California	2005-2008	This prospective study examined the relation of neighborhood food stores with 3-y risk of overweight/obesity and change in BMI. Per capita density of food stores was identified from data from 2006 InfoUSA, a commercial database. Stores were classified according to industry codes into 9 separate categories, including convenience stores, drug stores, fast-food outlets, farmers' markets, full-service restaurants, small grocery stores, specialty stores, specific food store venues, and supermarkets. Neighborhoods were assessed at 0.4- and 1.6-km buffers around homes. BMI was measured.	After adjustment for baseline BMI/weight and family sociodemographics: <ul style="list-style-type: none"> Within both a 0.4- and 1.6-km buffer, neither fast-food outlets nor full-service restaurants were associated with 3-y risk of overweight/obesity or change in BMI z score. See the separate sections in this Table for findings related to supermarkets and grocery stores (above) and farmers' markets (below).

Alter and Eny, 2005 ³¹¹	Observational, cross-sectional	380 geographical regions (Forward Sortation Area) in Ontario, Canada	2001	This study examined the relation between interregional differences in fast-food concentrations and variations in all-cause mortality and acute coronary syndromes. Electronic public access files from 2001 were used to identify 1630 fast-food restaurants from 9 leading fast-food chains in 380 regions throughout Ontario. Per capita density of fast-food restaurants per region was calculated. Regional per capita total mortality and acute coronary syndrome hospitalization rates were obtained using 2001 vital statistics data and hospital discharge data.	After adjustment for age, gender, and SES: <ul style="list-style-type: none"> Total mortality and admission for acute coronary syndromes were higher in regions with greater concentrations of fast-food restaurants. Each additional fast-food restaurant per 100,000 people was associated with 1 additional death per 100,000 ($P<0.001$). These relationships were similar in both high- and low-income communities.
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Accessibility to Farmers' Markets

Reference	Design	Population	Duration	Intervention/Evaluation	Major Findings
McCormack et al, 2010 ³¹⁹	Systematic review of peer-reviewed US studies of farmers' markets or community gardens	12 US studies evaluating farmers' markets and various diet-related outcomes, including fruit and vegetable intake (most studies) or other foods/drinks (1 study). No identified studies evaluated adiposity.	Studies published between January 1980 and January 2009	<ul style="list-style-type: none"> 7 studies were on the FMNP for women enrolled in WIC, including 4 cross-sectional observational studies and 3 quasi-experimental studies (pre-/postintervention, nonrandomized, with control group). 5 studies were on farmers' market programs for seniors, some funded by the USDA SFMNP, including 3 cross-sectional observational studies and 2 quasi-experimental studies (pre-/postintervention). 	<p>FMNP cross-sectional:</p> <ul style="list-style-type: none"> The National Association of FMNP found that among WIC participants from 30 WIC program centers enrolled in FMNP (N=24,800), 73% reported eating more fresh produce because of the farmers' market vouchers. Kropf et al found that WIC participants enrolled in FMNP (who received \$18 per recipient per season in farmers' market coupons) reported eating slightly more vegetables (2.2 vs 1.9 servings per day, $P=0.04$), but not fruit ($P=0.77$) than WIC participants not enrolled in FMNP (N=1075). Similarly, Galfond et al found that WIC participants who received farmers' market coupons reported higher average fruit and vegetable intake than those who didn't receive coupons (N=2725). A 4th study evaluated only perceived food security. <p>FMNP quasi-experimental:</p> <ul style="list-style-type: none"> 2 of 3 studies (N=455, N=216, N=603) showed increased fruit and vegetable

					<p>consumption among WIC participants who were given farmers' market coupons, compared with controls. One successful intervention provided \$20 once and the other \$10 per week for 6 mo. The intervention showing no effect provided \$10 once.</p> <p>Senior farmers' market cross-sectional:</p> <ul style="list-style-type: none"> • 3 small cross-sectional surveys (N=658, N≈300, N=124) found that program participants reported greater intention to eat more fruits and vegetables or attendance at farmers' markets because of the program (coupons ranging from \$5 to \$50 once). No controls. <p>Senior farmers' market quasi-experimental:</p> <ul style="list-style-type: none"> • Both studies evaluated provision of free market baskets to homes, which does not test neighborhood availability of farmers' markets. <p>4 additional studies on community gardens were identified, as summarized in the next section of this Table, below.</p>
Racine et al, 2010 ³²⁰	Observational, cross-sectional	N=179 black women who were pregnant and enrolling in WIC in Washington, DC (N=71), which offers the FMNP, or Charlotte, NC (N=108), which does not	May–June 2007	Women were surveyed about past participation and dietary habits.	Adjusting for city of residence, women who reported prior participation in the FMNP reported higher intake of fruits and vegetables ($P<0.01$).
Freedman et al, 2011 ³²¹	Quasi-experimental (pre-/postintervention)	N=221 adults or children participating in a local farmers' market initiative who completed at least 1 survey	June–August 2008	34 farmers' markets (average 2 h per week) were held at 4 Boys and Girls Clubs over 1 summer. Educational programs were held at the clubs, youth were directly involved in setting up and running each farmers' market, and food-related field trips were taken. Vouchers (up to \$20) were provided to community members for use at the markets. Effects on attitudes were assessed by surveys.	<ul style="list-style-type: none"> • Participants reported positive attitudes about the farmers' markets as both a learning opportunity and exposure to fresh foods for children.

Jilcott et al, 2010 ²⁹⁷	Observational, cross-sectional	3106 counties in all 50 states	2007-2009 market/store data, 2006-2008 BRFSS data	The USDA Food Environment Atlas was used to map per capita farmers' markets, grocery stores/supermarkets, and supercenters in each county. County prevalence of adult obesity was also obtained from the Atlas, based on BRFSS. Results were stratified by whether the county was rural (no cities with >50,000 residents) or metropolitan (all others).	After adjustment for county-level race, age, median income, and natural amenities (topography, climate, water access): <ul style="list-style-type: none"> No significant associations were seen for farmers' markets overall. In rural counties, per capita density of farmers' markets was inversely associated with obesity: per each 7/100,000 greater farmers' markets, obesity prevalence was 0.07% lower ($P=0.049$). When all 3 types of outlets were considered together, densities of stores/supermarkets and supercenters, but not farmers' markets, were independently associated with lower obesity. Findings for grocery stores/supermarkets and supercenters are described above in this same Table, in the section on supermarkets, grocery stores, and convenience stores.
Salois, 2011 ²⁹⁸	Observational, cross-sectional	Ecological (county-level) analysis including 3051 counties in all 50 states	2007	The USDA Food Environment Atlas was used to map per capita density of farmers' markets, grocery stores, supermarkets, supercenters, fast-food outlets, and full-service restaurants in each county. County prevalences of adult obesity and diabetes were also obtained from the Atlas, based on BRFSS.	After adjustment for county-level race, median income, poverty, recreational and fitness centers, natural amenities, travel distance/challenges, direct farm sales per capita, and each of the different food outlets: <ul style="list-style-type: none"> Per capita density of farmers' markets was inversely associated with prevalent diabetes but was not significantly associated with prevalent obesity. Densities of fast-food outlets and convenience stores were each associated with higher diabetes, but not obesity. Density of full-service restaurants was associated with lower obesity and diabetes. Density of superstores was associated with more obesity but not diabetes.
Leung et al, 2011 ²⁹⁹	Observational, longitudinal	N=353 girls, age 6-7 y, recruited from a health maintenance organization in Northern California	2005-2008	This prospective study examined the relation of neighborhood food stores with 3-y risk of overweight/obesity and change in BMI. Per capita density of food stores was identified from 2006 data from InfoUSA, a commercial database. Stores were classified	After adjustment for baseline BMI/weight and family sociodemographics: <ul style="list-style-type: none"> Within a 0.4-km buffer, availability of farmers' markets was not associated with risk of overweight/obesity or change in BMI z score. Within a 1.6-km buffer, availability of

				according to industry codes into 9 separate categories, including convenience stores, drug stores, fast-food outlets, farmers' markets, full-service restaurants, small grocery stores, specialty stores, specific food store venues, and supermarkets. Neighborhoods were assessed at 0.4 and 1.6-km buffers around homes. BMI was measured.	farmers' markets was inversely associated with overweight/obesity (OR=0.22; 95% CI, 0.05, 1.06) but not with change in BMI z score ($P>0.10$). <ul style="list-style-type: none"> Convenience stores within 0.4 km were associated with a higher risk of overweight/obesity and increase in BMI z score (see that separate section in this Table above). No other significant relations were seen.
Accessibility to Community Gardens					
Author, y	Design	Population	Duration	Intervention/Evaluation	Major Findings
McCormack et al, 2010 ³¹⁹	Systematic review of peer-reviewed US studies	4 US studies evaluating community gardens and various diet-related outcomes, including fruit and vegetable intake (most studies) and other foods/drinks (1 study)	Studies published between January 1980 and January 2009	Four observational studies were identified, and 3 of these are described below. The 4th study, by Blair et al, compared 144 gardeners with 67 nongardeners in Pennsylvania.	<ul style="list-style-type: none"> Blair et al found that gardeners reported eating more vegetables than nongardeners.
Alaimo et al, 2008 ³²²	Observational, cross-sectional	N=766 adult residents of Flint, Michigan, identified by random phone survey	2003	This study examined the relation between household participation in a community garden and fruit and vegetable consumption. Fruit and vegetable intake was measured using the BRFSS questionnaire, and household participation in a community garden was assessed by direct query from the respondent.	After adjustment for demographics, neighborhood participation, and health characteristics: <ul style="list-style-type: none"> Adults with a household member who participated in a community garden ate fruits and vegetables 1.4 more times per day than those who did not participate, and they were 3.5 times more likely to eat fruits and vegetables at least 5 times daily.
Lackey et al, 1998 ³²³	Observational, cross-sectional	N=123 gardeners and 123 community controls from a community garden sponsored by the University of Wisconsin Cooperative Extension	1997	This study evaluated a university program that included rental gardens, youth gardens, and gardens designed for food pantry clientele. The evaluation sample included at least 1 typical garden from each category with a minimum of 15 easily accessible clients. Qualitative data were collected (document reviews, participant	<ul style="list-style-type: none"> Gardeners reported eating a greater variety of vegetables and more vegetable servings compared with nongardeners. Gardeners were also more likely than nongardeners to agree with the statement, "In the past 4 mo, I have eaten a balanced diet most days from the food pyramid (which includes breads/cereals, fruit/vegetables, meat/fish/beans, and

				observations at gardens, interviews with program stakeholders). Posttest surveys were administered to 123 gardeners (79% were at least 18 y of age), and 123 matched nongardeners sampled based on individual gardener characteristics, geographic area, and garden type. Participants self-reported vegetable servings eaten in the previous 24 h.	dairy products).”
Johnson and Smith, 2006 ³²⁴	Quasi experimental	N=61 community garden participants in Moses Lake, Washington	2003-2004	This study evaluated a pilot program that aimed to create and support a healthy environment through development of a community garden, as well as walking trails and community breastfeeding facilities. Evaluation surveys were given to community garden participants. Survey details and data collection methods were not described in detail.	<ul style="list-style-type: none"> • More than half of gardeners reported eating more fruits and vegetables while participating in the garden.

In-Store Availability of Different Foods

Author, y	Design	Population	Duration	Intervention/Evaluation	Major Findings
Cheadle et al, 1993 ³¹³	Observational, serial cross-sectional	N≈6000 residents of 11 communities in California and 1 community in Hawaii	2 cross-sectional surveys in 1988 and 1990	In-store surveys were conducted to measure the percentage of shelf space devoted to red meat, low-fat milk products, and dark breads. Dietary intakes were assessed by telephone interview FFQ of ≈500 residents in each community living in the same catchment area as these stores.	In crude (unadjusted) analyses: <ul style="list-style-type: none"> • Cross-sectionally, positive correlations were found between individuals' consumption (days per week) and percentage of shelf space devoted to red meat ($r=0.59$, $P=0.04$), reduced-fat milk ($r=0.64$, $P=0.03$), and dark bread ($r=0.52$, $P=0.08$). • No significant correlations were found between changes in shelf space and changes in dietary intake over time between 1988 and 1990.
Fisher et al, 1999 ³¹⁴	Observational, cross-sectional	N=503 randomly selected stores of 53 ZIP codes and 250 randomly selected residents of 19 of these ZIP codes in 7 New York counties, representing large	1994-1996	This study examined the relation between the proportion of low-fat (skim or 1%) milk in food stores and the presence of low-fat milk at home. Surveys were conducted in randomly selected stores from the same areas as the residents to assess the proportion of all milk on shelves	In crude (unadjusted) analyses: <ul style="list-style-type: none"> • The proportion of low-fat milk in stores was directly related to the presence of low-fat milk in households (slope=0.81; 95% CI, 0.58, 1.07).

		metropolitan, mid-size urban, and rural areas		that was low-fat. Phone interviews assessed the type of milk present or usually present in the home refrigerator.	
Edmonds et al, 2001 ³¹⁵	Observational, cross-sectional	N=172 black Boy Scouts, age 11-14 y, in Houston, Texas	Not reported	This study evaluated the relation between the boys' consumption of fruits, vegetables, and juice and local (census tract) availability in grocery stores (absolute amount of shelf space), restaurants (on the menu), and their own homes.	<ul style="list-style-type: none"> In analyses adjusting only for census tract black median income, restaurant availability of vegetables and fruit juices was significantly associated with intake of these foods (partial correlations=0.72 and 0.70, respectively, $P<0.05$ each). In both crude (unadjusted) analyses and full multivariable analyses, none of the environmental predictors were significantly associated with intake of any of these foods.
Bodor et al, 2008 ³¹⁶	Observational, cross-sectional	N=102 randomly selected households in 4 contiguous census tracts in central New Orleans, Louisiana	2001	This study examined the relation of distance to and linear shelf space in neighborhood supermarkets and fruit and vegetable consumption. Telephone interviews and a modified 24-h recall instrument were used to assess fruit and vegetable consumption.	<p>After adjustment for age, gender, race/ethnicity, income, food assistance participation, car ownership, and distance to the nearest supermarket, associations were only seen for supermarkets very close (within 100 m) to home:</p> <ul style="list-style-type: none"> When fresh vegetable shelf space was >3 m, mean vegetable intake was 4.5 ± 2.4 servings per day, compared with 2.4 ± 1.6 when there was no fresh vegetable shelf space ($P<0.05$). No significant relation was found between shelf space and fruit intake.
Auchincloss et al, 2008 ³¹⁷	Observational, cross-sectional	For person-level data, N=2026 adults, age 45-84 y, in the MESA cohort; for area-level data, N=5988 adults living in the same geographic regions in the Community Survey	2004	This study evaluated the relation of neighborhood resources with insulin resistance (homeostasis model assessment index). Data on person-level factors were obtained from clinic examination. Measures of area resources were obtained from a separate, population-based, random-digit-dialing telephone survey. Healthy food resources were derived from self-reported responses to 3 questions (eg, "A large selection of fresh fruits and vegetables is available in my neighborhood"; "A large selection of low-fat foods is	<p>After adjustment for age, sex, family history of diabetes, income, and education:</p> <ul style="list-style-type: none"> Greater healthy food resources were inversely related to insulin resistance, with 15% lower insulin resistance across the interdecile range (90th vs 10th percentile). The association was no longer statistically significant after adjustment for race/ethnicity. Findings for neighborhood physical activity resources are described in Supplementary Table 11. Greater physical activity resources were inversely related to insulin resistance, with 23% lower insulin

				available in my neighborhood”); and physical activity resources from 6 questions (eg, “My neighborhood offers many opportunities to be physically active”; “It is pleasant to walk in my neighborhood”).	resistance across the interdecile range (90th vs 10th percentile). The association remained significant after adjustment for race/ethnicity.
Rose et al, 2009 ³¹⁸	Observational, cross-sectional	N=1243 residents of the 28-county area of southeastern Louisiana	2004-2005	This study assessed shelf space for fruits and vegetables and energy-dense snack foods (candies, pastries, cookies, sodas, and salty snacks) in a random sample of 103 urban census tracts in a 28-county area. The neighborhood food environment was evaluated at 500 m, 1 km, and 2 km, from respondents’ homes. Random-digit-dialed phone interviews assessed self-reported height and weight and other sociodemographic variables.	After adjustment for age, gender, race/ethnicity, income, education, and car ownership: <ul style="list-style-type: none"> • Neighborhood shelf space for fruits and vegetables was not associated with BMI. • Neighborhood shelf space for energy-dense snack foods, particularly within 1 km of home, was positively associated with BMI. Each 10-m increase in shelf space was associated with 0.01 higher BMI ($P<0.05$).

ARIC indicates Atherosclerosis Risk in Communities; FFQ, food-frequency questionnaire; RR, relative risk; CI, confidence interval; PIN, Pregnancy, Infection and Nutrition study; USDA, US Department of Agriculture; RDA, recommended daily allowance; AI, adequate intake; OR, odds ratio; ECLS-K, Early Childhood Longitudinal Study—Kindergarten Class; BMI, body mass index; CVD, cardiovascular disease; SES, socioeconomic status; BRFSS, Behavioral Risk Factor Surveillance System; MESA, Multi-Ethnic Study of Atherosclerosis; AHEI, Alternate Healthy Eating Index; FPM, fats and processed meats; ERS, Economic Research Service; CARDIA, Coronary Artery Risk Development in Young Adults; GIS, geographical information systems; WIC, Women, Infants, and Children Program; SD, standard deviation; RFEI, Retail Food Environment Index; NETS, National Establishment Time-Series; FMNP, Farmers Market Nutrition Program; and SFMNP, Senior Farmers Market Nutrition Program.

Note: Reference numbers (eg, Morland et al, 2002²⁷⁸) appearing in this supplementary table correspond with those listed in the reference section of the statement. For the purposes of this supplementary table, these meta-analyses or systematic reviews (see "Author, y" column) are considered the primary citation. Additional studies mentioned in the primary citation may be included in the "Intervention/Exposure" and "Findings" columns. The additional studies can be accessed through the primary citation.