The Effectiveness of Interventions to Increase Physical Activity

A Systematic Review

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Overview: The *Guide to Community Preventive Service*'s methods for systematic reviews were used to evaluate the effectiveness of various approaches to increasing physical activity: informational, behavioral and social, and environmental and policy approaches. Changes in physical activity behavior and aerobic capacity were used to assess effectiveness. Two informational interventions ("point-of-decision" prompts to encourage stair use and community-wide campaigns) were effective, as were three behavioral and social interventions (school-based physical education, social support in community settings, and individually-adapted health behavior change) and one environmental and policy intervention (creation of or enhanced access to places for physical activity combined with informational outreach activities). Additional information about applicability, other effects, and barriers to implementation are provided for these interventions. Evidence is insufficient to assess a number of interventions: classroom-based health education focused on information provision, and family-based social support (because of inconsistent findings); mass media campaigns and college-based health education and physical education (because of an insufficient number of studies); and classroom-based health education focused on reducing television viewing and video game playing (because of insufficient evidence of an increase in physical activity). These recommendations should serve the needs of researchers, planners, and other public health decision makers.

Medical Subject Headings (MeSH): exercise, leisure activities, physical fitness, physical endurance, decision making, evidence-based medicine, economics, preventive health services, public health practice, meta-analysis, review literature (Am J Prev Med 2002;22(4S):73–107)

Introduction

Regular physical activity is associated with enhanced health and reduced risk of all-cause mortality.[1–4] Beyond the effects on mortality, physical activity has many health benefits, including reduced risk of cardiovascular disease,[5,6] ischemic stroke,[7–9] non–insulin-dependent (type 2) diabetes,[10–16] colon cancers,[17–20] osteoporosis, [21–23] depression,[24–27] and fall-related injuries.[28–31] Despite the benefits of regular physical activity, only 25% of adults in the United States report engaging in the recommended amounts of physical activity (i.e., 30 minutes of moderate-intensity activity on 5 or more days per week, or 20 minutes of vigorous-intensity activity on 3 or more days per week)[32]; 29% report no leisure-time regular physical activity[33]; and only 27% of students (grades 9 through 12) engage in moderate-intensity physical activity (30 minutes, 5 or more days per week).[32]

In *Healthy People 2010*,[32] physical activity is ranked as a leading health indicator. *Healthy People 2010* has developed goals to improve levels of physical activity among adults, adolescents, and children and to reduce sedentary behavior among adolescents (Table 1).

Recommendations to increase physical activity have been made for individuals and clinical settings but not for community settings. Increased physical activity has

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Table 1. Selected objectives for increasing physical activity (PA), *Healthy People 2010*[32]

Objective	Population	Percentage of population	
		Baseline[a]	2010 objective
No leisure-time PA	Adult	40% (1997)	Reduce to 20%
At least 30 minutes of moderate physical activity regularly, preferably daily	Adult	15% (1997)	Increase to 30%
At least 30 minutes of moderate physical activity on ≥5 of previous 7 days	Adolescents	27% (1999)	Increase to 35%
Vigorous PA that promotes the development and maintenance of cardiorespiratory fitness ≥3 days per week for 20 minutes/occasion	Adult	23% (1997)	Increase to 30%
Vigorous PA that promotes the development and maintenance of cardiorespiratory fitness ≥3 days per week for 20 minutes/occasion	Adolescents	65% (1999)	Increase to 85%
Daily school physical education	Adolescents	29% (1999)	Increase to 50%
View television ≤2 hours on a school day	Adolescents	57% (1999)	Increase to 75%
Trips of ≤1 mile made by walking	Adults	17% (1995)	Increase to 25%
Trips to school of ≤1 mile made by walking	Children and adolescents	31% (1995)	Increase to 50%
Trips of ≤5 miles made by bicycling	Adults	0.6% (1995)	Increase to 2%
Trips to school of ≤2 miles made by bicycling	Children and adolescents	2.4% (1995)	Increase to 5%

[a]Years indicate when the data were analyzed to establish baseline estimates. Some of the estimates are age adjusted to the year 2000 standard population.
Source: U.S. Department of Health and Human Services. Healthy people 2010: conference edition. Washington, DC: U.S. Department of Health and Human Services, 2000.[32]

been linked not only to behavioral and social correlates but also to physical and social environmental correlates. Therefore, the role of community-based interventions to promote physical activity has emerged as a critical piece of an overall strategy to increase physical activity behaviors among the people of the United States. In 1996, the American College of Sports Medicine and the Centers for Disease Control and Prevention (CDC) recommended that every adult in the United States accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week.[34] That same year, the U.S. Preventive Services Task Force recommended that healthcare providers counsel all patients on the importance of incorporating physical activity into their daily routines.[35] To date, community-based interventions to increase physical activity have not been summarized in an evidence-based process.

The *Guide to Community Preventive Services*

The systematic reviews in this report represent the work of the independent, nonfederal Task Force on Community Preventive Services (the Task Force). The Task Force is developing the *Guide to Community Preventive Services* (the *Community Guide*) with the support of the U.S. Department of Health and Human Services (DHHS) in collaboration with public and private partners. The Centers for Disease Control and Prevention (CDC) provides staff support to the Task Force for development of the *Community Guide*. A special supplement to the *American Journal of Preventive Medicine*, "Introducing the *Guide to Community Preventive Services*: Methods, First Recommendations, and Expert Commentary," published in January 2000, presents the background and the methods used in developing the *Community Guide*.[36]

Healthy People 2010 Goals and Objectives for Increasing Physical Activity

The interventions reviewed in this article should be useful in reaching the objectives set in *Healthy People 2010*.[32] The two main foci of the *Healthy People* prevention objectives are to increase (1) the amount of moderate or vigorous physical activity performed by people in all population subgroups and (2) opportunities for physical activity through creating and enhancing access to places and facilities where people can be physically active. This article provides information on interventions that relate to both of these foci, which can be used by communities to help increase levels of exercise and fitness. The specific objectives are listed in Table 1.

Recommendations from Other Advisory Groups

The U.S. Preventive Services Task Force

In 1996, in the *Guide to Clinical Preventive Services*,[35] the U.S. Preventive Services Task Force (USPSTF) recommended that healthcare providers counsel their patients to incorporate regular physical activity into their daily routines. This recommendation was based on the accepted health benefits of such activity rather than the proven effectiveness of clinician counseling. The

USPSTF found that problems associated with establishing the effectiveness of counseling included lack of information about long-term compliance and the typical problems of generalizing to a broad population. The USPSTF is revisiting the effectiveness of clinical interventions for promoting long-term changes in physical activity, and a revised recommendation will be released later this year.

American College of Sports Medicine/CDC

A panel of scientists convened by the American College of Sports Medicine and CDC developed a consensus statement recommending that every adult in the United States accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week.[34] This recommendation was modified to emphasize that physical activity does not need to be continuous or strenuous to produce health benefits. The Surgeon General's Report[37] and the National Institutes of Health Consensus Statement[38] support this recommendation.

Methods for Conducting the Review

The general methods used to conduct systematic reviews for the *Community Guide* have been described in detail elsewhere.[39,40] The specific methods for conducting this review, including intervention selection, outcome determination, and search strategy for interventions to increase physical activity, are presented in Appendix A. The conceptual approach to the review, critical both for describing the methods and for understanding the results of the review, is described below.

Conceptual Model

The general conceptual model (also called the "logic framework") used to evaluate the effectiveness of interventions to increase physical activity is shown in Figure 1. This framework illustrates the relationships between physical activity, several indicators of physical fitness, and morbidity and mortality outcomes. For example, a large body of literature shows that increasing physical activity results in physiologic improvements, affecting endurance, strength, body composition, insulin sensitivity, and lipid levels.[37] In turn, these improvements have been shown to result in improved health and quality of life across a variety of conditions. Those who are physically active have a reduced risk of developing cardiovascular disease,[41–44] type 2 diabetes (formerly called non–insulin-dependent diabetes),[14–16] colon cancers,[17–20] osteoporosis,[21–23] and depression,[25–27] and of having fall-related injuries.[28–31]

Selection of Interventions for Review

The relationships between increased physical activity and health were assumed by the coordination team to be well established and, subsequently, were not the focus of the systematic review. Instead, the coordination team focused on interventions to increase physical activity behaviors. By using the categories of behavioral precedents established in the logic framework, the coordination team (defined in Appendix A, see author list) initially developed the following three categories of interventions:

- Informational approaches to change knowledge and attitudes about the benefits of and opportunities for physical activity within a community;
- Behavioral and social approaches to teach people the behavioral management skills necessary both for successful adoption and maintenance of behavior change and for creating social environments that facilitate and enhance behavioral change; and
- Environmental and policy approaches to change the structure of physical and organizational environments to provide safe, attractive, and convenient places for physical activity.

Within these three categories, the coordination team generated a comprehensive list of candidate interventions (Appendix A, Table A-1) for inclusion that addressed each of the modifiable determinants (i.e., individual level factors, social environment, and physical environment). This list was put in priority order for review through a process of polling the coordination team, consultation team,[a] and other specialists in the field about their perception of the public health importance (number of people affected), the practicality of application, and the need of those promoting physical activity for information on each intervention. Interven-

[a]Consultants for the systematic review on increasing physical activity were Terry Bazzarre, PhD, Robert Wood Johnson Foundation, Princeton, NJ; Carl J. Caspersen, PhD, National Center for Chronic Disease Prevention and Health Promotion, CDC, Atlanta, GA; Diana Cassady, DrPH, California Department of Health Services, Sacramento; Carlos J. Crespo, DrPH, State University of New York School of Medicine and Biomedical Sciences, Buffalo; Steve Hooker, PhD, California Department of Health Services, Sacramento; Jonathan Fielding, MD, MPH, MBA, University of California Los Angeles School of Public Health; Barbara Fraser, RD, MS, Nebraska Department of Health and Human Services, Lincoln; George J. Isham, MD, HealthPartners, Minneapolis, MN; Abby C. King, PhD, Stanford University School of Medicine, Stanford, CA; I-Min Lee, MD, ScD, Harvard Medical School/Brigham and Women's Hospital, Boston, MA; Denise G. Simons-Morton, MD, PhD, National Heart, Lung, and Blood Institute, National Institutes of Health, Bethesda, MD; Reba A. Norman, MLM, National Center for Chronic Disease Prevention and Health Promotion, CDC, Atlanta, GA; Cindy Porteous, MA, Indianapolis Park Foundation, Indianapolis, IN; Michael Pratt, MD, MPH, National Center for Chronic Disease Prevention and Health Promotion, CDC, Atlanta, GA; Thomas Schmid, PhD, National Center for Chronic Disease Prevention and Health Promotion, CDC, Atlanta, GA; Christine G. Spain, MA, The President's Council on Physical Fitness and Sports, Washington, DC; Wendell C. Taylor, PhD, MPH, University of Texas Health Science Center at Houston.

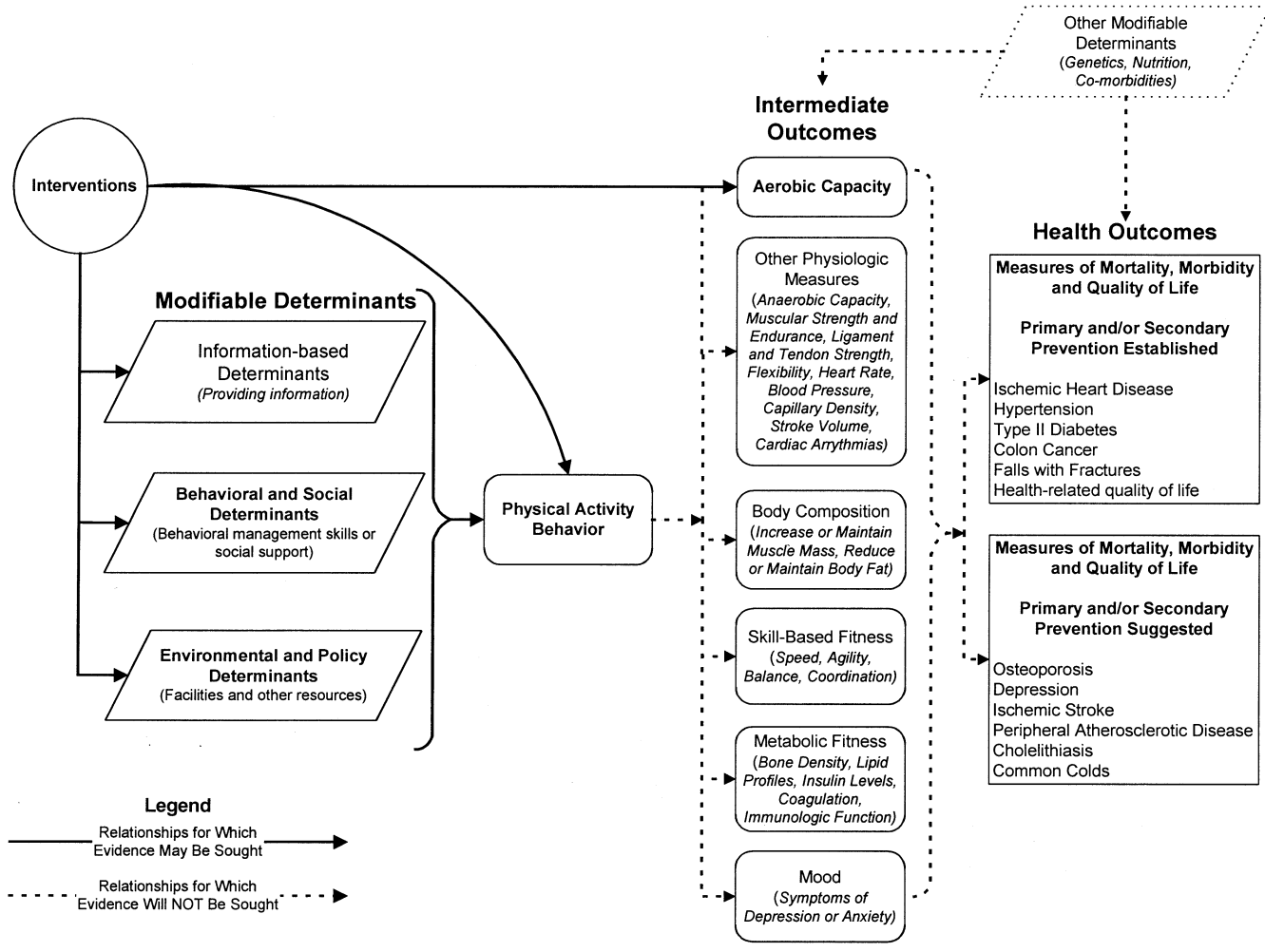

Figure 1. Logic framework illustrating the conceptual approach used in this review.

tions reviewed were either single component (i.e., using only one activity to achieve desired outcomes) or multicomponent (i.e., using more than one related activity). Some interventions fell into more than one category.

Selection of Outcomes for Review

Many of the studies included in the body of evidence targeted other behavioral risk factors in addition to physical inactivity, most often poor diet and smoking. Many of the physiologic benefits observed in those studies could be the result of improvements in these other behaviors rather than improvements in physical activity. To be able to estimate the effectiveness of an intervention in increasing physical activity, the team decided to base recommendations on changes in physical activity behavior. However, self-reported measurement of behavior change, particularly in children, is prone to significant measurement error; objective measures are needed (e.g., heart rate monitoring, accelerometers) to enhance reliability and validity.[45] Additionally, many of the studies did not attempt to measure behavior even when the intervention targeted behavior, measuring instead physiologic changes as an indicator of behavior. The team chose to use measures of aerobic capacity as well as behavioral measures as outcomes on which recommendations would be based. Aerobic capacity is defined as the maximum amount of oxygen that can be transported from the lungs to the tissues during exercise.[46] Maximal oxygen uptake (VO_2 max) or a measure of VO_2 max is commonly used to measure changes in fitness level associated with increased activity (behavior change).

Results: Part I. Informational Approaches to Increasing Physical Activity

Informational approaches are designed to increase physical activity by providing information necessary to motivate and enable people to change their behavior, as well as to maintain that change over time. The focus is mainly on the cognitive skills thought to precede behavior. The interventions use primarily educational approaches to present both general health informa-

tion, including information about cardiovascular disease prevention and risk reduction, as well as specific information about physical activity and exercise. These programs were originally developed to complement a medical model of disease management by involving communities in understanding the cognitive antecedents of behavior.

The provision of information is intended to change knowledge about the benefits of physical activity, increase awareness of opportunities within a community for increasing physical activity, explain methods for overcoming barriers and negative attitudes about physical activity, and increase participation in community-based activities. Interventions reviewed here are (1) "point-of-decision" prompts to encourage use of stairs as an alternative to elevators or escalators, (2) community-wide education campaigns, (3) mass media campaigns, and (4) classroom-based health education focused on information provision and skills related to decision making.

Point-of-Decision Prompts

Point-of-decision prompts are signs placed by elevators and escalators to motivate people to use nearby stairs. Messages on the signs recommend stair use for health benefits or weight loss. Signs are thought to be effective in one of two ways: by reminding people already predisposed to becoming more active, for health or other reasons, about an opportunity at hand to be more active or by informing them of a health benefit from taking the stairs. All interventions evaluated in this category were single-component interventions, in which placement of the sign was the only intervention activity.

Reviews of evidence

Effectiveness. Our search identified six reports (one paper reported two studies)[47–51] on the effectiveness of point-of-decision prompts. All studies were of moderate suitability, using time-series designs. All were conducted between 1980 and 2000. Two of the studies (reported in one paper)[49] were of good execution; the remaining four[47,48,50,51] were rated as fair. All were included in the body of evidence. Details of the six qualifying studies are provided at the website (www.thecommunityguide.org).

Baseline rates of stair use were generally low, with all but one under 12% (range, 4.8% to 39.6%). In five studies[47–49,51] the median increase in stair-climbing was 53.9%. The remaining study[50] showed an unspecified increase in stair-climbing and also found that the signs were effective in getting those who were less active (as measured by responses to a brief survey) to take the stairs. The range of effect sizes varied from a 5.5% net increase to 128.6%.

Applicability. The body of evidence used to evaluate the applicability of this intervention was the same as that used to evaluate effectiveness. Four studies were conducted in the United States,[47,49,51] and one study each was conducted in England[50] and Scotland.[48] The studies included in this review were implemented in shopping malls,[47,49,50] train and bus stations,[48,49] and a university library.[51] Three studies[47,48,51] measured effectiveness separately among men and women and found that signs were effective in both groups.

Two studies[47,49] reported effectiveness separately for obese and nonobese people. Although the signs were effective in both groups, the median net increase in the percentage of people taking the stairs was greater among the obese group. Among obese people, a sign that linked stair use to the potential for weight loss showed a higher increase in stair use than the sign linking stair use to general health benefits.

The same two studies[47,49] reported results separately for blacks and found mixed evidence of effectiveness. One study[47] showed a decline in the percentage of blacks taking the stairs when the sign contained a generic message. A message specifically designed for a black population, however, was effective in increasing the percentage of stair users.

This type of intervention is likely to be effective across diverse settings and population groups, provided that appropriate care is taken to adapt the messages.

Other positive or negative effects. None of the studies measured outcomes other than the percentage of people using the stairs.

Economic. No studies were found that met the requirements for inclusion in a *Community Guide* review.[40]

Barriers to intervention implementation. Stairways in many buildings and facilities are often difficult to find and poorly lit, maintained, or secured. As a result they may appear to be, or actually be, unsafe. Additionally, some stairwells are locked, preventing user access to them.

Conclusion. According to *Community Guide* rules of evidence,[39] sufficient evidence shows that point-of-decision prompts are effective in increasing levels of physical activity, as measured by an increase in the percentage of people choosing to take the stairs rather than an elevator or escalator. Findings from several of the studies suggest that tailoring the prompts either by specifying the benefits of stair use or by customizing the sign to appeal to specific populations may increase intervention effectiveness.

Community-Wide Campaigns

Community-wide campaigns involve many community sectors in highly visible, broad-based, multiple intervention approaches to increasing physical activity. In addi-

tion to addressing sedentary behavior, most of the studies in this body of evidence also addressed other cardiovascular disease risk factors, particularly diet and smoking. Communication techniques were a common element in all of the campaigns. Campaign messages were directed to large and relatively undifferentiated audiences through diverse media, including television, radio, newspaper columns and inserts, direct mailings, billboards, advertisements in transit outlets, and trailers in movie theaters. Messages were communicated in the form of paid advertisements, donated public service announcements, press releases, the creation of feature items, or a combination of two or more of these approaches.

In addition to incorporating substantial communication activities through mass media, interventions in this review typically included some combination of social support, such as self-help groups; risk factor screening, counseling, and education about physical activity in a variety of settings, including worksites, schools, and community events; and environmental or policy changes such as the creation of walking trails. These interventions were evaluated as a "combined package" because it was impossible to distinguish the relative contributions of each component.

Reviews of evidence

Effectiveness. Our search identified ten reports[52–61] on the effectiveness of community-wide campaigns. All studies were used in the body of evidence. Two studies[52,53] had the greatest suitability of study design and good execution. The remaining eight studies had fair execution. Of those, five[54–58] had the greatest suitability of study design and three[59–61] were of moderate suitability. Details of the ten qualifying studies are provided at the website (www.thecommunityguide.org).

Many of the interventions[52–58] were designed to decrease levels of cardiovascular disease morbidity and mortality throughout a community over a period of several years. Activities were directed both at increasing levels of physical activity and improving dietary behaviors. These interventions included many activities supported by media efforts but conducted independently. In the remaining studies,[59–61]the duration of intervention activities ranged from 6 weeks to 6 months, and activities were more circumscribed, although still presented community-wide.

Six arms from five studies[52,53,55,56,60] measured change in the percentage of people being active, with a median net increase of 4.2% (range, −2.9% to 9.4%). Three arms from two studies[54,58] measured change in energy expenditure with a median net increase of 16.3% (range, 7.6% to 21.4%). Five arms from four studies[53,58–60] reported other measures of physical activity; all but one showed increases in physical activity.

Applicability. The body of evidence used to evaluate the applicability of this intervention was the same as that used to evaluate the effectiveness. Five studies were conducted in the United States,[52,54,56,58,59] and one study each was conducted in Sweden,[57] Denmark,[55] Australia,[60] Scotland,[61] and Wales.[53] Studies were conducted in rural, suburban, and urban areas and encompassed all socioeconomic groups. Two studies reported results for black populations,[56,59] and two studies reported results for Hispanic or Latino populations.[54,59]

This type of intervention is likely to be effective across diverse settings and population groups, provided that appropriate care is taken to adapt the interventions to the target populations.

Other positive or negative effects. Seven arms from five studies[52–54,56,59] examined weight change among people in the communities receiving the interventions. Measures included body mass index (BMI), weight, relative weight (i.e., ideal weight/actual weight), and the percentage of people who were overweight. Three arms from three separate studies[52,56,59] showed weight losses, two arms from two studies[52,54] showed no changes, and two arms from one study[53] showed slight weight gains over the course of the intervention. Across the body of evidence, the net decrease in weight was 0.6%. Four arms from two studies[54,58] reported positive changes in knowledge about exercise, with a median increase of 19.9%. Three studies[55,61,62] with seven study arms reported physical activity intentions, that is, the percentage of people either intending to increase activity or actually doing so. Five of the arms reported an increase in intention to increase physical activity, one showed no change, and one reported a decrease.

In addition to increased physical activity, other health benefits may result from the interventions. Most of the studies in this body of evidence also addressed other cardiovascular disease risk behaviors, particularly diet and smoking. Although these results were not systematically reviewed, improvements were evident in some studies. Community-wide education campaigns may also produce other benefits that can improve health and build social capital in communities. For example, through working together communities may develop a greater sense of cohesion and collective self-efficacy. Social networks may also be developed or strengthened to achieve intervention goals, and community members may become involved in local government and civic organizations, thereby increasing social capital.

Economic. No studies were found that met the requirements for inclusion in a *Community Guide* review.[40]

Barriers to intervention implementation. Community-wide campaigns require careful planning and coordination, well-trained staff, and sufficient resources to carry out the campaign as planned. Success is greatly

enhanced by community buy-in, which can take a great deal of time and effort to achieve. Insufficient resources may result in exposure to messages and other planned campaign interventions that is inadequate to achieve the "doses" necessary to change knowledge, attitudes, or behavior over time, especially among high-risk populations. Inadequate resources and lack of professionally trained staff may affect how completely and appropriately interventions are implemented and evaluated.

Conclusion. According to *Community Guide* rules of evidence,[39] strong evidence exists that community-wide campaigns are effective in increasing levels of physical activity, as measured by an increase in the percentage of people engaging in physical activity, energy expenditure, or other measure of physical activity.

Mass Media Campaigns

Mass media campaigns are interventions that address messages about physical activity to large and relatively undifferentiated audiences. The campaigns are designed to increase knowledge, influence attitudes and beliefs, and change behavior. Messages are transmitted by using channels such as newspapers, radio, television, and billboards singly or in combination. In this review, interventions that use mass media and include other components (e.g., support groups, risk factor screening and education, and community events) are classified as community-wide campaigns and are discussed elsewhere (see Community-Wide Campaigns section).

Reviews of evidence

Effectiveness. Our search identified three studies[54,59,63] evaluating the effectiveness of mass media campaigns. All studies had fair execution. The study designs were a nonrandomized community trial,[54] a time-series,[59] and a before-and-after design with no concurrent comparison group.[63] These designs were rated as having greatest, moderate, and least suitable study designs, respectively. Details of the three qualifying studies are provided at the website (www.thecommunityguide.org).

Effectiveness measures were (1) the change in the percentage of people doing a specified level of activity (i.e., walking, moderate- and vigorous-intensity physical activity, aerobic and nonaerobic activity),[59,63] (2) change in energy expenditure,[54] and (3) the percentage of the population categorized as sedentary.[63] Overall, some but not all measures suggested a modest trend toward increasing physical activity, especially at lower levels of physical activity. According to *Community Guide* rules of evidence,[39] we concluded that, because of small numbers of available studies and limitations in the designs and execution of the available studies, insufficient evidence was available to assess the effectiveness of mass media campaigns, when used alone, to increase physical activity or improve fitness.

Applicability. Evidence about applicability was not assessed for this intervention because effectiveness was not established.

Other positive or negative effects. Two studies[54,59] examined the effects of mass media campaigns on adiposity: One[59] showed a decrease in weight over the 3-month intervention period and the other[54] found no effect. Significant and substantial improvements in knowledge and beliefs were seen in two studies.[54,63] Mass media campaigns might play important roles in changing awareness of opportunities for and benefits of physical activity, helping to build support for environmental and policy changes that improve physical activity behavior and fitness, or both. Our reviews, however, did not assess the effect of mass media campaigns on such outcomes.

Economic. Evidence about economic effectiveness was not collected because effectiveness of the intervention was not established.

Barriers to intervention implementation. Evidence about barriers to implementation of this intervention was not collected because effectiveness was not established.

Conclusion. Available studies provide insufficient evidence to assess the effectiveness of mass media campaigns, when used alone, to increase physical activity or improve fitness. Media campaigns are, however, a component of other effective interventions (see Community-Wide Campaigns section) and might provide additional benefits. Until more and better information becomes available, communities might choose to make decisions about the use of education-only programs on grounds other than the evidence found in available studies.

Classroom-Based Health Education Focused on Information Provision

Health education classes that provide information and skills related to decision making are usually multicomponent, with the curriculum typically addressing physical activity, nutrition, smoking, and cardiovascular disease. Health education classes, taught in elementary, middle, or high schools, are designed to effect behavior change through personal and behavioral factors that provide students with the skills they need for rational decision making. Many of the classes in the studies reviewed had a behavioral skills component (e.g., role-play, goal-setting, contingency planning) but did not add time spent in physical activity to the curriculum. In most cases, comparison groups received the standard health education curriculum.

Reviews of evidence

Effectiveness. Our search identified 13 studies[64–76] evaluating the effectiveness of classroom-based health education focused on information provision. Of these, three studies had limited quality of execution and were not included in our review.[74–76] The ten remaining studies had greatest suitability of study design. One had good execution[64] and nine had fair execution.[65–73] Details of the ten qualifying studies are provided at the website (www.thecommunityguide.org).

Most of the interventions were designed to reduce the risk of developing chronic disease. Four interventions[65,71–73] were designed with the use of the Know Your Body curriculum. (The Know Your Body curriculum is designed to provide children with the skills needed to adopt behaviors that reduce the risk of developing cardiovascular disease. The classes focus on nutrition, physical fitness, and preventing cigarette smoking.) One intervention[68] focused on prevention of type 2 diabetes by encouraging students to eat low-fat foods and to exercise regularly. The duration of the intervention activities ranged from 3 months to 5 years.

The studies reviewed showed variable effects of these interventions on time spent in physical activity outside the school setting: three study arms from two studies showed increases in activity,[66–68] and five study arms from two studies showed decreases in self-reported activity.[64,66] Other measures of physical activity were also varied: five study arms from one study found positive changes in self-reported behavior,[66] and 11 study arms from two studies found no change or negative changes in self-reported behavior.[64,66] Aerobic capacity was not measured in any of these studies.

Applicability. Evidence about applicability was not assessed for this intervention because effectiveness was not established.

Other positive or negative effects. Although these studies did not show changes in activity, four of five study arms from three studies showed increases in general health knowledge, exercise-related knowledge, and self-efficacy about exercise.[64,67,68] Effects on adiposity were mixed,[69] showing decreases in BMI among both boys and girls but decreases in skinfold measurements among boys only.

Economic. Evidence about economic effectiveness was not collected because effectiveness of the intervention was not established.

Barriers to intervention implementation. Evidence about barriers to implementation of this intervention was not collected because effectiveness was not established.

Conclusion. According to *Community Guide* rules of evidence,[39] the studies reviewed provided insufficient evidence to assess the effectiveness of classroom-based health education focused on information provision in increasing levels of physical activity or improving fitness because of inconsistent results among studies.

Results. Part II. Behavioral and Social Approaches to Increasing Physical Activity

Behavioral and social approaches focus on increasing physical activity by teaching widely applicable behavioral management skills and by structuring the social environment to provide support for people trying to initiate or maintain behavior change. Interventions often involve individual or group behavioral counseling and typically include the friends or family members that constitute an individual's social environment. Skills focus on recognizing cues and opportunities for physical activity, ways to manage high-risk situations, and ways to maintain behavior and prevent relapse. Interventions also involve making changes in the home, family, school, and work environments.

Interventions reviewed here are (1) school-based physical education (PE), (2) college-based health education and PE, (3) classroom-based health education focused on reducing television viewing and video game playing, (4) family-based social support interventions, (5) social support interventions in community settings, and (6) individually-adapted health behavior change programs.

School-Based PE

Interventions that used this approach modified curricula and policies to increase the amount of time students spend in moderate or vigorous activity while in PE classes. This can be done in a variety of ways, including (1) adding new (or additional) PE classes, (2) lengthening existing PE classes, or (3) increasing moderate to vigorous physical activity (MVPA) of students during PE class without necessarily lengthening class time. Examples of the last approach include changing the activities taught (e.g., substituting soccer for softball) or modifying the rules of the game so that students are more active (e.g., having the entire team run the bases together if the batter makes a hit). Many of these interventions also included the presentation of information on cardiovascular disease prevention, rendering it difficult to separate the effects of health education and modified PE.

Reviews of evidence

Effectiveness. Our search identified 16 articles (one study was reported in two papers)[77–93] reporting on 17 studies that evaluated the effectiveness of modified school-based PE curricula and policies. Of these, four studies had limited quality of execution and were not

included in our review.[78,84,85,92] Twelve of the remaining thirteen studies (one study reported in two papers) had greatest suitability of study design.[77,79–83,86–91,93] The remaining study[79] had a least suitable design. Four had good execution[80,81,83,89,93] and nine had fair execution.[77,79,82,86–88,90,91] Details of the 13 qualifying studies are provided in Appendix B and at www.thecommunityguide.org.

Reported behavioral outcomes were energy expenditure,[80,81,90] percentage of class time spent in MVPA,[80,81,90,91] minutes spent in MVPA,[80,81,90,91] observed activity score,[77,90] and self-reported type and frequency of physical activities outside of school.[80,81,86,89,90,94] Eleven studies also reported aerobic capacity as estimated maximal oxygen uptake (VO_2 max),[77,79] results from timed runs,[77,80,81,88,90,93] or endurance testing (step test or shuttle runs).[82,89,93] These studies showed consistent increases in time spent in physical activity at school. Five arms from four studies showed increases in the amount[77,91,94] and percentage[80,81,90,91] of time spent in MVPA in PE classes. The net increase in the amount of PE class time spent in MVPA was 50.3% (range, 6.0% to 125.3%; because one study[91] reported an increase from 0, percentage increase from baseline could not be calculated). The net increase in the percentage of class time in MVPA was 10% (range, 3.3% to 15.7%), with an additional study reporting a 762% increase from a very small baseline value. Three arms from two studies[80,81,90] showed increases in energy expenditure as well. Fourteen arms from eleven studies[77,79–84,88–90,93] showed increases in aerobic capacity with a median of 8.4% (interquartile range, 3.1% to 18.9%).

Applicability. The body of evidence used to evaluate the applicability of this type of intervention was the same as that used to evaluate effectiveness. Nine studies were conducted in the United States,[77,82,83,86–88,90,91,94] one in Crete,[89] and two in Australia.[79,93] Ten studies (one study was reported in two papers)[77,79–81,86–91,93] were conducted among elementary school students, and two studies were conducted among high-school students.[82,83] The intervention was successful among both elementary and high school students.

Overall results indicate that this type of intervention is likely to be effective across diverse settings and population groups, provided that appropriate care is taken to adapt the intervention to the target population.

Other positive or negative effects. Ten studies[77,79,82,83,88–90,93–95] examined weight change. Measures included BMI, skinfold measurements, percentage of body fat, and weight. BMI estimates mostly showed small decreases or no change; one study arm showed a small increase of 1.2%. Skinfold estimates showed a median change of −4.4% (interquartile range, −6.0% to −0.7%). Changes in percentage of body fat showed inconsistent results, with some increases and some decreases.

Indicators of physical fitness other than aerobic capacity also showed improvements. Flexibility, as measured through sit-and-reach tests, showed improvements in two[87,89] of three studies.[87,89,90] Muscular endurance also increased in most arms in the two studies[89,90] reporting this measurement; the exception was for girls performing pull-ups in one study.[90] These interventions were also associated with increases in knowledge about exercise,[86,87] fitness,[89] nutrition,[80,81,87,88] and general health,[83,89] as well as self-efficacy about physical activity.[80,81]

Although there is a perception that the time spent in PE may harm academic performance, both an examination of the literature included in this review and the results of a systematic search of other studies on the effects of PE on academic performance found no evidence of this harm.

Economic. No studies were found that met the requirements for inclusion in a *Community Guide* review.[40]

Barriers to intervention implementation. The primary barrier to implementation exists within the school systems. PE is mandated in almost every state, but requirements for the amount of PE instruction are generally low (e.g., four semesters, two to three times per week or two semesters of daily PE). Few middle and high schools require daily PE, and schools face increasing pressure to eliminate PE to make more time available for academic subjects.

Conclusion. According to *Community Guide* rules of evidence,[39] there is strong evidence that school-based PE is effective in increasing levels of physical activity and improving physical fitness.

College-Based Health Education and PE

College-based health education and PE interventions aim to set long-term behavioral patterns during the transition to adulthood. To this end, they use didactic and behavioral education efforts to increase physical activity levels among college students. The physical education classes do not have to be offered by PE or wellness departments in college and university settings, but they do include supervised physical activity in the class.

The studies in our review included lecture classes that addressed the benefits and potential risks of physical activity, the current recommendations about the amount and type of physical activity one should get, and behavioral management techniques. Students applied these lessons in "laboratory"-type sessions in which they engaged in supervised physical activity, developed goals and activity plans, and wrote term papers based on their experiences. Students also received social support and phone calls from each other

and made behavioral contracts for an agreed-on amount of physical activity.

Reviews of evidence

Effectiveness. Our search identified five studies (one study was reported in two papers)[96–101] evaluating the effectiveness of college-based health education and PE classes. Three[96,98,101] of the five studies were not included in the review of effectiveness because they had limited quality of execution. The designs of the two remaining studies were categorized as greatest suitability. One study, reported in two papers,[99,100] had good execution and an initial intervention period of 15 weeks; participants were followed for an additional 2 years to examine maintenance of effect after the intervention ended. The other study[97] was fair in execution and measured a 5-week intervention period. Details of the two qualifying studies are provided at the website (www.thecommunityguide.org).

The studies generally showed consistent increases in physical activity and aerobic capacity in the short term. The 2-year follow-up showed declines in activity back to previous levels and did not find the desired effects on the proposed mediators of behavioral change. According to *Community Guide* rules of evidence,[39] because of the small number of qualifying studies, limitations in some of the studies' design and execution, and some inconsistency in the results (with positive results mostly limited to very short follow-up times), insufficient evidence was available to assess the effectiveness of college-based health education and PE interventions to increase physical activity behavior and fitness.

Applicability. Evidence about applicability was not assessed for this intervention because effectiveness was not established.

Other positive or negative effects. One study, reported in two papers,[99,100] measured effects on several hypothesized mediators of behavioral change. Among men, there was some evidence of an increase in the social support of friends and family for physical activity and of self-efficacy for resisting relapse into physical inactivity. Some evidence was available of a decrease in the perceived barriers to being physically active. Among women, increases were found in the use of experiential and behavioral processes of change and statistically nonsignificant increases in enjoyment, social support, self-efficacy, and perceived benefits and barriers.

Economic. Evidence about economic effectiveness was not collected for this intervention because effectiveness was not established.

Barriers to intervention implementation. Evidence about barriers to implementation was not collected for this intervention because effectiveness was not established.

Conclusion. Available studies provided insufficient evidence to assess the effectiveness of college-based health education and PE interventions to increase physical activity and fitness.

Classroom-Based Health Education Focused on Reducing Television Viewing and Video Game Playing

In elementary school classrooms, as part of a general health curriculum, regular classroom teachers taught classes that specifically emphasized decreasing the amount of time spent watching television and playing video games. Classes included instruction in behavioral management techniques or strategies such as self-monitoring of viewing behavior, limiting access to television and video games, and budgeting time for television and video. All studies included a "TV turnoff challenge" in which the students were encouraged not to watch television for a specified number of days. Activities that required greater energy expenditure than watching television or playing video games were not specifically recommended. Parental involvement was a prominent part of the intervention, and all households were given automatic television use monitors.

Reviews of evidence

Effectiveness. Our search identified three studies[102–104] evaluating health education focused on reducing television viewing and video game playing. All studies had fair execution and greatest suitability of design, incorporating a concurrent comparison group and taking measurements before and after the intervention. Two studies[102,103] occurred over a 2-year intervention period, and one study[104] took place during a 6-month intervention period. All studies measured the time spent watching television and playing video games as the primary outcome of interest. One study[104] also measured time spent in other sedentary behavior. The main effectiveness measure from these studies used in our review was the time spent in vigorous,[103] moderate or vigorous,[102] or unspecified[104] physical activity per day.

The studies showed a consistent and sizable decrease in television viewing and video game playing for both boys and girls according to children's self-report[102–104] and parental report.[104] Time spent in other sedentary behaviors also decreased in a single study.[104] Reductions in television viewing and video game playing did not, however, consistently correspond with increases in physical activity. Six measures of physical activity showed inconsistent results, with two measures showing increases and four measures showing decreases.

According to *Community Guide* rules of evidence,[39] available studies provide insufficient evidence to assess the effectiveness of health education classes focused on

reducing television viewing and video game playing to increase physical activity behavior, because of inconsistent results for that outcome.

Applicability. Evidence about applicability was not assessed for this intervention because effectiveness was not established.

Other positive or negative effects. Two of the studies[102,104] examined effects on adiposity. One study[104] showed significant decreases in both BMI (2.3%) and skinfold measurements (11.5%). One study[102] showed a 24.2% reduction in the prevalence of obesity among girls and no change among boys, as well as higher rates of obesity remission in the intervention group compared with the control group. (Obesity remission occurs when a child who is defined as obese "grows into" his or her weight: body weight does not decrease but the child grows in height, thus reducing the BMI to a level that is no longer considered obese.) Because there was no evidence of effect on levels of physical activity, it is thought that reductions in adiposity might be the result of lower levels of snacking while watching television. An alternative explanation is that the interventions caused an increase in light physical activity that was not captured by the methods used.

Economic. Evidence about economic effectiveness was not collected for this intervention because effectiveness was not established.

Barriers to intervention implementation. Evidence about barriers to implementation of this intervention was not collected because effectiveness was not established.

Conclusion. Available studies provide insufficient evidence to assess the effectiveness of classroom-based health education focused on reducing television viewing and video game playing to increase physical activity. Such classes do, however, have additional benefits in terms of reducing television watching and may lower levels of adiposity. More research is needed into the links between reducing time spent watching television or playing video games and increasing physical activity.

Family-Based Social Support

Family-based interventions attempt to change health behavior through the use of techniques that increase the support of family members for behavior change. The family is a major source of influence for children in the modeling of health behaviors and is, therefore, an appropriate target for intervention. Many disease risk factors, both behavioral and physiologic, aggregate within families. Moreover, a supportive social environment has been shown to increase maintenance of behavior change.

These interventions target factors in the social environment and interpersonal and behavioral patterns that are likely to influence physical activity behaviors. Interventions may be targeted to families with children or to spouses or partners without children. Programs typically include joint or separate educational sessions on health, goal-setting, problem-solving, or family behavioral management and will often incorporate some physical activities.

Interventions in this category targeted to children and their families are often implemented as part of a larger strategy that includes other school-based interventions, such as school-based PE or classroom-based health education. In this setting, the family component is often conceptualized as an adjunct home curriculum to the school activities, involving take-home packets, reward systems, and family record keeping. They may also include family-oriented special events (e.g., the CATCH [Child and Adolescent Trial for Cardiovascular Health] program has Family Fun Nights, which are "mini-health fairs" for family and peers that offer games, prizes, food, and beverages).

Reviews of evidence

Effectiveness. Our search identified 12 studies[67,80,81,87–90,105–110] on the effectiveness of family-based social support interventions. Of these, one had limited quality of execution and was not included in our review. One of the reviewed studies[109] had a least suitable study design. The remaining 11 studies[67,80,81,87–90,105–108,110] generally indicated no change, with some studies showing increases in activity and others showing decreases. This inconsistency of results across the body of evidence can also be seen in the physiologic measures. Results were considered inconsistent because many of the studies had multiple arms with varying results. Four studies reported an increase in energy expenditure, and four arms from one study reported a decrease in energy expenditure. Both increases and decreases also were seen in aerobic capacity and flexibility. Details of the 11 qualifying studies are provided at the website (www.thecommunityguide.org).

The 11 studies included in this review can be broadly divided into those that were implemented as part of a school-based program[67,87–90,94,107] and those that were implemented as independent studies in the community setting.[105,106,108,110] Studies that were implemented as part of a school-based program had slightly greater evidence of effectiveness, but the combination of techniques makes it impossible to attribute that success to the family-based social support intervention. In addition, studies that compared home and school interventions with school-only interventions showed no differences in effectiveness.

Applicability. Evidence about applicability was not assessed for this intervention because effectiveness was not established.

Other positive or negative effects. Eight arms from six studies[67,87–89,107,108] showed increases in knowledge about disease risk factors, fitness, exercise, and health among both children and adults. One study[94] showed evidence of an increase in self-efficacy for physical activity. One study[108] showed an increase in satisfaction with the amount of family activity.

Economic. Evidence about economic effectiveness was not collected for this intervention because effectiveness was not established.

Barriers to intervention implementation. Evidence about barriers to implementation of this intervention was not collected because effectiveness was not established.

Conclusion. According to *Community Guide* rules of evidence,[39] available studies provide insufficient evidence to assess the effectiveness of family-based social support interventions in increasing levels of physical activity or improving fitness, because of inconsistent results among the studies.

Social Support Interventions in Community Settings

These interventions focus on changing physical activity behavior through building, strengthening, and maintaining social networks that provide supportive relationships for behavior change. This change can be achieved either by creating new social networks or working within pre-existing networks in a social setting outside the family, such as the workplace. Interventions typically involved setting up a "buddy" system, making a "contract" with others to achieve specified levels of physical activity, or setting up walking or other groups to provide companionship and support while being physically active.

Reviews of evidence

Effectiveness. Our search identified nine reports[59,111–118] on the effectiveness of social support interventions in community settings. All studies were used in the body of evidence. One study[116] had the greatest suitability of design and good execution. The remaining eight studies had fair execution. Of those, seven[111–115,117,118] had greatest suitability of study design and one[59] was of moderate suitability. Details of the nine qualifying studies are provided at the website (www.thecommunityguide.org).

The typical intervention reviewed involved recruiting people into voluntary groups in which members provided companionship and support for attaining self-selected activity goals. Each study participant received phone calls from other participants and from study staff members to monitor progress and to encourage continuation of activities. Some studies involved formal discussion groups in which barriers to exercise and negative perceptions about activity were addressed. The measured outcomes were varied and included the frequency and duration of exercise episodes (e.g., blocks walked daily, flights of stairs climbed daily, frequency of attendance at exercise sessions, frequency of jogging episodes, participation in exercise and organized sports, or minutes spent in activity).

Five arms from four studies[59,111,112,117]measured change in time spent in physical activity with a median net increase of 44.2% (interquartile range, 19.9% to 45.6%). Six arms from three studies[111,114,118] measured change in frequency of exercise or physical activity with a median net increase of 19.6% (interquartile range, 14.6% to 57.6%). Fitness also improved: five arms from three studies[111–113] showed a median net increase in aerobic capacity of 4.7% (interquartile range, 3.3% to 6.1%).

One study[116] found that those who received more frequent support were more active than those who received less frequent support, although both highly structured and less formal support were equally effective in getting people to be more active.

Applicability. The body of evidence used to evaluate the applicability of this intervention was the same as that used to evaluate effectiveness. Seven studies were conducted in the United States,[59,111–116] one in Canada,[118] and one in Australia.[117] Six studies[59,111,112,115,117,118] were conducted in community settings, including community centers and churches. One study was conducted at a worksite[113] and two were conducted in university settings.[114,116]

Six studies[111,112,114–116,118] exclusively or primarily reported results for women, and three studies[59,113,117] also included men in their study populations. Study populations for most studies were middle-aged; one study[111] included women aged 18 years or older, and one study[115] focused on "older" women (aged 50 to 65 years). Three studies[111,112,114] restricted their populations to those that were sedentary at the beginning of the study; the rest included people at any initial level of activity. Given the diversity of countries, settings, and populations included in this body of evidence, these results should be applicable to diverse settings and populations, provided appropriate attention is paid to adapting the intervention to the target population.

Other positive or negative effects. Five arms from four studies[59,111,112,117] reported changes in adiposity among those enrolled in social support interventions. BMI, waist-to-hip ratio, and percentage of body fat and weight were measured. Ten of eleven measurements showed decreases in adiposity, with a median net change of −7.3% (interquartile range, −8.1% to −6.8%). Four arms from three studies[111,112,117] showed increases in confidence about exercise and in knowledge of and social support for exercise.

Economic. No studies were found that met the requirements for inclusion in a *Community Guide* review.[40]

Barriers to intervention implementation. No barriers were identified to the implementation of social support in community settings to promote physical activity.

Conclusion. According to *Community Guide* rules of evidence,[39] there is strong evidence that social support interventions in community settings are effective in increasing levels of physical activity, as measured by an increase in the percentage of people engaging in physical activity, energy expenditure, or other measure of physical activity.

Individually-Adapted Health Behavior Change Programs

Individually-adapted health behavior change programs are tailored to the individual's readiness for change, specific interests, and preferences. These programs teach participants specific behavioral skills that enable them to incorporate moderate-intensity physical activity into daily routines. Behaviors may be planned (e.g., a daily scheduled walk) or unplanned (e.g., taking the stairs when the opportunity arises). Many or most of these interventions use constructs from one or more established health behavior change models such as Social Cognitive Theory,[119] the Health Belief Model,[120] or the Transtheoretical Model of Change.[121] All programs incorporated the following behavioral approaches: (1) setting goals for physical activity and self-monitoring of progress toward goals, (2) building social support for new behavioral patterns, (3) behavioral reinforcement through self-reward and positive self-talk, (4) structured problem-solving geared to maintenance of the behavior change, and (5) prevention of relapse into sedentary behaviors. All of the interventions evaluated were delivered to people either in group settings or by mail, telephone, or directed media.

Reviews of evidence

Effectiveness. Our search identified 20 reports on the effectiveness of individually-adapted health behavior change programs.[60,122–140] Of these, two studies[138,139] had limited quality of execution and were not included in our review. Seven studies had good execution; of these, four,[128,130,132,134] two,[125,126] and one[129] had greatest, moderate, and least suitable study design, respectively. Eleven studies had fair execution.[60,122–124,127,131,133,135–137,140] Of those, seven,[60,123,124,127,135–137] two,[122,133] and two[131,140] had greatest, moderate, and least suitable designs, respectively. Details of the 18 qualifying studies are provided at the website (www.thecommunityguide.org).

The typical intervention reviewed involved recruiting people into voluntary groups working toward physical activity goals. Members provided companionship and support for attaining self-selected activity goals. Study participants received phone calls from each other and from study staff members to monitor progress and to encourage continuation of activities. Some studies involved formal discussion groups in which barriers to exercise and negative perceptions about activity were addressed. The measured outcomes were varied and included the frequency and duration of exercise episodes (i.e., blocks walked daily, flights of stairs climbed daily, frequency of attendance at exercise sessions, frequency of jogging episodes, participation in exercise and organized sports, and minutes spent in activity).

Twenty arms from ten studies[60,124–128,131,134–136] measured change in the time spent in physical activity with a median net increase of 35.4% (interquartile range, 16.7% to 83.3%). Thirteen arms from four studies[125,126,132,136] measured change in VO_2 max with a median increase of 6.3% (interquartile range, 5.1% to 9.8%; Figure 2). Fifteen arms from four studies[125–127,129] measured change in energy expenditure with a net median increase of 64.3% (interquartile range, 31.2% to 85.5%). Other measures of physical activity, including attendance at exercise sessions,[135] the number of prescribed exercise sessions completed,[132] the percentage of people starting exercise programs,[122] and the frequency of physical activity[60,136] increased as well.

Although we did not attempt a single quantitative summary across the diverse effect measures because they could not be transformed to the same scale, the results of the various effect measures support a generally similar narrative conclusion: the preponderance of the evidence suggests that this type of intervention is effective in increasing physical activity.

Applicability. The body of evidence used to evaluate the applicability of this intervention was the same as that used to evaluate effectiveness. Seventeen studies were conducted in the United States[122–137,140] and one in Australia.[60] Fourteen studies were conducted in community settings.[60,123–134,140] Four studies were conducted at worksites,[59,112,122,125] two at schools or universities,[135,136] and one at a telecommunications company.[137]

These studies typically included volunteer samples, which limit generalizing to the entire population. Three studies[123,124,131] reported results only for women. The remainder provided combined results for men and women. Study populations for most studies were middle-aged; four studies[128,130,132,135] focused on people age 50 years or older.

Given the diversity of settings and populations included in this body of evidence, these results should be applicable to diverse settings and populations, provided appropriate attention is paid to adapting the interventions to the target populations.

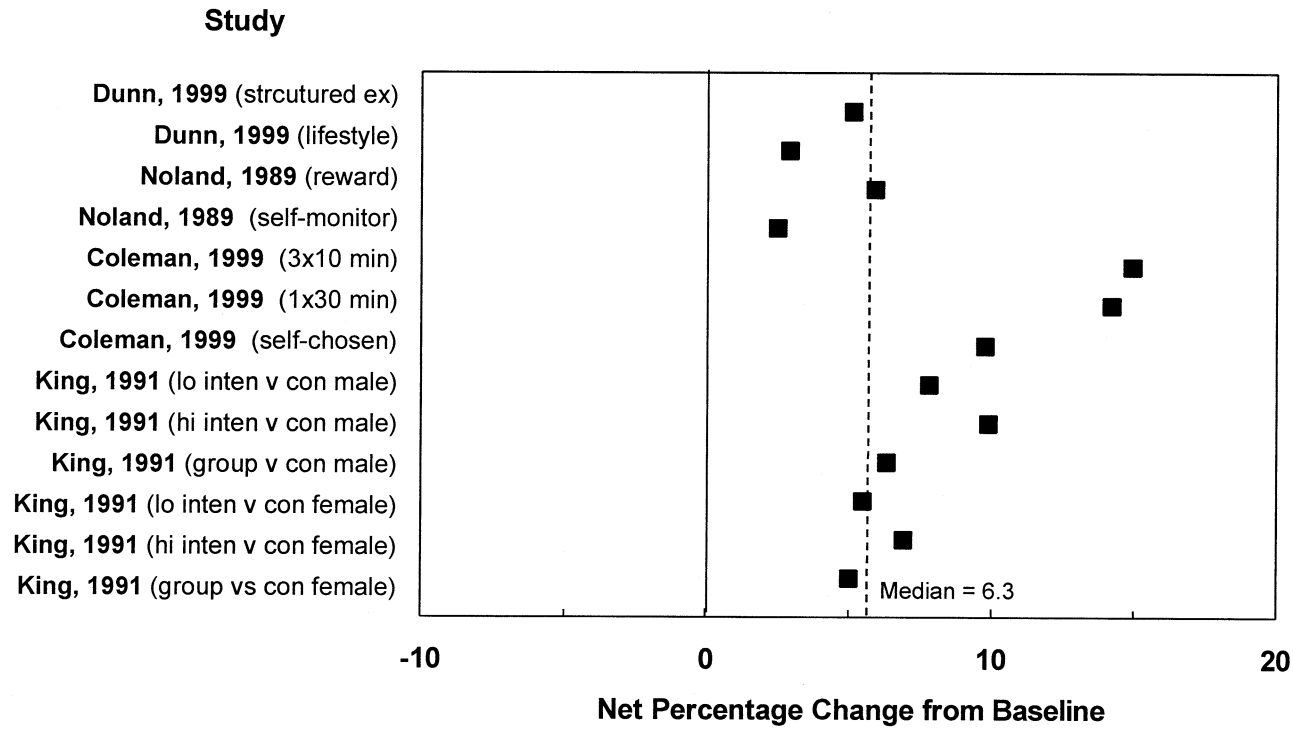

Figure 2. Individually-adapted health behavior change: net percentage change in maximal oxygen consumption (VO_2 max) from baseline in individuals being taught health behavior change strategies.
con, control; ex, exercise; inten, intensity; lo, low; v, versus.

Other positive or negative effects. Fourteen of sixteen measurements from six studies[125,126,129,131,140,141] reported a decrease in body weight, with a median net change of −3.9% (interquartile range, −7.2% to −0.7%). All six measurements from three studies[125,126,141] reported a decrease in percentage of body fat, with a median of −4.1% (interquartile range, −5.9% to −2.3%). Seven of nine measurements from two studies[130,141] reported an increase in strength, with a median of 7.8% (interquartile range, 4.1% to 11.0%). Two measurements from two studies[130,141] reported an increase in flexibility.

Economic. Our search identified one economic evaluation of individually-adapted health behavior change programs. This 2-year study,[142] conducted at a fitness facility in Dallas, Texas, evaluated the cost-effectiveness of two physical activity interventions (lifestyle and structured interventions) provided to adults aged 35 to 60 years. The lifestyle intervention consisted of behavioral skills training to integrate moderate-to-intense physical activity into the lives of participants. Behavior modification and cognitive-behavior modification techniques were used for behavior change. The structured exercise intervention consisted of supervised center-based exercise, in which participants received an exercise intensity prescription of 50% to 85% of maximum aerobic power and exercise of 20 to 60 minutes at each session. Outcome measures included energy expenditure, moderate activity and hard activity (kilocalories per kilogram per day), sitting (hours per week), walking (minutes per day), stair climbing (flights per day), VO_2 max (milliliters per kilogram per minute), and treadmill time (minutes). The effect size for these outcome measures ranged between 0.23 (additional minutes on the treadmill) and 13.07 (walking minutes per day), and 0.33 (additional kilocalorie per kilogram expenditure of moderate activity) to 26.75 (walking minutes per day for lifetime and structured interventions). Program costs included personnel, capital equipment, facilities, and general supplies, but research costs, recruitment costs, and value of participants' time were not included. The adjusted cost-effectiveness ratio for each intervention arm ranged between $0.05 to $3.94 and $0.07 to $5.39 per average unit (as defined in the outcomes measured above) of improvement for lifestyle and structured intervention, respectively. This study was classified as good, based on the quality assessment criteria used in the *Community Guide*.[40] The economic summary table for the study is provided in Appendix A, Table A-3, and at the website (www.thecommunityguide.org).

Barriers to intervention implementation. Individually-adapted health behavior change programs require careful planning and coordination, well-trained staff members, and resources sufficient to carry out the program as planned. Inadequate resources and lack of

professionally trained staff members may affect how completely and appropriately interventions are implemented and evaluated.

Conclusion. According to *Community Guide* rules of evidence,[39] there is strong evidence that individually-adapted health behavior change programs are effective in increasing levels of physical activity, as measured by an increase in the percentage of people engaging in physical activity, energy expenditure, or other measure of physical activity.

Results. Part III. Environmental and Policy Approaches to Increasing Physical Activity

Environmental and policy approaches are designed to provide environmental opportunities, support, and cues to help people develop healthier behaviors. The creation of healthful physical and organizational environments is attempted through development of policy that lends itself to creating supportive environments and strengthening community action. Correlational studies have shown that physical activity levels are associated with factors such as the availability of exercise equipment in the home and the proximity and density of places for physical activity within neighborhoods. Other neighborhood and environmental characteristics such as safety lighting, weather, and air pollution also affect physical activity levels, regardless of individual motivation and knowledge.

To affect entire populations, interventions in this category are not directed to individuals but rather to physical and organizational structures. The interventions are implemented and evaluated over a longer period of time than more individually oriented interventions. Interventions are conducted by traditional health professionals, but they also involve many sectors that have not previously been associated with public health, such as community agencies and organizations, legislators, and the mass media. The goal is to increase physical activity through changing social networks, organizational norms and policies, the physical environment, resources and facilities, and laws. In addition to the intervention reviewed below, two more interventions to increase physical activity by using environmental and policy approaches (i.e., [1] transportation policies and infrastructure changes to promote nonmotorized transit and [2] urban planning approaches—zoning and land use) are under way and will be included in a subsequent report.

Creation of or Enhanced Access to Places for Physical Activity Combined with Informational Outreach Activities

These interventions involve the efforts of worksites, coalitions, agencies, and communities to create or provide access to places and facilities where people can be physically active. For example, interventions in the body of evidence include providing access to weight and aerobic fitness equipment in fitness centers or community centers, creating walking trails, and providing access to nearby fitness centers.

In addition to promoting access, many of these studies incorporated components such as training on equipment, health behavior education and techniques, seminars, counseling, risk screening, health forums and workshops, referrals to physicians or additional services, health and fitness programs, and support or buddy systems. These multicomponent interventions were evaluated together because it was not possible to separate out the incremental benefits of each component.

Reviews of evidence

Effectiveness. Our search identified a total of 12 studies[143–154] evaluating the effectiveness of creation of or enhanced access to places for physical activity combined with informational outreach activities. Of these studies, two were excluded because of limited study design.[146,147] The remaining ten studies all had fair quality of execution, seven had greatest suitability of study design,[143–145,148,150,153,154] and three had least suitability of study design.[149,151,152] Details of the ten qualifying studies are provided at the website (www.thecommunityguide.org).

Eight arms from five studies[144,150,151,153,154] measured change in aerobic capacity: the median increase was 5.1% (interquartile range, 2.8% to 9.6%). Three arms from two studies[144,153] measured change in energy expenditure: the median increase was 8.2% (range, −2.0% to 24.6%). Four arms from two studies[145,148] measured change in the percentage reporting some leisure-time physical activity: the median increase was 2.9% (interquartile range, −6.0 to 8.5%). Six arms from one study[152] measured exercise score: the median increase was 13.7% (interquartile range, −1.8% to 69.6%). Four arms from three studies[143,148,151] measured the percentage reporting three or more exercise sessions per week, and two studies[149,150] measured frequency of physical activity (Figure 3); the median increase was 48.4% (interquartile range, 21.0% to 83.8%). Although we did not attempt a single quantitative summary across the diverse effect measures because they could not be transformed to the same scale, the results of the various effect measures support a generally similar narrative conclusion: the preponderance of the evidence suggests that this type of intervention is effective in increasing physical activity.

Applicability. All of the studies were conducted in the United States. Eight studies were conducted at worksites, which included industrial plants (automotive, brewing, printing), universities, and federal agen-

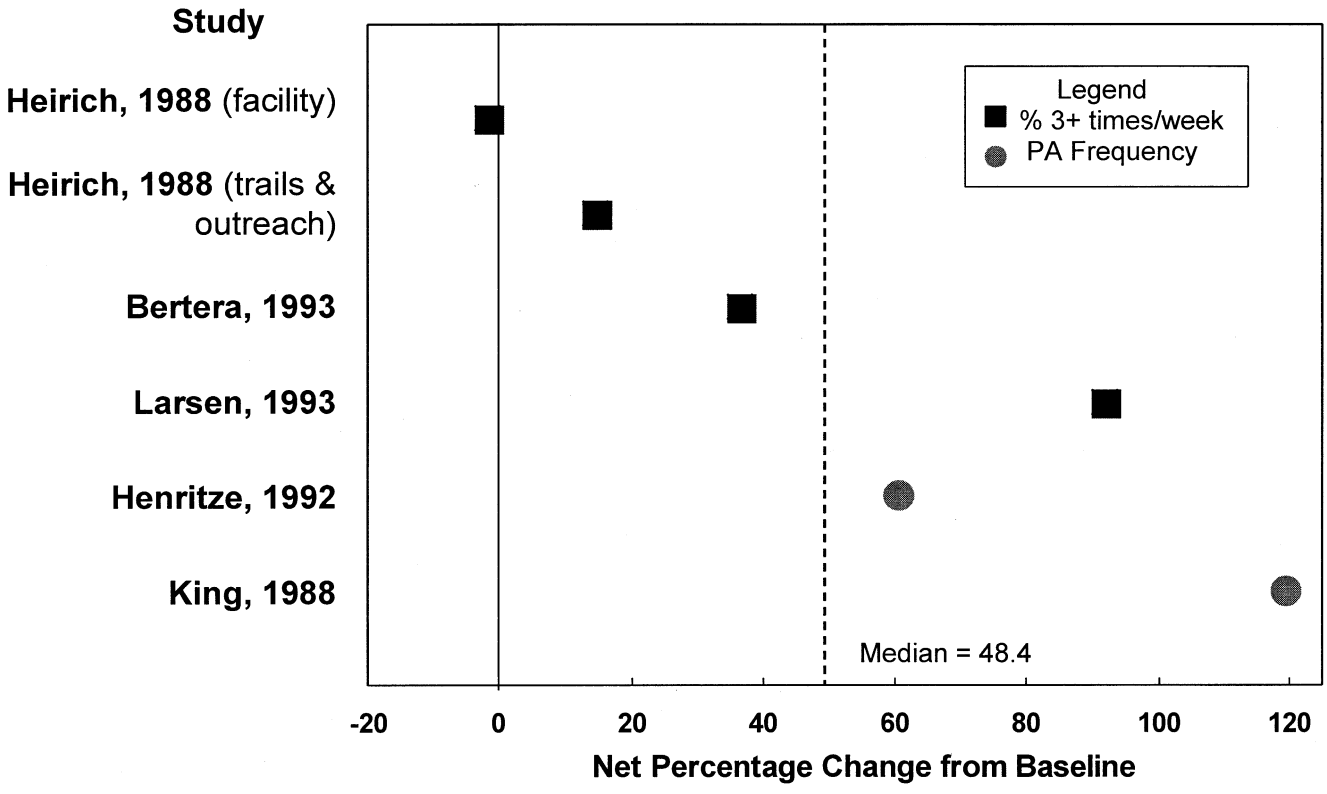

Figure 3. Creation of or enhanced access to places for physical activity combined with informational outreach: net percentage change from baseline in frequency of physical activity.
PA, physical activity.

cies.[143,144,148–151,153,154] Two studies were conducted in low-income communities.[145,152] One study included only men[150] and two studies stratified for men and women.[145,152] One study[152] included only blacks, and one study reported results specific to blacks.[145] Given the diversity of settings and populations included in this body of evidence, these results should be applicable to diverse settings and populations, provided appropriate attention is paid to adapting the intervention to the target population.

Other positive or negative effects. Ten arms from six studies[145,148–150,153,154] examined weight change. Measures included percentage of body fat, weight, and percentage of people who were overweight. Nine arms from the same six studies showed decreases in percentage of body fat or weight losses.[145,148–150] One arm from one study[148] showed a weight gain. One study showed improvements in strength and improvements on the Physical Readiness Test composite score.[153] One study[154] showed improvements in flexibility. One study[150] showed increases in perceived energy and confidence in the ability to exercise regularly.

In addition to the direct health benefits in terms of physical activity, other health benefits also may have resulted from the intervention. Many of the studies in this body of evidence also addressed cardiovascular disease risk factors, particularly diet and smoking, through provision of information.

Economic. Our search identified two economic evaluations[155,156] of interventions to create or enhance access to places for physical activity. One 4-year study[155] conducted at fitness facility in Houston, Texas, for employees of an insurance company conducted a cost–benefit analysis of a structured physical fitness program. The program included regularly scheduled classes in aerobic dancing, calisthenics, and jogging; seminars on obesity, smoking, alcohol abuse, and stress reduction also were offered. Program benefits included savings in major medical costs, reduction in average number of disability days, and reduction in direct disability dollar costs. Program costs included personnel, nonsalary operating expenses, and medical claims. The adjusted estimates for benefits and costs for 1 year of the program are $1106 and $451, respectively. On the basis of the quality assessment criteria used in the *Community Guide* this study was classified as good.[40] The economic summary table for the study is provided at the website (www.thecommunityguide.org).

A 5-year study[156] with projections for an additional 10 years was conducted in a workplace setting among 36,000 employees and retirees of an insurance company. The researchers conducted a cost–benefit analy-

sis of a company-sponsored health and fitness program that used health promotion centers, newsletters, medical reference texts, videotapes, and quarterly media blitzes. Program benefits included cost savings from healthcare costs averted, absenteeism reduction, deaths averted, and increased productivity. Program costs included personnel, overhead, capital equipment, materials, and rent; employee time away from the job was not included as a program cost. The adjusted estimates for benefits and costs are $139 million and $43 million, respectively. On the basis of the quality assessment criteria used in the *Community Guide*, this study was classified as good.[40]

Barriers to intervention implementation. One potential barrier to creation of or enhanced access to places for physical activity is that building new facilities is time and resource intensive. In addition, creation of or enhanced access to facilities requires careful planning and coordination, as well as resources sufficient to carry out the construction. Success is greatly enhanced by community buy-in, which can take a great deal of time and effort to achieve. Inadequate resources and lack of professionally trained staff members may affect how completely and appropriately interventions are implemented and evaluated.

Conclusion. According to *Community Guide* rules of evidence,[39] there is strong evidence that creation of or enhanced access to places for physical activity combined with informational outreach activities is effective in increasing levels of physical activity, as measured by an increase in the percentage of people engaging in physical activity or other measures of physical activity.

Research Issues

Informational Approaches to Increasing Physical Activity

Effectiveness. The effectiveness of recommended and strongly recommended interventions in this section (i.e., community-wide campaigns and point-of-decision prompts) is established. However, important research issues about the effectiveness of these interventions remain.

Point-of-decision prompts

- What is the sustained effect of placing signs near the elevator or escalator?
- What effect does varying the message or format of the sign have on providing a "booster" to stair climbing among the targeted population?
- What type of sign is most effective? What effect do format or size have, if any?
- Does effectiveness vary by setting and target audience?
- Is there a "critical distance" from the elevator or escalator to the stairs in which the effect of signage on stair-climbing behavior is reduced?

Because the effectiveness of mass media campaigns and classroom-based health education focused on information provision has not been established, basic research questions remain.

- Are these interventions effective in increasing physical activity?
- Do these interventions promote positive or negative attitudes toward physical activity?
- Do these interventions promote changes in physical activity mediators, such as stage of change or changes in policy, which may lead to population shifts?

Community-wide campaigns

- What characteristics and components of community-wide campaigns are most effective?
- How can community-wide efforts be institutionalized?
- What are the most effective and efficient delivery settings and channels (e.g., media, work settings)?
- Do coalitions enhance the delivery and effectiveness of interventions in community settings? If so, is the enhanced effect worth the potential added cost and burdens of implementation?

Behavioral and Social Approaches to Increasing Physical Activity

Effectiveness. The effectiveness of recommended and strongly recommended interventions in this section (i.e., school-based PE, social support interventions in community settings, individually-adapted health behavior change programs) is established. However, research issues about the effectiveness of these interventions remain.

School-based PE

- Is school-based PE as effective for preschool, elementary, and high school students as for middle school students?
- Is effectiveness of school-based PE different in coed classes versus single-sex classes in junior high and high school?
- Are classroom teachers as effective as PE specialists?
- What is the relationship between PE class and overall daily physical activity? Is activity outside the school setting reduced when activity in PE is increased?
- Are before-school and after-school PE programs effective in increasing student's total daily activity levels or improving fitness?
- Does physical activity incorporated into regular classes result in effects similar to physical activity incorporated in a dedicated PE class?
- Is the effectiveness or efficacy of school-based PE affected by school setting (e.g., type of school, urban,

suburban, etc.) or by population served (e.g., lower socioeconomic status, racial or cultural differences)?

Social support interventions in community settings

- What type of social support and what medium works for whom? Do intensity and structure of the support make a difference?
- How does effect size vary by frequency of social interaction?
- Does the effect of these interventions vary by gender?

Individually-adapted health behavior change

- What characteristics and components are most effective?
- What mode of delivery is most effective?
- Does the effectiveness of behavioral change method vary by type of physical activity?

Because the effectiveness of college-based health education and PE, classroom-based health education focused on reducing television viewing and video game playing, and family-based social support has not been established, basic research questions remain.

- Are these interventions effective in increasing physical activity?
- Do these interventions promote positive or negative attitudes toward physical activity?

Environmental and Policy Approaches to Increasing Physical Activity

Effectiveness. The effectiveness of the strongly recommended intervention in this section (i.e., creation of or enhanced access to places for physical activity) is established. However, research issues about the effectiveness of these interventions remain.

- What characteristics of a community are necessary for the optimal implementation of policy and environmental interventions?
- Does the effectiveness vary by type of access (e.g., worksite facility or community facility) or socioeconomic group?
- How can the necessary political and societal support for this type of intervention be created or increased?
- Does creating or improving access motivate sedentary people to become more active, give those who are already active an increased opportunity to be active, or both?
- If you build it, will they come? In other words, is enhanced access to places for activity sufficient to create higher physical activity levels, or are other intervention activities also necessary?
- What are the effects of creating new places for physical activity versus enhancing existing facilities?
- Which neighborhood features (e.g., sidewalks, parks, traffic flow, proximity to shopping) are the most crucial in influencing activity patterns?
- How does proximity of places such as trails or parks to residence affect ease and frequency of use?

General Research Issues

Effectiveness. Several crosscutting research issues about the effectiveness of all of the reviewed interventions remain.

- What behavioral changes that do not involve physical activity can be shown to be associated with changes in physical activity? For example, does a decrease in time spent watching television mean an increase in physical activity or will another sedentary activity be substituted? Does an increase in the use of public transportation mean an increase in physical activity or will users drive to the transit stop?
- Physical activity is difficult to measure consistently across studies and populations. Although several good measures have been developed, several issues remain to be addressed.
- Reliable and valid measures are needed for the spectrum of physical activity.

  Rationale: Current measures are better for vigorous activity than for moderate or light activity. Sedentary people are more likely to begin activity at a light level; this activity is often not captured by current measurement techniques.

- Increased consensus about "best measures" for physical activity would help to increase comparability between studies and would facilitate assessment of effectiveness.

  Note: This is not intended to preclude researchers' latitude in choosing what aspects of physical activity to measure and to decide which measures are most appropriate for a particular study population. Perhaps a useful middle ground position would be the establishment of selected core measures that most researchers should use which could then be supplemented by additional measures. The duration of an intervention's effect was often difficult to determine. Although some researchers did attempt long-term follow-up and assessment, many questions remain.

- How long does the effect of an intervention endure after intervention activities cease?
- Does the duration of an intervention affect the maintenance of activity? For example, does a 2-year intervention show effectiveness for a longer period after the intervention ends than a 10-week intervention? What strategies can be used to maintain an intervention effect after the intervention ends? Are periodic "boosters" necessary or helpful?
- What is the nature and role of program "champions"

in ensuring the successful implementation and adoption of an intervention?

Applicability. Each recommended and strongly recommended intervention should be applicable in most relevant target populations and settings, assuming that appropriate attention is paid to tailoring. However, possible differences in the effectiveness of each intervention for specific subgroups of the population often could not be determined. Several questions about the applicability of these interventions in settings and populations other than those studied remain.

- Are there significant differences in the effectiveness of these interventions, based on the level or scale of an intervention?
- What are the effects of each intervention in various sociodemographic subgroups, such as age, gender, race, or ethnicity?

Other positive or negative effects. The studies included in this review did not report on other positive and negative effects of these interventions. Research on the following questions would be useful:

- Do informational approaches to increasing physical activity help to increase health knowledge? Is it necessary to increase knowledge or improve attitudes toward physical activity to increase physical activity levels?
- Do these approaches to increasing physical activity increase awareness of opportunities for and benefits of physical activity?
- What are the most effective ways to maintain physical activity levels after the initial behavior change has occurred?
- Are there other benefits from an intervention that might enhance its acceptability? For example, does increasing social support for physical activity carry over into an overall greater sense of community?
- Are there any key harms?
- Is anything known about whether or how approaches to physical activity could reduce potential harms (e.g., injuries or other problems associated with doing too much too fast)?

Economic evaluations. The available economic data were limited. Therefore, considerable research is warranted on the following questions:

- What is the cost-effectiveness of each of these interventions? or
- How can effectiveness in terms of health outcomes or quality-adjusted health outcomes be better measured, estimated, or modeled? or
- How can the cost benefit of these programs be estimated?
- How do specific characteristics of each of these approaches contribute to economic efficiency?
- What combinations of components in multicomponent interventions are most cost-effective?

Barriers. Research questions generated in this review include the following:

- What are the physical or structural (environmental) barriers to implementing these interventions?
- What resource (time and money) constraints prevent or hinder the implementation of these interventions?

Summary

The *Community Guide*'s physical activity recommendations identify intervention tools that practitioners can use to achieve the *Healthy People 2010* Objectives for Physical Activity and Fitness.[32] The Task Force strongly recommends community-wide health education campaigns, school-based PE, and social support in community settings, highlighting the role of multisite, multicomponent interventions in successfully increasing physical activity behaviors. Two strongly recommended approaches—individually-adapted health behavior change and creation of and enhanced access to places for physical activity combined with informational outreach activities—point out the roles that policy and environmental approaches and behavioral and social approaches to increasing physical activity can play in combating inactivity in our culture. The recommendation for the use of point-of-decision prompts as a strategy to promote physical activity underlines the relative simplicity of many of the recommended strategies. These recommendations should serve well the needs of researchers, planners, and other public health decision makers in shaping the future agenda for efforts to explore and promote physical activity and thereby improve the health of the nation.

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Appendix A
Methods

The Task Force on Community Preventive Services (the Task Force) chose the topic "increasing physical activity" for inclusion in the *Guide to Community Preventive Services* (the *Community Guide*) because of the high and increasing prevalence of physical inactivity in the United States and the accompanying impact on the health of the American public. In addition, physical inactivity is largely preventable. Using systematic review methods, The Task Force sought evidence of effectiveness of interventions to increase physical activity and reduce the public health burden of sedentary behavior.

The *Community Guide's* methods for conducting systematic reviews and linking evidence to recommendations have been described elsewhere.[1,2] In brief, for each *Community Guide* topic, a diverse team representing a range of disciplines, backgrounds, experiences, and work settings conducts a review by:

- developing a conceptual framework for organizing, grouping, and selecting the interventions for the health issues under consideration and for choosing the outcomes used to define success for each intervention;
- systematically searching for and retrieving evidence;
- assessing the quality of and summarizing the strength of the body of evidence of effectiveness;
- summarizing information regarding other evidence; and
- identifying and summarizing research gaps.

This report describes the specific methods used in the systematic literature reviews to determine the effectiveness of interventions to increase physical activity. In this review effectiveness is defined as the actual improvement in health outcomes that an intervention can produce in typical community-based settings.

Systematic Review Development Team

Three groups of individuals served on the systematic review development team:

- The coordination team consisted of a Task Force member, methodologic experts in systematic reviews and economics from the Community Guide Branch (Epidemiology Program Office, Centers for Disease Control and Prevention [CDC]), and physical activity experts from the National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP), CDC and the National Heart, Lung and Blood Institute (NHLBI), National Institutes of Health. This team drafted the conceptual framework for the reviews, managed the data collection and review process, and drafted evidence tables, summaries of the evidence, and the reports.
- The consultation team reviewed and commented on materials developed by the coordination team and set priorities for the reviews. This team consisted of physical activity experts in state and local public health settings, academic organizations, federal agencies, and voluntary organizations, with backgrounds in medicine, public health, economics, health promotion intervention design and implementation, health education, health policy, and epidemiology.
- The abstraction team collected and recorded data from studies for possible inclusion in the systematic reviews. (See "Evaluating and Summarizing the Studies," below.) This team included some members of the coordination and consultation teams as well as graduate students and preventive medicine residents.

Unless otherwise noted, in this report and the accompanying article,[3] the term *team* refers to the coordination team.

Conceptual Approach

The systematic reviews were designed to address the following research questions:

- What interventions are effective in increasing or maintaining levels of physical activity in populations?
- What interventions in current use are ineffective, inefficient, or potentially harmful?

When developing the systematic reviews, the team first created a conceptual framework that included the following elements:

- A graphic illustration depicting the relationships between factors that precede and are thought to affect physical activity, physical activity behavior itself, physical fitness and other physiologic effects of physical activity, and health outcomes. We refer to this illustration as the *logic framework* (Figure 1 in the main body of this article).
- A list of candidate interventions to increase physical activity (Table A-1);
- The criteria used to select interventions for review;
- The final list of interventions evaluated; and
- The outcomes for which evidence was to be sought and the subset that would be used to define success and result in recommendations ("recommendation outcomes").

Table A-1. Candidate interventions

Proposed intervention category	Selected examples (for illustration only)
Interventions aimed at changing the **physical environment** to increase exercise opportunities	• Creation of safe, lighted walking paths • Creation of worksite and school fitness facilities • Creation of safer pedestrian environments • Provision of signs, other prompts at choice points for physical activity

Organization-based policy interventions to increase exercise opportunities	• School-based skills-oriented interventions
	  • Classroom curricula
	  • Physical education curricula
	• Johnson & Johnson Live for Life

Community-wide policy interventions to increase exercise opportunities	• Policies or legislation establishing financial incentives for organizations and communities to provide access to exercise opportunities
Community coalition-building, partnerships, community organizations to promote physical activity	• Planned Approach to Community Health (PATCH) • Bootheel Project (State of Missouri)
Health education classes to change knowledge and attitudes about benefits of exercise, ways to increase exercise	• School-based knowledge-oriented curriculum • Adult health education classes offered by health maintenance organizations
Provider training to change knowledge, attitudes, beliefs, and behavior about physical activity screening and promotion among clinical healthcare providers	• Physician-based Assessment and Counseling for Exercise (PACE) • Physically Active for Life (PAL)
Community-leader training, e.g., "Train-the-trainers"	• Community Health Advisors • Physical Activity Risk Reduction (PARR) • Zuni study
Special support mechanisms to facilitate and maintain behavior change	• Telephone support, counseling • Physical activity and exercise clubs (e.g., walking, biking clubs) • Designation of walking partners • Family-based programs • School-based social support • Faith-based social support
Skills-oriented health or fitness classes to identify high-risk situations and exercise barriers, develop physical activity and exercise skills, self-management and monitoring skills, and relapse prevention skills	• Worksite-based physical activity courses • Healthcare-site health promotion classes
Use of **behavioral reinforcements**	• Use of contingencies, incentives to change exercise and physical activity behavior • Contracting and/or goal-setting to develop intentions to exercise • Reminder systems for exercise and physical activity
Home-based exercise programs	• Videotapes • Exercise "prescription" for home
Structured/supervised exercise programs	• Hospital and cardiac rehabilitation programs • Health spa—proprietary programs
Public information and social marketing campaigns to change knowledge, attitudes, and beliefs about benefits, opportunities for exercise; change social norms about desirability or need for exercise; or create demand for increased opportunities for exercise	• Mass media campaigns • National health initiatives

Logic Framework

To develop the logic framework, the coordination team first illustrated the relationships between physical activity, physical fitness, morbidity, and mortality. For example, physical activity has been shown to improve measures of fitness such as aerobic capacity, muscular strength and endurance, body composition, agility, and coordination.[4] Physical activity also improves metabolic functioning, exemplified by improvements in bone density, lipid profiles, insulin levels, and immune function. Regular physical activity is also associated with improved health and quality of life and a reduced risk for all-cause mortality.[5–8] Those who are physically active have a reduced risk of developing cardiovascular disease,[9–12] non-insulin-dependent (type 2) diabetes,[13–15] colon cancers,[16–19] osteoporosis,[20–22] depression,[23–25] and fall-related injuries.[26–29]

These relationships between increased physical activity and health were assumed by the team to already be well established and were not the focus of the systematic review. Instead, the team focused on whether particular interventions increased physical activity behaviors. The logic framework also shows the means by which interventions are thought to be effective. Modifiable determinants of behavior are grouped into three categories: (1) information-based determinants such as knowledge and attitudes about physical activity and behaviors that precede physical activity, motivation to be active, or intentions to engage in activity; (2) behavioral and social skills that facilitate the adoption and maintenance of behavioral change; and (3) characteristics of the physical environment that increase the possibility and likelihood of physical activity occurring, such as safe and accessible parks and recreation facilities.

Candidate Interventions

Using the logic framework, the coordination team initially developed three categories of interventions:

- Individual approaches: behavior modification, social learning, and individually-tailored programs.
- Setting-specific interventions: school-based, worksite-based, health facility-based, and faith-based.
- Community-wide interventions: community organizing, coalitions, and partnerships; mass media and social marketing approaches; environmental change approaches; legislative action, policy change, and incentives.

From these three categories, the team generated a comprehensive list of candidate interventions for inclusion that addressed each of the modifiable determinants (i.e., individual level factors, social and behavioral factors, and physical environment). This list was put in priority order for review through a process of polling the coordination and consultation teams and other specialists in the field. Factors for priority setting were the perceived public health importance (e.g., the number of people affected and likely magnitude of intervention effect), the practicality of application, and the need of those promoting physical activity to have information on each intervention. Interventions reviewed were either single-component (i.e., using only one activity to achieve desired outcomes) or multicomponent (i.e., using more than one related activity). The specific interventions chosen for review are described in the main body of this article.

Selection of Interventions for Review

In this review, the coordination team decided to exclude interventions that use physical activity solely as a therapeutic intervention or address a population group because the members share a clinical condition. For example, we excluded studies that examined the effect of exercise on rehabilitation from myocardial infarction or stroke as well as studies that focus on exercise as a treatment for conditions such as arthritis or depression. We also excluded training studies, that is, efficacy studies of physical activity on health parameters. These decisions were made for several reasons. Rehabilitative studies were excluded because the team wanted to focus on interventions aimed at changing the behavior of the general population; it was felt that populations with clinical conditions or those receiving therapy would have special motivating factors that might positively influence the apparent effectiveness of a given strategy. Training studies were excluded because the health benefits of physical activity are already well established.[4]

Selection of Outcomes for Review

Many of the studies included in our body of evidence targeted behavioral risk factors in addition to physical inactivity, most often poor diet and tobacco use. Many physiologic benefits of increased physical activity can also result from improvements in these other behaviors.

The team's primary outcome of interest was physical activity behavior. We also used aerobic capacity, defined as the maximum amount of oxygen that can be transported from the lungs to the tissues during exercise.[30] We used aerobic capacity for two reasons: first, physical activity is difficult to measure, especially among children, making an alternative measure desirable. Second, changes in aerobic capacity and changes in physical activity are inextricably linked, since the only way to increase aerobic capacity is to increase physical activity. Therefore, an increase in aerobic capacity can be used as an indicator of (or marker for) increased physical activity.

Aerobic capacity is measured with greater reliability and validity than is behavior. Therefore, in most cases, measures of aerobic capacity were considered superior to measures of physical activity if both were available for the same study. The team developed an algorithm to guide the Task Force when reviewing conflicting results in behavioral (physical activity) and physiologic (aerobic capacity) measures (Table A-2).

Search Strategy

The reviews of interventions to increase physical activity reflect systematic searches of seven computerized databases (MEDLINE, Sportdiscus, Psychlnfo, Transportation Research Information Services [TRIS], Enviroline, Sociological Abstracts, and Social SciSearch) as well as reviews of reference lists and consultations with experts in the field. These yielded 6238 titles and abstracts for review. Studies were eligible for inclusion if they:

- were published in English during 1980-2000;

Table A-2. Algorithm to aid in making recommendations when there are conflicting results in the two outcomes measured

Aerobic capacity (VO_2 max)	Physical activity behavior		
	Increase	**No change**	**Decrease**
Increase	Recommend for	Recommend for	Recommend for[a]
No change	Recommend for[b]	Insufficient evidence	Recommend against
Decrease	Insufficient evidence[a]	Insufficient evidence	Recommend against

[a]Bodies of evidence (or studies) that fall into these categories should be examined to look at issues related to measurement error.
[b]This result may occur, depending on dose (frequency, intensity, and duration) of physical activity, duration of the intervention, or the initial level of fitness among the population being studied.

- were conducted in an Established Market Economy;[a]
- assessed a behavioral intervention primarily focused on physical activity;
- were primary investigations of interventions selected for evaluation rather than, for example, guidelines or reviews;
- evaluated outcomes selected for review; and
- compared outcomes among groups of persons exposed to the intervention with outcomes among groups of persons not exposed or less exposed to the intervention (whether the study design included a concurrent or before-and-after comparison).

After review of the abstracts and consultation with specialists in the field, a total of 849 reports was retrieved. Of these, 253 were retained for full review. On the basis of limitations in execution or design or because they provided no additional information on studies that were already included, 159 of these were excluded and were not considered further. The remaining 94 studies were considered qualifying studies.

Individual studies were grouped together on the basis of the similarity of the interventions being evaluated, and analyzed as a group. Some studies provided evidence for more than one intervention. In these cases, the studies were divided into arms and reviewed for each applicable intervention, population, or outcome measure. Interventions and outcome measures were classified according to definitions developed as part of the review process. The classification and nomenclature used in our systematic reviews sometimes differs from that used in the original studies.

Evaluating and Summarizing the Studies

Each study that met the inclusion criteria was evaluated using a standardized abstraction form and was assessed for suitability of the study design and threats to validity.[1,31] On the basis of the number of threats to validity, studies were characterized as having good, fair, or limited execution.[1,31] Studies with limited execution were not included in the summary of the effect of the intervention. The remaining studies (i.e., those with good or fair execution) were considered qualifying studies. Estimates of effectiveness are based on those studies.

In this review, effect sizes were calculated as the net percent change from baseline. This was done by one of three different methods, depending on study design. Our preferred measure was calculated from studies with the greatest suitability of design, that is, randomized or non-randomized clinical or community trials, multiple measurement before-and-after designs with concurrent comparison groups, and prospective cohort studies. These present both a control (C) group and measurements made before and after an intervention (I). The intervention effect was calculated according to the following formula:

$$\frac{I_{post}-I_{pre}}{I_{pre}} - \frac{C_{post}-C_{pre}}{C_{pre}}$$

When studies did not include a control group, we assumed that in the absence of an intervention, no change would have occurred; that is, $C_{post} - C_{pre} = 0$, and we calculated the net intervention effect using measurements from the intervention group:

$$\frac{I_{post}-I_{pre}}{I_{pre}}$$

When studies had a control group but no baseline measurements, we assumed that the intervention and comparison groups were equivalent at baseline, that is, $I_{pre} = C_{pre}$. The next intervention effect was calculated as:

$$\frac{I_{post}-C_{post}}{C_{post}}$$

Net intervention effects were calculated for all reported measurements of a given outcome. Often, different variables were used within a study to assess changes affecting the same outcome (e.g., changes in physical activity might be calculated by measuring times per week in physical activity, self-reported physical activity score, minutes per week in physical activity, or all three). Multiple measurements of the same outcome were examined for consistency. Medians were calculated as summary effect measures for each type of measurement and were compared across outcomes for consistency.

Recommendations were based on behavioral measurements or measurements of aerobic capacity or both, according to the algorithm outlined in Table A-2.

Bodies of evidence of effectiveness were characterized as strong, sufficient, or insufficient on the basis of the number of available studies, the suitability of study designs for evaluating effectiveness, the quality of execution of the studies, the consistency of the results, and the effect size.[1]

Other Effects

The *Community Guide's* systematic reviews of interventions to increase physical activity also sought information on other

[a]Established Market Economies as defined by the World Bank are Andorra, Australia, Austria, Belgium, Bermuda, Canada, Channel Islands, Denmark, Faeroe Islands, Finland, France, Germany, Gibraltar, Greece, Greenland, Holy See, Iceland, Ireland, Isle of Man, Italy, Japan, Liechtenstein, Luxembourg, Monaco, the Netherlands, New Zealand, Norway, Portugal, San Marino, Spain, St. Pierre and Miquelon, Sweden, Switzerland, the United Kingdom, and the United States.

effects (i.e., positive and negative health or nonhealth 'side effects'). In addition to physical activity and aerobic capacity outcomes, we collected information about adiposity and measures of physical fitness, including flexibility, muscular strength, agility, balance, and coordination. We also collected information about changes in knowledge, attitudes, and intentions, which are outcomes that may precede and thus affect physical activity. Information on other effects was only derived from studies that measured physical activity and aerobic capacity, as having information about these variables was one of the inclusion criteria.

Evidence of potential harms of these interventions was sought if they were mentioned in the effectiveness literature or if the team thought they were important. For example, in the reviews of school-based physical education, the team specifically sought information about the effect of the interventions reviewed on academic performance, because of stated concerns about the potential negative effects of taking time away from academic subjects.

Evaluating Economic Efficiency

For all interventions that were either recommended or strongly recommended by the Task Force, the team conducted systematic reviews of the evidence of economic efficiency. These reviews are provided to help decision makers choose among recommended interventions on the basis of comparing costs with intended outcomes.

The general methods for conducting systematic reviews of economic efficiency have been previously reported[2] and are summarized here as they were adapted for the review of interventions to increase physical activity. The four basic steps are:

- searching for and retrieving evidence;
- abstracting and adjusting the economic data;
- assessing the quality of the identified economic evidence; and
- summarizing and interpreting the evidence of economic efficiency.

Searching for and retrieving economic evidence

The databases MEDLINE, Transportation Research Information Services (TRIS), Combined Health Information Database (CHID), ECONLIT, PsychInfo, Sociological Abstracts, Sociofile, Social SciSearch, and Enviroline were searched for the period 1980–2000. In addition, the references listed in all retrieved articles were reviewed and experts were consulted. Most of the included studies were either government reports or were published in journals. To be included in the review a study had to:

- be a primary study rather than, for example, a guideline or review;
- take place in an Established Market Economy;[a]
- be written in English;
- meet the team's definitions of the recommended and strongly recommended interventions;
- use economic analytical methods such as cost analysis, cost-effectiveness analysis, cost-utility, or cost-benefit analysis; and
- itemize program costs and costs of illness or injury averted.

Abstraction and adjustment of economic data

Two reviewers read each study meeting the inclusion criteria. Any disagreements between the reviewers were reconciled by consensus of the team members. A standardized abstraction form (available at www.thecommunityguide.org) was used for abstracting data. For those studies conducting cost-effectiveness and cost-utility analysis, results were adjusted to approximate the analysis to the reference case suggested by the Panel on Cost-effectiveness in Health and Medicine.[32] Results from cost-benefit analyses were adjusted for currency (to U.S. dollars) and base-year (to 1997 dollars) only. When feasible, results were recalculated if the discount rate used in the study was other than 3%.

Assessing the quality of the evidence

Quality of study design and execution was systematically assessed across five categories: study design, cost data, outcome measure, effects, and analysis. By subtracting points for each limitation from a perfect score of 100, study quality was characterized as very good (90–100), good (80–89), satisfactory (60–79), or unsatisfactory (less than 60). Results from unsatisfactory studies were not presented.

Summarizing the body of evidence

The findings regarding the economic efficiency of interventions are presented in summary tables. The summary tables include information on seven aspects of each included study. Table A-3 is an example of a summary table.

Ratios or net present values (i.e., the summary measures for use in cost-effectiveness or cost-utility analyses and cost-benefit analysis, respectively) are pooled in ranges in those cases in which the intervention definition, population at risk, and comparator match across studies.

Barriers

Information regarding barriers to implementation of the interventions was abstracted from reviewed studies, evaluated on the suggestion of the team, or both. Information on barriers did not affect the Task Force recommendations, but is provided to assist readers contemplating implementation of the interventions.

Translating Strength of Evidence into Recommendations

The Task Force recommendations presented in the accompanying article[3] are based on the evidence gleaned from the systematic reviews conducted in accordance with the methods presented here. The strength of each recommendation is based on the strength of the evidence of effectiveness (e.g., an intervention is strongly recommended when there is strong evidence of effectiveness, and recommended when there is sufficient evidence).[1] Other types of evidence can also affect a recommendation. For example, evidence of harms resulting from an intervention might lead to recommendation that the intervention not be used if adverse effects outweigh improved outcomes. In general, the Task Force does not use economic information to modify recommendations.

A finding of insufficient evidence of effectiveness should not be seen as evidence of ineffectiveness, but rather reflects the fact that the systematic review did not identify enough information for the Task Force to make a recommendation.

Table A-3. Sample of economic summary table

–Authors –Authors' affiliation –Funding source –Publication Date –Study Period	–Analytic method –Reported or calculated summary measure	–Study location –Setting type –Population description –Follow-up period	–Interventions studied –Comparisons	–Reported currency and base year –Costs included –Reported summary measure –Reported effect size	–Adjusted currency and base year –Adjusted value summary measure –Notes	–Quality category –Quality score –Notes
Individually-adapted Health Behavior Change Program						
–Sevick MA, Dunn AL, Morrow MS, Marcus BH, Chen GJ, Blair SN –Wake Forest University; Cooper Institute for Aerobics Research –National Institutes of Health, Nordic Track, Stair master, Cybex, PreCor and Yamax Corporation. –2000 –2 years	–Cost-effectiveness analysis –Program cost per average unit of improvement for lifestyle intervention (C_1) and structured intervention (C_2)	–Dallas, Texas –Fitness facility –Adults aged 35–60 years –No follow-up	–Center-based lifestyle exercise consisting of behavioral skills, and structured exercise consisting of supervised center-based exercise –Baseline	–1994 U.S. dollars –Costs included personnel, capital equipment, facilities and general supplies –Program cost per average unit of improvement[a] C_1: \$0.04–\$3.63/average unit of improvement C_2: \$0.06–\$4.98/average unit of improvement –Effect size included different measures of physical activity and cardiorespiratory fitness	–1997 U.S. dollars –Program cost per average unit of improvement C_1: \$0.05–\$3.93/average unit of improvement C_2: \$0.07–\$5.39/average unit of improvement	–Good –88 –Study did not use societal perspective, did not define the analytic horizon, and did not report base-year for resource prices

[a]The range values are for several outcome measures.

Further, it is important for identifying areas of uncertainty that require additional research. In contrast, sufficient or strong evidence of ineffectiveness leads to a recommendation that the intervention not be used.

Summarizing Research Gaps

Systematic reviews in the *Community Guide* identify existing information on which to base public health decisions about implementation of interventions. An important additional benefit of these reviews is the identification of areas in which information is lacking or of poor quality. To summarize these gaps, remaining research questions for each intervention evaluated were identified. Where evidence of effectiveness of an intervention was sufficient or strong, remaining questions regarding effectiveness, applicability, other effects, economic consequences, and barriers were summarized.

Where evidence of effectiveness of an intervention was insufficient, remaining questions regarding only effectiveness and other effects were summarized. Applicability issues were summarized only if they affected the assessment of effectiveness. The team decided that it would be premature to identify research gaps in economic evaluations or barriers before effectiveness was demonstrated.

For each category of evidence, issues that had emerged from the review were identified, based on the informed judgment of the team. Several factors influenced that judgment. When a conclusion was drawn about evidence, the team decided if additional issues remained.

- If effectiveness was demonstrated using some but not all outcomes, all other possible outcomes were not necessarily listed as research gaps.
- If the available evidence was thought to be generalizable, all subpopulations or settings where studies had not been done were not necessarily identified as research gaps.
- Within each body of evidence, the team considered whether there were general methodologic issues that would improve future studies in that area.

The Reviews of Evidence

This appendix describes the general methodologic approach used in the systematic reviews of interventions to increase physical activity. The main text of this article presents the supporting evidence on which the Task Force based its recommendations about these interventions. It describes the scope and extent of the problem studied, discusses the conceptual approach to the review of evidence for the interventions studied, and presents additional information about methodology specific to the review of those interventions, in addition to giving a detailed report on the findings for each intervention.

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Appendix B. Studies Measuring the Effectiveness of School-based Physical Education (PE)

Author & year Design suitability: design Quality of execution Evaluation setting	Intervention and comparison elements	Study population description Sample size	Results [a] Effect measure	Value used in summary [b]	FU time
Luepker RV, 1996[1] McKenzie TL, 1996[2] Greatest: Randomized group trial Good execution Elementary school	Location: Austin, TX; Minneapolis, MN; New Orleans, LA; and San Diego, CA Intervention: Child and Adolescent Trial for Cardiovascular Health (CATCH) PE: ≥90 min of CATCH PE in 3 sessions/wk and engage students in moderate to vigorous physical activity (MVPA) ≥40% of time, classroom curricula promoting cardiovascular health, tobacco curriculum and tobacco school policy, home/family component. Comparison: Health behavior & other assessments standard health education curriculum, but no CATCH intervention.	3rd grade students from 4 locations; ethnically diverse Cohort: N= 5106 Schools: I1= 7; I2 = 7; C=10 Students: I = ~5375; C= ~3700	*Classes:* Net % change from baseline: I - C *Students:* % diff in I vs C *Follow-up:* Net % change from end of I: I - C	Change p *Classes* PE lesson length (min) 1.3% NS % MVPA during lesson **15.7%** 0.0016 EE during lesson (kcal/kg) **9.0%** 0.002 EE rate (kcal/kg/min) **5.6%** 0.002 9-minute run (# yards) 1.0% NS *Students* VPA (mins brth hard) 26.0% 0.003 Met-weighted VPA 25.6% 0.003 NS for PA, met-weighted PA *Followup results* 1 2 3 VPA (mins brth hard) -2.9% 1.5% 2.4% Total PA (mins) 2.8% 4.1% 2.8% BMI, skinfolds NS Curves for I and C diverged significantly for MVPA and vigorous physical activity (VPA) Positive sig changes for PA self-efficacy, NS for PA ± social support	I: ~2.5 years FU (maintenance) phase : 3 yrs
Fardy PS, 1996 [3] Greatest: Randomized individual trial Good execution High school	Location: New York City (inner city) Intervention: 20–25 min daily PE class with circuit weight and aerobic training; 5 min daily health ed lecture Comparison: Usual PE classes - volleyball games and skills	High school freshman and sophomores (80%), juniors and seniors (20%); 97% minority (50% Black), mean age ~15.5 years	Net % change from baseline, I - C Knowledge = % correct on 50-item multiple choice test	Pop. subgroup Outcome Change Male Knowledge **28.5%** Female Knowledge **19.2%** Male VO_2max (ml/kg/min) 1.4% Female VO_2max (ml/kg/min) **12.1%** Changes in BMI, % body fat, self-reported PA, health attitude scores all NS	11 weeks
Donnelly JE, 1996[4] Greatest Nonrandomized group trial Fair execution Elementary school	Location: Rural Nebraska Intervention: Increased and enhanced PA program with emphasis on aerobic activity, 3 times/wk 30–40 min; health (nutrition) education; modified school lunches Comparison: Control schools with usual programs	3rd–5th graders, white, ~43% eligible for free or reduce cost lunch I school (n=236), C school (n=102); Subsamples of 100 students per school for lab tests	Net % change from baseline, I - C	Outcome Change 1 2 3 1-mile walk/run (sec) -1.1% **-2.8%** 0.5% VO_2max (ml/kg/min) 5.2% Weight (kg) -0.8% Body fat (%) 8.4% Classroom PA (avg. SOFIT score: C = 3.4; I=3.6) ~6% difference in PA; C levels did not change over 2 years Outside PA: C sig > I in after-school PA	2 years

Author & year Design suitability: design Quality of execution Evaluation setting	Intervention and comparison elements	Study population description Sample size	Results [a]		
Hopper CA, 1992[5] Greatest: Nonrandomized group trial Fair execution Elementary school	Location: Not specified (assume near Humboldt State University, in Arcata, CA) Intervention: In-class instruction, PE activities (3 times/wk for 40 min) emphasizing cardiovascular fitness, flexibility, endurance through non-competitive games, other activities. Home-based program with family exercise activities for 1 intervention group Comparison: Regular curriculum instruction	5th and 6th grade students from 6 classes: Total students = 132 School-based (S): 43 School- and home-based (SH): 45 Control (C): 44	1. (% change I - % change C)/ % change C 2. change I/ I pre	Pop Subgroup — Outcome — Change *Students* I1 (SH) vs C — Exercise knowledge — **23.1%** I1 (SH) vs C — Sit and reach flex — **13.3%** I2 (S) vs C — Exercise knowledge — **27.4%** I2 (S) vs C — Sit and reach flex — **10.8%** *Parents* Sit and reach flex — **12.6%** Situps (min) — **11.9%**	6 weeks
Hopper CA, 1996[6] Greatest: Nonrandomized group trial Fair execution Elementary school	Location: Rural CA (Arcata, CA) Intervention: In-class instruction, PE activities (3 times/wk for 40 min) emphasizing cardiovascular fitness, flexibility, endurance through non-competitive games, other activities. Home-based program with family exercise activities and storybook. Comparison: Regular curriculum instruction	2nd and 4th grade students Total students = 97; I: 48 C: 49	Students: % change I - % change C)/ % change C Parents: (I post – I pre)/ I pre	Outcome — Change — p *Students* Weight (kg) — 3.5% Skinfolds (mm) — 5.9% Mile run (sec) — 8.1% Fitness and nutrition knowledge — **24.8%** — <0.001 *Parents* Weight (kg) — 0.3% Skinfolds (mm) — -3.9% Mile run (sec) — 1.5% Fitness and nutrition knowledge — **5.3%** — < 0.05	12 weeks
Dwyer T, 1983[7] Greatest: Randomized group trial Fair execution Elementary school	Location: Adelaide, South Australia Intervention: Changes in how PE is taught. Both intervention groups increased frequency and duration of PA; Skills group (S): daily skill and competence training; Fitness group (F) aerobic activity with increased heart rate, intensity (1.25 hrs/day) Comparison: Standard PE curriculum	5th graders; 7 schools, 3 classrooms, > 500 students with broad distribution of ethnic and SES groups	Net % change from baseline: I - C	I Group — Outcome — Diff in % change S v. C — PWC 170/Kg (Kpm/min/Kg) — 4.5% F v. C — PWC 170/Kg (Kpm/min/Kg) — **11.5%** S v. C — Skinfolds (mm) — -1.4% F v. C — Skinfolds (mm) — **-5.9%**	14 weeks
Dwyer T, 1983[7] Least: Before-and-after Fair execution Elementary school	Location: Adelaide, South Australia Intervention: Combination of Fitness and Skills programs described above Comparison: 5th graders before implementation and 5th graders 2 years after program adopted	5th graders; 5 schools, 216 students with broad distribution of ethnic and SES groups	Cross-sectional Net % change from baseline, before and after intervention adopted	Outcome — Change — p *Males* PWC 170/Kg (Kpm/min/Kg) — **25.3%** — < 0.01 Skinfolds (mm) — **-10.3%** — < 0.05 *Females* PWC 170/Kg (Kpm/min/Kg) — **25.0%** — < 0.01 Skinfolds (mm) — **-10.0%** — < 0.05 % children w/ high skinfolds — **-9.4%** — < 0.05	2 years
Ewart CK, 1998[10] Greatest: Individual random trial Fair execution High school	Location: Baltimore, MD Intervention: 1 semester of aerobic exercise classes, including didactic instruction. PE used large muscle activities performed 3–5 times/wk, 20–60 min at 50%–85% of maximal oxygen uptake. Classes conducted in 50-min periods over the 18 wk semester. 18 lecture classes, ~60 exercise classes. Comparison: Standard PE curriculum	9th grade girls, 99/135 eligible students randomized, 88 completed study I =45, C = 54	Net % change from baseline: I - C	Outcome — Change — p Step test duration (sec) — **20.3%** — 0.0003* Pulse rate (bpm) — -0.6% — NS BMI (kg/m^2) — 1.2% — NS *for diff I - C (one-tailed)	3 academic years

Author & year Design suitability: design Quality of execution Evaluation setting	Intervention and comparison elements	Study population description Sample size	Results[a]		
Harrell JS, 1998[11] Greatest: Randomized group trial Fair execution Elementary school	Location: 3 North Carolina regions (Piedmont, Coastal, Mountain) Intervention: 8-week intervention delivered to (1) all children in classroom (CB) and (2) selected high-risk children (RB). American Heart Association-based classroom curriculum 2 times/wk with focus on nutrition, PA, smoking. Aerobically-oriented PE classes 3 times/week taught by PE specialists. Comparison: Received usual health instruction	Schools: N=18; Students: children with 2 risk factors at all schools: N=422 (19%) children; RB: 164 CB: 108 C: 150	Net % change from baseline: I - C Knowledge: (% change I - % change C)/ % change C	Outcome RB CB Overall p BMI (kg/m^2) 1.3% 0.7% 0.059 VO_2max (ml/kg/min) 1.4% 3.7% 0.326 PA score -1.0% 9.1% 0.407 Ex Knwl (% correct) 3.5% 19.0% 0.019* * Sig diff between RB and CB	8 weeks
Simons-Morton BG, 1991[12] Greatest: Non-randomized group trial Fair execution Elementary school	Location: Texas City, TX Intervention: PE classes with fitness curriculum; classroom health curriculum; modified school lunch; teacher training Comparison: Control schools (measurement only)	4 elementary schools: 2 I, 2 C Students: Baseline: 144 I, 133 C; Post: 171 I, 159 C	Increase median minutes MVPA (pre-post) Increase median % class time in MVPA	1. Grade 3: I1=8.5, I2=16.0; C1=2.0, C2=2.0, Grade 4: I1=23.0, I2=16.0; C1=1.0, C2=1.0, sig diff between groups at =0.05 2. Change ≤5% in control schools, 28%- ≥39% in intervention schools, all sig at α=0.05 except for 1 class	2 years
Sallis JF, 1997[13] Greatest: Randomized group trial Fair Execution Elementary School Sports, Play and Active Recreation for Kids (SPARK) program	Location: Suburban San Diego, CA Intervention: PE classes with fitness curriculum; classroom health curriculum; modified school lunch; teacher training Comparison: Control schools (measurement only)	Schools N= 7 I1 = 2; I2 = 2; C = 3; Students: 1538 completed BL measurements; FU (n=955, 62.1%) I1: 234 I2: 331 C: 360	Change 1: PES vs C, (% change I - % change C)/ % change C, adjusted for BL Change 2: TT vs C, % change I - % change C)/ % change C, adjusted for BL	In-school PA Post 1 Outcome Change 1 Change 2 MVPA (min/wk) 125.8% 83.7% EE (kcal/kg/wk) 118.2% 75.8% # lessons/wk 61.1% 44.4% PE/week (min) 109.7% 70.0% Out-of-school PA Boys Girls Change 1 2 1 2 Weekday act. ct 1.8% -5.4% -11.7% -3.8% Weekend act. ct 25.1% -12.6% 4.6% 4.2% 1-day PA recall -4.0% -10.3% -15.1% -10.0% Mile run (sec) -11.0% 10.0% -7.4% 7.6% Sum SF (mm) -5.2% -8.2% 8.1% -4.4% Sit-up (#/min) 36.9% 0.0% 49.3% 11.3% Pull-up (#) 12.5% 26.7% -32.5% -4.3% Sit-and reach (in) -1.0% -14.6% 3.7% -16.9%	2 years
Project SPARK[13] Sallis JF, 1997 Greatest: Randomized group trial Fair execution Elementary school	Location: Suburban San Diego, CA Intervention: PE classes with fitness curriculum; classroom health curriculum; modified school lunch; teacher training Comparison: Control schools (measurement only)	Schools N= 7 I1 = 2; I2 = 2; C = 3; Students: 1538 completed BL measurements; FU (n=955, 62.1%) I1: 234, I2: 331, C: 360	Change 1: PES post 2 - post 1/ post 1 Change 2: TT post 2 - post 1/ post 1	Outcome Change p MVPA (min/wk) -47.6% 0.008 Time very active (min) -34.0% 0.015 EE (kcal/kg/wk) -45.8% 0.005 # lessons/wk -44.8% 0.009 PE/week (min) -45.7% 0.005 % class time MVPA -4.2% NS % time very active -1.4% NS	1.5 years after end of intervention

Author & year Design suitability: design Quality of execution Evaluation setting	Intervention and comparison elements	Study population description Sample size	Results [a]		
Vandongen R, 1995[14] Greatest Good Execution Elementary school	Location: West Australia Intervention: Fitness program (running, relays, skipping etc); teacher training Comparison: Traditional physical fitness curriculum	Grade 6 classes from 10 schools; matching for SES. I=158 (81 boys, 77 girls) C=145 (78 boys, 67 girls)	Net % change from baseline: I - C Intervention group is limited to the Fitness only group.	Boys / Girls Outcome — % change — p — % change — p BF (%) — 0.51 — NS — -2.89 — NS Tri SF (mm) — 1.35 — NS — -5.38 — NS Subsc SF (mm) — -4.00 — NS — -6.61 — NS BMI (kg/m^2) — -0.55 — NS — -2.31 — NS Leger score (laps) — 3.50 — <.05 — 14.87 — <.05 Run Time (min) — -1.34 — <.05 — -8.19 — <.05	1 school year
Manios Y, 1999[15] Greatest Good Execution Elementary school	Location: Crete Intervention: Adaptation of "Know Your Body", PE and classroom-based; Parental involvement, teacher training Comparison: Usual PE	Grade 1 students from 40 schools; 24 I schools (288 students), 16 C schools (183 students)	Net % change from baseline: I - C	Outcome — % change — p BMI (kg/m^2) — -6.10% — 0.001 bicep SF (mm) — 8.64% — NS Tricep SF (mm) — 10.22% — NS Supriliac SF (mm) — -13.26% — 0.04 Subscp SF (mm) — 5.60% — NS Leisure MVPA(hr/wk) — 168.30% — <0.0005 Standing BJ (cm) — 7.57% — 0.023 Sit-up (#) — 46.90% — <0.0005 Sit and Reach (cm) — 5.65% — NS Handgrip (kg) — -4.99% — NS Shuttle run (stages) — 25.00% — NS Health Knowled (% right) — 9.80% — <0.0005	3 years

[a] Unless otherwise noted, results are presented as a net intervention effect showing the difference in percent change from baseline between intervention and control groups using the following formula:

$$\frac{I_{post} - I_{pre}}{I_{pre}} - \frac{C_{post} - C_{pre}}{C_{pre}}$$

[b] **Bold text indicates statistically significant difference**

BF, body fat; BJ, broad jump; BL, baseline; BMI, body mass index; brth, breath; C, control or comparison; ed, education; EE, energy expenditure; FU, Follow-up; HS, high school; Int, intervention; min, minutes; MVPA, moderate to vigorous physical activity; PA, physical activity; PWC, physical work capacity; PE, physical education; PES, PE specialist condition; PWC, peak work capacity; SES, socioeconomic status; SF, skinfold; TT, trained teacher condition.

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