PART F. CHAPTER 11. PROMOTING REGULAR PHYSICAL ACTIVITY

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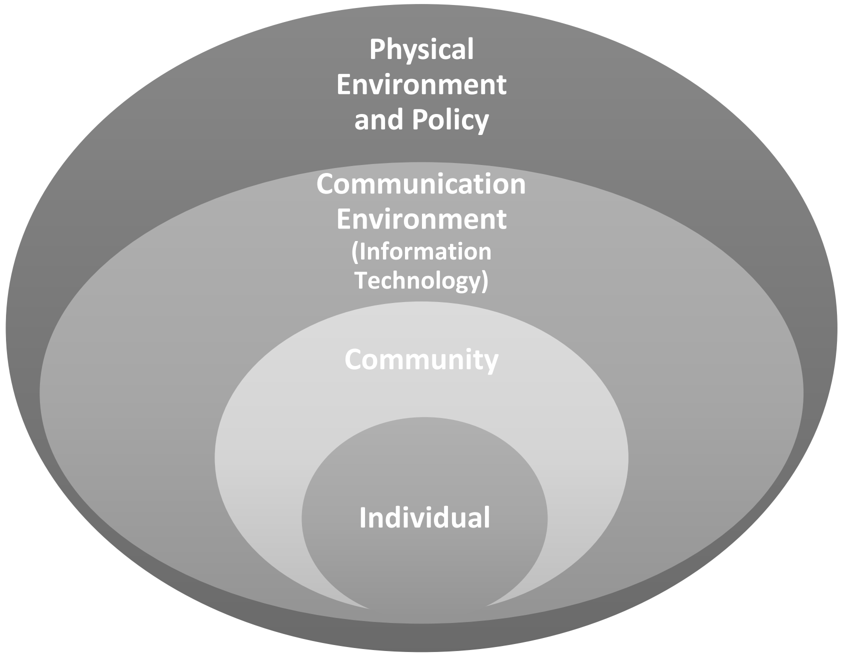
INTRODUCTION

In the preceding chapters of this report, the breadth and depth of the current evidence base on the physical and mental health benefits of regular physical activity have been described. This evidence base and the solid foundation for action that it provides, leads to one of the major challenges facing public health: Given its numerous benefits for individuals across the life course, what strategies and approaches can increase regular physical activity in the U.S. population?

Simply understanding the variety of benefits accompanying an active lifestyle is, for most in the population, insufficient to create a regularly active lifestyle. In fact, research indicates that many Americans understand that regular physical activity is beneficial to their health and well-being, and know that they should include more physical activity in their daily lives.[1] Yet, current national surveillance data continue to show that the physical activity levels of many in the United States remain insufficient to attain the full benefits of an active lifestyle described in the earlier chapters of this report. For instance, in 2015, only 49.8 percent of U.S. adults reported levels of aerobic physical activity consistent with federal guidelines for Americans,[2] while 30 percent of U.S. adults reported being inactive during their leisure time.[3] Similarly, in 2015, only 27.1 percent of U.S. high school students reported levels of physical activity that met the federal guideline of 60 minutes or more of physical activity per day.[4] Interventions designed to supplement knowledge with specific approaches and strategies that effectively promote and sustain physical activity are thus critical. This chapter represents the first evidence review of the physical activity promotion area included in a Physical Activity Guidelines Advisory Committee Report.

Early conceptualizations of physical activity behavior focused largely on individuals' personal motives and behaviors that could influence their physical activity levels. However, over the past several decades, the powerful role that environmental, sociocultural, and community contexts play in shaping and maintaining active lifestyles has been increasingly recognized. The realization that multiple levels of influence affect short- as well as long-term physical activity patterns underlies our use of a social ecological framework (Figure F11-1) to organize the current evidence base in the physical activity promotion field.[5] Applying an adapted version of this framework, the research evaluating physical activity promotion approaches that were available from the completed literature search is divided broadly into four levels of impact or influence—individual, community, the communication environment (which focuses on interventions delivered through information and communication technologies [ICT]), and physical environments and policy. ICT can be employed in interventions emanating from the other levels of impact (individual, community, physical environment, and policy). However, because of its unique potential to influence populations, the accelerating growth of its evidence base, and the distinctive methods and opportunities it presents for physical activity intervention development, implementation, and evaluation, this topic merited a separate description. In addition, in light of the accelerating evidence base pertaining to the health risks accrued by extended periods of sedentary time, even among individuals who achieve recommended amounts of daily physical activity (see *Part F. Chapter 2. Sedentary Behavior*), the Physical Activity Promotion Subcommittee has included in its review the 2011-2016 evidence base of interventions to reduce daily sedentary time among youth and adults, and within worksite settings.

Figure F11-1. Social Ecological Framework



Source: Adapted from data found in Napolitano et al., 2013.[5]

REVIEW OF THE SCIENCE

Overview of Questions Addressed

This chapter addresses 2 major questions, which discuss evidence in the following intervention areas:

1. What interventions are effective for increasing physical activity at different levels of impact?
   a) Individual Level
      - Older Adults
      - Postnatal Women
      - Youth
      - Theory-based Behavioral Interventions and Techniques
        - Rewards and Incentives
        - Behavior Change Theories and Strategies
      - Peer-led Interventions
   b) Community Level
      - Community-Wide Interventions
      - Child Care and Preschool Settings
      - Faith-based Community Interventions
      - Nurse-delivered Interventions in Home or Other Community Settings
      - Interventions in Primary Care Settings
      - School Interventions

- Worksite Interventions

c) Communication Environment Level (Information and Communication Technologies)
- Wearable Activity Monitors
- Telephone-assisted Interventions
- Web-based or Internet-delivered Interventions
- Computer-Tailored Print Interventions
- Mobile Phone Programs
- Social Media
- Interactive Video Games Promoting Active Play or Exercise

d) Physical Environment and Policy Level
- Point-of-Decision Prompts to Promote Stair Use
- Built Environment Characteristics that Support Active Transport
- Community Design and Characteristics that Support Recreational Physical Activity
- Access to Indoor and/or Outdoor Recreation Facilities or Outlets

2. What interventions are effective for reducing sedentary behavior?
    a) Youth Interventions
    b) Adult Interventions
    c) Worksite Interventions

Data Sources and Process Used to Answer Questions

The nature and size of the evidence base in the physical activity promotion field, which dates back more than 50 years, and the fact that this area was not included in the *Physical Activity Guidelines Advisory Committee Report, 2008*,[6] required the Physical Activity Promotion Subcommittee to reduce the scope of the literature reviewed in this area. This was accomplished by using global key word terms targeted to the physical activity promotion and sedentary behavior reduction fields to search the evidence base, and including only systematic reviews, meta-analyses, and government reports that met the Physical Activity Guidelines Advisory Committee's eligibility criteria (for more details on these criteria, see *Part E. Systematic Review Literature Search Methodology*).

To optimize efficiency during the evidence acquisition phase, the global key word terms for both the physical activity promotion and sedentary behavior reduction fields were included in one comprehensive search. Relevant articles for each of these fields were subsequently sorted to specifically address physical activity promotion interventions (Question 1) and sedentary behavior interventions (Question 2). In addition, when an initial search beginning in the year 2000 yielded a vast number of reviews that proved unwieldy in light of the time period under which the Subcommittee was operating, the search was necessarily limited to the years 2011 through the end of 2016.

Global key word terms related to physical activity promotion and sedentary behavior reduction identified relevant literature that was subsequently sorted into categories used to describe the evidence if a category had one or more systematic reviews, meta-analyses, and/or government reports that met the eligibility criteria set by the Committee (see *Part E. Systematic Review Literature Search Methodology*) and these articles contained a sufficient number of studies to determine an evidence grade of Strong, Moderate, or Limited. In some cases, articles contained sufficient information in both areas (physical activity interventions and sedentary behavior interventions) to be used for both questions. The final categories that were used to organize the evidence review were agreed upon by the Subcommittee with approval from the Physical Activity Guidelines Advisory Committee. These categories reflect the enormous heterogeneity of research that is being conducted in the physical activity promotion and sedentary behavior reduction fields.

As reflected in the organizational layout of the chapter, investigators have employed different rubrics or foci in conducting their reviews. They have grouped the evidence by target population (e.g., older adults, youth), intervention location (e.g., schools, worksites), intervention targets (e.g., built environments), intervention delivery channels (e.g., websites, phones), intervention delivery sources (e.g., peer-led interventions), and intervention content (e.g., theory-derived interventions). This diversity made categorization of the literature challenging. Note that the categories that were arrived at by the Subcommittee were not identified a priori and were not specifically included as search terms. Such a condensed approach necessarily limits the size and, potentially, the types of evidence considered in this review (i.e., the chapter review is not exhaustive and does not include a systematic review of the evidence base for the general population).

The major focus of the reviews in this chapter pertains to changes in physical activity levels and sedentary behaviors occurring through different approaches or strategies. The majority of the systematic reviews, meta-analyses, and reports in the physical activity promotion area consist of studies in which physical activity behavior change was measured through a variety of means, including through self-report and/or ambulatory devices (i.e., accelerometers or pedometers), or, in some cases, through behavioral observation. When a physical activity promotion topic area used primarily one of these physical activity outcome measures (e.g., the wearable activity monitors section), it is noted in the methods section describing that topic area.

In contrast to other chapters in this report, the evidence grading for the physical activity promotion field focused on those topic areas that had sufficient evidence-based systematic reviews, meta-analyses, and/or governmental reports to assign an evidence grade of either Strong, Moderate, or Limited. (That is, we did not use a “Not assignable” designation). This decision was due to the fact that the evidence review was necessarily condensed, as described above, with a possible outcome being that a number of topic areas might not have been sufficiently represented in the evidence search to receive any designation, including the “Not assignable” designation.

In grading the available physical activity promotion and sedentary behavior reduction evidence, the Subcommittee often used the evidence grade of “Limited” to refer to a nascent or emerging topic area that has not yet received sufficient rigorous attention from the scientific community to achieve a higher grade. In addition, some topic areas had a larger evidence base but less rigorous designs and methods, small sample sizes, and short intervention periods. Such areas also received a “Limited” evidence grade. “Moderate” or “Strong” evidence grades were assigned when more systematic scientific attention had been given to a topic, and the evidence demonstrated a more consistent effect across more rigorously designed studies. “Strong” evidence grades were distinguished from “Moderate” evidence grades by virtue of the larger pool of more rigorously designed studies available (e.g., randomized controlled trials [RCTs], natural experiments), which generally yielded more consistent positive effects across typically longer time periods.

The following chapter sections on the different levels of impact include comments, when evidence existed from the articles reviewed, on results for specific population subgroups (e.g., by age, sex, chronic disease status, race/ethnicity, socioeconomic status, weight status). They also include, when available from the search, any evidence of dose-response relationships, adverse events, cost-effectiveness, and the specific effects on physical activity levels when the interventions included physical activity combined with other health behaviors, such as dietary change. In general, these factors were rarely reported in the literature that was reviewed, although it is possible that such information was contained within individual articles included in the systematic reviews, meta-analyses, and reports that were evaluated, but simply not discussed at any length in the reviews themselves.

Question 1. What interventions are effective for increasing physical activity at different levels of impact?

INDIVIDUAL LEVEL

Physical activity interventions at the Individual level of impact have been among the earliest types of interventions that have been tested systematically in the physical activity promotion field. This form of intervention generally consists of in-person individual or small group-based physical activity advice and support that can take place in a variety of settings or locales. The articles included in this evidence level did not explicitly target a particular setting as part of their reviews (e.g., schools). Intervention formats typically include one-on-one or group-delivered programs that can involve actual structured exercise and/or educational approaches that teach participants how to employ different types of cognitive and/or behavioral strategies to increase their regular physical activity levels. As such, individual-level interventions can provide a flexible means for providing tailored advice and support to meet individual needs and preferences. However, they also may require a level of staff involvement that can be costly or burdensome over the long run.

The decades of physical activity promotion research at the Individual level have created a rich foundation upon which to build a solid evidence base, particularly in relation to general adult populations.[7] The following systematic review of the evidence in this area, beginning in 2011, highlights areas that extend the evidence base from general adult populations to specific population subgroups, including older adults, postnatal women (i.e., women 0 to 5 years postpartum), and youth. The increasing focus on population subgroups reflects the growing understanding of the importance of developing interventions that are specific to the needs, preferences, and capabilities of different groups. Two other intervention areas containing a sufficient body of systematic reviews and/or meta-analyses since 2011 to support an evidence grade also are described. These two areas—theory-based programs and peer-led programs—reflect specific types of intervention approaches that have received increasing attention in the literature. Peer-led programs are a type of intervention delivery source that has the potential for mitigating the staff burden and costs noted earlier.

As described previously, the categories were not identified a priori and were not specifically included as search terms, but rather emerged during the broad 2011-2016 evidence search that the Subcommittee undertook. Such a condensed approach necessarily limits the size and, potentially, the types of evidence considered at this level.

Older Adult Interventions

Sources of evidence: Systematic reviews, meta-analysis

Conclusion Statement

Strong evidence demonstrates that physical activity interventions that target older adults have a small but positive effect on physical activity when compared with minimal or no-treatment controls, particularly over time periods of 6 to 12 months. **PAGAC Grade: Strong**

Review of the Evidence

Three systematic reviews were included.[8-10] The largest review included 158 studies and covered a timeframe from 1990 to December 2014.[8] A second review covered 24 studies from inception of the database to November 2013,[9] and the third review included 18 studies from 2006 to 2011.[10] The included reviews examined interventions among individuals after retirement,[8] community-dwelling adults ages 60 years and older,[9] and older adults in general, defined as ages 55 years and older.[10] Baxter et al[8] found few studies focused on retirement, but were still interested in the retirement age; thus, that review also focused on older adults in general, defined as ages 50 to 74 years. French et al[9] assessed behavior change techniques that contributed to increases in self-efficacy and physical activity behavior. Nigg and Long[10] reviewed single versus multiple health behavior interventions of physical activity among older adults. However, they identified too few multiple health behavior change studies to allow comparison to single health behavior change interventions.

Evidence on the Overall Relationship

The effectiveness of the interventions was consistently positive when compared to minimal or no-intervention control arms. However, the magnitude of the effect was not easy to determine. Of the reviews included, only French et al[9] provided effect sizes for the effectiveness of the physical activity interventions. Baxter et al[8] stated that the diverse range of physical activity outcomes, as well as the limited number of studies comparing interventions to control groups that did not have an active control group, precluded the use of meta-analysis to provide a statistical summary of intervention effectiveness. Overall, French et al[9] reported that interventions had a small effect on physical activity, with Cohen's d=0.14 (95% confidence interval (CI): 0.09-0.20, P<0.001) and effect sizes ranging from d= −0.02 to d=0.63. They found that three behavior change techniques were significantly associated with higher physical activity behavior effect sizes when present: the use of barrier identification or problem solving, the provision of rewards contingent on successful behavior, and the use of modeling and similar demonstrations of the physical activity behavior being targeted.

Baxter et al[8] commented on the importance of considering the appeal and enjoyment of physical activity, as well as the social aspects of interventions. They reported that advice and counseling, group sessions, and individual sessions were moderately effective at increasing physical activity. Advice and counseling were delivered by various delivery sources, including peer mentors, trained physicians, nurses, and exercise professionals, and at times used combined physician and exercise professional input. For interventions with group sessions, all but one of 15 interventions reviewed resulted in positive physical activity effects.

Nigg and Long[10] reported that, overall, the evaluated interventions were effective. All but one of the physical activity interventions reviewed were conducted in a community setting. Of the 12 single health behavior change studies evaluating physical activity or exercise among older adults, participants were reported to have significantly improved their level of activity at 6- and 12-month follow-ups relative to controls. Only two studies of multiple health behavior change were included in the review, and both were conducted in a community setting. Both included physical activity and diet as the health behaviors studied, but it was not reported whether the behaviors were simultaneously or sequentially targeted. In one study, interventions combining physical activity and fruit and vegetable consumption among older adults improved only the nutrition behavior, and physical activity actually decreased.[11] In the other study, participants improved in both the weight loss behavior and the physical activity behavior compared to the control group.[12]

Overall, studies in this area were of short duration (less than 6 months), with a few that were of medium (between 6 to 11 months), or longer-term (12 months or more) duration.

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups, adverse events, and cost-effectiveness is currently lacking or infrequently reported. Few reviews were found that specifically targeted subgroups of older adults that are increasingly prevalent, including informal family caregivers,[13] and those with chronic conditions.[14-16] As noted above, some studies evaluated interventions that included both physical activity and another health behavior (e.g., dietary change), with mixed results. Nigg and Long[10] found too few multiple health behavior intervention studies in older adult populations to allow confidence when comparing single health behavior interventions with multiple health behavior interventions in this age group.

Features of physical activity intervention targets and measures: Physical activity outcome variables consisted primarily of self-reported minutes per week of moderate-to-vigorous physical activities, as well as the proportion of the sample achieving the physical activity guidelines.[2] Several studies used pedometer-derived step counts and/or accelerometer-derived activity. The review articles did not provide details about prescribed or targeted physical activity types or modes, or duration given to participants.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

The number of older adults in the United States is rapidly growing. Given that many older adults have one or more chronic conditions, sometimes co-occurring, which may be ameliorated by participating in regular physical activity, interventions targeted to their needs and preferences are strongly indicated. (For more details on this issue, see *Part F. Chapter 9. Older Adults* and *Part F. Chapter 10. Individuals with Chronic Conditions.*) However, due to a number of barriers, physical activity participation rates often remain low among many older adults. Older adults who are isolated, frail, have mobility limitations or disabilities, and have fewer resources available may be particularly vulnerable to the effects of inactivity. Research also has identified disparities in health conditions, such as chronic pain and arthritis, in low-income and African American adults ages 50 years and older.[17] Chronic pain and arthritis could represent additional barriers to physical activity among populations who are already at high risk of poor health outcomes associated with low levels of physical activity.

Postnatal Women

Postnatal interventions refer to programs that seek to improve physical activity in women with young children, typically 0 to 5 years postpartum, when adequate physical activity is often difficult to increase or maintain.[18]

Sources of evidence: Systematic reviews, meta-analysis

Conclusion Statement

Limited evidence suggests that postnatal interventions are effective for increasing physical activity in postnatal women compared with minimal or no-treatment control conditions. **PAGAC Grade: Limited.**

Review of the Evidence

One meta-analysis[18] and two systematic reviews[19, 20] were included. The meta-analysis[18] included 20 studies overall, of which 14 studies were reviewed meta-analytically. The systematic reviews covered 11[19] and 10 studies.[20] The timeframe reviewed was 1980 to 2015, with the majority of studies reviewed since 2010. Studies targeted postnatal women who were inactive but healthy, postnatal women who experienced gestational diabetes, and postnatal women with other chronic diseases. The defined postnatal period varied across studies from 1 year postpartum[18] to 5 years postpartum[19, 20] and interventions were reviewed that focused either solely on physical activity or were weight and diabetes management studies that targeted diet and physical activity simultaneously.

Evidence on the Overall Relationship

Only limited evidence is available overall that interventions are effective at increasing physical activity in postnatal women. Gilinsky et al[18] reported a moderate and variable effect size for increases in frequency of physical activity (standardized mean difference (SMD)=0.53; 95% CI: 0.05-1.01, *P*=0.03) but small and non-significant effect sizes for increases in overall volume of physical activity (SMD=0.15; 95% CI: -0.6 to 0.35) and for walking (SMD=0.07; 95% CI: -0.21 to 0.36). The most promising effects concerned the six of seven studies targeting postnatal women who were previously inactive but otherwise healthy. These studies reported significant increases in moderate-to-vigorous physical activity and walking after 6 weeks to 6 months of intervention.[18] Intervention approaches that included goal setting, behavioral self-monitoring, setting graded tasks, and reviewing behavioral goals were more commonly delivered in efficacious studies.[18]

The evidence for successfully increasing physical activity or walking within the context of weight management,[18] or among women with gestational diabetes[20] or postnatal depression[18] also was limited. The studies reviewed were generally short (i.e., less than 6 months) to medium (i.e., 6 to 11 months) in length and of poor to moderate quality with respect to nonrandomized designs, high dropout rates, inadequate missing data handling and poor measurement approaches.

Features of physical activity intervention targets and measures: The postnatal interventions ranged in duration from 6 weeks to 6 months and the most prevalent intervention strategies included goal setting, self-monitoring, and instruction. The frequency and duration of contacts was not clear. Studies focused primarily on increasing physical activity generally without a particular focus toward a specific type or intensity of activity. An exception was the three studies that specifically targeted walking.[21-23] However, these interventions were not found to be more effective than other physical activity interventions. Most studies reported outcomes from self-reported measures of physical activity (i.e., minutes per week of moderate-to-vigorous physical activity; MET-minutes per week, and activity kilocalories per week), while four studies also used pedometers and/or accelerometers to assess increases in steps per day. Little information was systematically reported in relation to intervention effects on specific step per day increases.

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups, adverse events, and cost-effectiveness is currently lacking or infrequently reported.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

The postnatal period is a critical and challenging period to increase and maintain adequate physical activity levels to promote weight management and reduce disease risk factors. Although the evidence remains limited, interventions that include prominent behavior change strategies (e.g., goal setting, behavioral self-monitoring) as well as those that target generally healthy (albeit inactive) women appear to yield the most promising results.

Youth

Sources of evidence: Systematic reviews, meta-analyses

Conclusion Statement

Strong evidence demonstrates that interventions focused on promoting physical activity in healthy youth have a small but positive effect on physical activity when compared with a variety of control conditions. Interventions directly targeting youth are effective, and effects are further enhanced when interventions also incorporate family or are delivered in school settings during the school day. **PAGAC Grade: Strong**.

Review of the Evidence

The Subcommittee reviewed two meta-analyses[24, 25] designed to explain outcome patterns within the wider systematic review.[24] Included studies were from inception through April 2013[25] and September 2015.[24] Brown et al[24] identified 47 family-based interventions studies focused on children ages 5 to 12 years in the systematic review, 19 of which provided sufficient information to be included in the meta-analysis. Cushing et al[25] identified 89 unique papers, 58 of which focused on physical activity among youth younger than age 18 years. Both reviews focused on generally healthy youth, with Cushing et al[25] specifically excluding studies of youth with chronic illnesses, including obesity, cancer, and asthma. Brown et al[24] focused specifically on interventions that engaged families to increase physical activity in children, while Cushing et al[25] focused on any intervention strategies that included health behavior as a dependent variable. A range of intervention strategies and comparison groups were identified in both reviews. The Subcommittee also reviewed *The Physical Activity Guidelines Midcourse Report: Strategies to Increase Physical Activity Among Youth,*[26] which included a review of reviews of physical activity intervention studies focused on youth ages 3 to 17 years that were published January 2001 through July 2012; a total of 31 reviews containing 910 studies (not mutually exclusive) were included.

Evidence on the Overall Relationship

The effectiveness of the intervention strategies and reported effect sizes were consistent across both reviews. Cushing et al[25] reported an aggregate random-effects effect size for immediate post-intervention effects, expressed as Hedges' *g* (*g*). Assessments of the impact of intervention strategies targeting physical activity showed significant effect sizes for interventions targeting individuals only (g=0.27; 95% CI: 0.12-0.42), which were further enhanced when individual interventions also included families (g=0.44; 95% CI: 0.23-0.66) or school and print or digital media (e.g., newspaper, radio; g=0.30; 95% CI: 0.04-0.57). The interventions included self-report and objective measures of physical activity. When only studies with objective measures of physical activity were considered, effect sizes were smaller but still significant. The Brown et al[24] meta-analysis of family-based physical activity interventions found a small but significant effect size favoring the intervention group (SMD=0.41; 95% CI: 0.15-0.67).

The types of intervention strategies evaluated within the reviews primarily included in-person and web-based education, hands on experiential activities (e.g., supervised exercise sessions, dance classes, sports or recreational activities), physical education classes, and advice to reduce sedentary behaviors (e.g., television turnoff) and replace those sedentary behaviors with increased physical activity. Physical activity interventions were delivered in school settings (in-school and after school), day camps, community-based settings, participant's households, and over the Internet. Family-based interventions included primarily group-based educational activities and interactive physical activity during group sessions, with encouragement (e.g., homework, websites for parents to monitor children's activities, tips for increasing physical activity, home-based exercise programs, step counters) to participate in additional physical activity outside of the sessions.

Features of physical activity intervention targets and measures: Although the reviews included general information about the duration of interventions, they did not provide significant detail about the level of physical activity that was encouraged in interventions or specific physical activity goals within interventions. Physical activity outcomes included objectively and subjectively monitored participation in moderate-to-vigorous physical activity, step counts, and self-reported participation in specific types of physical activity (e.g., outdoor sports, physical education, general physical activity). When interventions were stratified by type of physical activity outcome, Brown et al[24] found that 63 percent of accelerometer-derived moderate-to-vigorous physical activity or counts per minute assessments, 71 percent of pedometer-derived step count assessments, 67 percent of self-reported physical activity frequency assessments, and 67 percent of self-reports of sport, dance, physical education, or outdoor play participation or outdoor observation assessments favored the intervention.

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups, adverse events, and cost-effectiveness is currently lacking or infrequently reported. A large proportion of studies included in the two reviews did not provide race/ethnicity information for participants. Only four studies included in the Cushing et al[25] discussed adverse events, with only one study[27] reporting injuries to two participants that might have been related to study participation; adverse events were not addressed in the meta-analysis by Brown et al.[24] The studies provided some evidence of intervention impact by health status. Although Cushing et al[25] excluded studies of children with chronic disease, Brown et al[24] evaluated studies by weight status of the target child and found that 80 percent of studies including mostly children with normal weight favored the intervention arm while only 59 percent of studies that focused mostly on children with overweight or obesity and 50 percent of studies that did not report weight status favored the intervention arm. Few studies included in the meta-analysis by Brown et al[24] focused on boys; 15 percent of studies focused on girls only, with 86 percent favoring the intervention arm, while 63 percent of mixed sex studies favored the intervention arm.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

Among children, individually-focused interventions delivered in a variety of settings can be successful for increasing physical activity levels. Evidence also indicates that their efficacy can be further enhanced when families and schools are incorporated within individual intervention approaches. (See the *Community Level: School Interventions* section of this chapter). Given the potential for family-based interventions to have a positive impact, additional attention should be provided to identify strategies to promote physical activities that appeal to family members of different ages within the same program or setting.

Opportunities to encourage the adoption of lifetime physical activities (e.g., leisure-time pursuits, non-competitive sports) should be encouraged among all youth. This could help youth identify activities during childhood that they could enjoy and participate in across the lifespan, including outside of school. Several evidence-based population approaches to support increases in physical activity that are relevant for youth at the individual level during out-of-school times include improving accessibility of recreation and exercise spaces through creating new spaces, enhancing existing spaces, implementing shared use agreements (e.g., use of school facilities during non-school hours) and improving sidewalk and street design and traffic safety, which could promote active commuting to or from school (see the *Physical Environment and Policy Level* section of this Chapter). High-risk population subgroups, particularly those living in high poverty and congested urban areas, often have limited safe spaces for recreation and physical activity. Children living in suburban areas also may have limited opportunities to engage in active commuting or to easily access recreational or play facilities without having a parent available for transportation.

Theory-Based Behavioral Interventions and Techniques

A range of behavioral theories, along with a number of different strategies and techniques derived from such theories, have been applied in developing physical activity interventions. The evidence review methods employed by the Subcommittee resulted in two distinct areas of evidence that are described below: the use of tangible rewards and incentives contingent upon physical activity behavior change, and the systematic evaluation of behavior change theories and strategies employed in physical activity programs.

Rewards and Incentives

Source of evidence: Systematic reviews

Conclusion Statements

Limited evidence suggests that providing rewards based on achieving physical activity goals is effective for improving device-measured physical activity behavior when goals include opportunities for sedentary adults to earn money, or opportunities for children to earn inexpensive recreational items or television access.[28, 29] **PAGAC Grade: Limited.**

Limited evidence suggests that, for general adult populations, providing guaranteed rewards is effective for increasing exercise session attendance when rewards are contingent upon achieving specific goals; lottery incentives were generally not effective strategies for increasing attendance at supervised exercise sessions.[28, 29] **PAGAC Grade: Limited.**

Limited evidence suggests that, for youth and different populations of adults, providing unconditional incentives contingent upon physical activity behaviors performed is no more effective than providing the same intervention without added incentives for increased physical activity levels, physical activity group session attendance, or fitness levels.[28] **PAGAC Grade: Limited.**

Review of the Evidence

One systematic review[28] and one meta-analysis[29] that included 12 and 11 studies, respectively, provided evidence. The reviews covered a time frame from inception to June 2012[29] and from January 1980 to March 2013.[28] Both reviews examined the effect of incentives on physical activity or exercise outcomes (e.g., exercise session attendance, aerobic fitness, and physical activity participation). Barte and Wendel-Vos[28] considered both unconditional incentives (provided regardless of whether some goal or related condition was met) and rewards (provided only when a specific goal or condition related to physical activity was met), and included studies focused on adults (N=9) and children (N=3). Incentives included financial rewards (adults), television access (youth), inexpensive items (adults and youth), or free access to exercise facilities or activities (adults). Mitchell et al[29] considered financial incentives, including cash and noncash rewards with a monetary value that was contingent on a pre-specified physical activity behavior or outcome, and included studies focused only on adults. Both reviews assessed changes in physical activity-related behaviors. Assessment of physical activity levels and intervention adherence outcomes varied across studies.

Evidence on the Overall Relationship

The effectiveness of rewards and incentives varied depending on the outcome of interest. With regard to exercise session adherence, one meta-analysis[29] reported a positive effect of providing lottery and escalating incentives on exercise session attendance when compared with no incentive for short-duration interventions lasting 4 to 26 weeks; pooled results showed an increase in exercise attendance of 11.55 percent; 95% CI: 5.61%-17.50%. Examples of the types of incentives that were tested included requiring participants to deposit $3 for a 1 in 7 chance to win $21; allowing participants to earn a weekly lotto token for attending 4 of 5 weekly aerobics sessions compared with providing a $5 deposit that could be earned back at a rate of $1 per week for attending 4 of 5 sessions; and allowing participants to earn up to $491, in an escalating fashion, over 18 months by participating in walk/run sessions ($1 for each of the first 25 walks, $1.50 for the next 50 walks, $2 for the next 50 walks, and then $3 per walk until the end of the program) compared with no incentive. Although such incentives improved exercise session attendance, they did not improve overall fitness or physical activity levels.

Both reviews[28, 29] reported that chance- or lottery-based financial incentives did not influence overall physical activity behaviors, including self-reported physical activity, objectively assessed physical activity, or fitness variables. In contrast, the studies in the two reviews[28, 29] generally showed that providing guaranteed direct rewards for reaching physical activity behavior goals was effective for increasing immediate post-intervention physical activity. For example, direct financial incentives and rewards ranging from $2.79 to $46.82 were effective for improving physical activity behaviors in general adult populations, with larger incentives (e.g., $26.75 to $46.82 per week) yielding larger effects.[30, 31] This was also true among sedentary older adults (ages 50 years and older) who were able to earn $10 to $25 per week, with a maximum of $100 in 4 weeks compared to control participants, who received a fixed payment of $75. These participants increased their daily aerobic minutes 16 more minutes than did the control group (P<0.001).[31] Among youth, children ages 7 to 11 years who were able to earn inexpensive recreational items (e.g., balls, Frisbees) for each day they reached pedometer target goals increased their steps per day compared with children who did not earn incentives (2,456 versus 1,033 steps per day, P<0.001).[32] Similarly, children ages 8 to 12 years with overweight or obesity who were able to earn tokens for television access or other inexpensive items, compared to control participants who had free television access, significantly increased their daily step counts (+160.8 versus +33, P=0.019) and daily minutes of moderate-to-vigorous physical activity (+9.4 versus +0.3 minutes, P=0.05).[33, 34]

Guaranteed direct rewards also appear to be effective for increasing attendance at supervised walks, fitness facilities, or group sessions in general adult populations. A study of paying members at a university fitness facility showed an increase in visits to the facility for those who had the opportunity to earn free attendance-based facility memberships compared to control participants who were not provided with an incentive (5.45 versus 3.77 visits, $P=0.003$).[35] An 18-month study of adults ages 25 to 55 years[36] included five conditions: standard behavior therapy (SBT); SBT with supervised walks (SW) 3 times per week; SBT + SW with personal trainers (PT), who walked with participants, made phone reminders, and did make-up SW; SBT + SW with monetary incentives (I) for completing SW; and SBT + SW + PT + I. Participants could earn $1 for their first 25 walks, $1.50 for the next 50 walks, $2 for their next 50 walks, and $3 for the remaining walks. The study found higher attendance at SW sessions among individuals who received behavioral counseling and the opportunity to earn financial rewards compared with individuals who received the same intervention with no opportunity to earn incentives (65.8 versus 35.0 walks in rewards versus non-reward groups without a personal trainer, and 103.4 versus 80.4 walks in reward versus non-reward groups with a personal trainer, $P<0.05$).

The impact of providing rewards or incentives for physical activity behaviors does not appear to extend beyond the immediate post-intervention period. In the aforementioned study that provided incentives to children for reaching activity goals and showed a positive impact on daily steps compared with children who did not receive incentives, effects were reversed in the 14 weeks after the intervention, with controls engaging in significantly higher daily steps compared to intervention participants. This suggests the possibility that rewards for achieving physical activity goals, while useful in inducing short-term increases in physical activity behavior, may undermine longer-term efforts to maintain those physical activity increases. One putative mechanism underlying this type of finding may relate to using extrinsic motivators, such as external rewards, for behavior change, which may serve to undercut the development of intrinsic motivators for such change that can potentially drive behavioral maintenance.[37]

Features of physical activity intervention targets and measures: Physical activity outcome variables consisted of self-report, pedometer-, or accelerometer-assessed step counts and daily moderate-to-vigorous physical activity, and adherence to intervention conditions (e.g., fitness facility attendance, supervised walking sessions, group exercise sessions). Very few details were provided about the intensity, type, and timing of physical activity prescribed in the interventions. Studies in the reviews[28, 29] that provided specific activity goals all showed positive impacts on physical activity attendance and behaviors. Examples of goals included attendance at fitness facilities (range equal to or greater than 11 times per month to 2 to 5 visits per week), increasing daily walking (e.g., to 1,500 steps more than baseline), and minutes of weekly aerobic physical activity (e.g., 15, 25, and 40 minutes daily).

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups, adverse events, and cost-effectiveness is currently lacking or infrequently reported. Interventions focused on previously inactive adults,[30, 31, 38] and incentives provided to lower income adults (with household incomes less than $50,000 in 2008 dollars) compared with higher income adults (with household incomes great than or equal to $50,000 in 2008 dollars),[31] yielded larger effects.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

Some population subgroups may be responsive to opportunities to earn rewards for achieving physical activity goals or attending supervised exercise sessions. However, providing unconditional incentives that are not associated with achieving a specific goal does not appear to provide additional benefit above and beyond providing a behavioral intervention alone. The success of small-to-moderate sized behaviorally based tangible incentives (e.g., financial rewards, television access, inexpensive recreational items, gym memberships based on facility use) in increasing physical activity adherence and behavior change in some populations of youth as well as adults suggests that such incentives could be potentially useful strategies for promoting physical activity while addressing some known barriers to physical activity participation (e.g., access to facilities). In addition, escalating or indexed incentives (e.g., reimbursement contingent upon completing a certain number of activities or opportunities to earn higher or more frequent incentives based on greater physical activity participation), cash or reimbursement incentives, and incentives that include a deposit that is held in escrow until a certain physical activity goal or condition is met may enhance the effectiveness of financial incentives in some subgroups.

Behavior Change Theories and Strategies

Sources of evidence: Systematic review, meta-analysis

Conclusion Statement

Strong evidence demonstrates that behavior change theories and techniques are effective for increasing physical activity levels in general adult populations. **PAGAC Grade: Strong**.

Review of the Evidence

One meta-analysis[39] provided evidence on the impact of theory-based interventions to promote physical activity. This meta-analysis contained 82 RCTs that included adults and that were published from inception through May 2013. Of the 61 studies based on a single behavioral theory, 31 were based on the Transtheoretical Model (TTM), 16 were based on Social Cognitive Theory (SCT), 8 were based on the Theory of Planned Behavior (TPB), 5 were based on Self-Determination Theory (SDT) and 1 was based on Protection Motivation Theory (PMT); 14 studies reported combining 2 theories, and 7 studies reported combining 3 to 5 theories. One systematic review[40] that included 41 controlled studies of individual-level walking and cycling interventions among adults provided evidence on behavior change techniques used to promote walking and cycling. The review covered studies published between 1990 and 2011 that compared an intervention strategy with no intervention or standard care; studies with alternate, more active intervention control conditions were not considered in that review. Intervention duration ranged from 1 week to multiple years.

Evidence on the Overall Relationship

The meta-analysis of theory-based interventions[39] (N=82 RCTs) found an overall average effect size of 0.31 (95% CI: 0.24-0.37) for such interventions compared with control groups; single theory intervention effect sizes ranged from 0.26 to 0.61. Analyses did not identify significant differences in physical activity changes between theories. However, interventions based on a single theory had stronger impacts than interventions based on a combination of theories. The effect size for single theory interventions was 0.35 (95% CI: 0.26-0.43) and for combined theories was 0.21 (95% CI: 0.11-0.32).

Of the 41 studies included in the Bird et al[40] review, 21 reported a statistically significant effect on walking and/or cycling outcomes, 12 reported an effect in the positive direction that was not statistically significant, and 13 did not provide information about statistical significance when testing the effect of the intervention on walking and/or cycling behavior. The mean number of behavior change techniques coded in the studies was 6.43 $\pm$ 3.92, 4.42 $\pm$ 3.29, and 1.69 $\pm$ 1.32 for studies reporting statistically significant, non-statistically significant, and no reported statistical significance information, respectively. When effect sizes were presented, studies using combinations of behavior change techniques were successful for increasing walking and cycling behaviors. Although a wide range of behavior change techniques were employed across the 41 studies included in the systematic review, they provided no evidence that a specific combination of techniques was more or less effective for influencing walking and/or cycling behavior. Among interventions that showed a statistically significant effect on walking or cycling, the post-intervention change in physical activity behavior ranged from +0 to +87 minutes per week in walking or cycling, +1.38 to +1.42 days of walking per week, +6,482 to +24,227 steps per week, and +1.1% walking and cycling trips. Effect sizes, where provided, ranged from 0.14 to 0.75. The most commonly reported behavior change technique among studies that reported changes in physical activity behavior (significant and non-significant) was self-monitoring of behavior and intention formation. Providing general encouragement was most commonly cited in interventions that did not provide information about the statistical significance of the effects.

Evidence on Specific Factors

Evidence in the reviews comparing different racial/ethnic groups or specifically reporting adverse events and cost-effectiveness is currently lacking or infrequently reported. Several systematic reviews were found aimed at a specific subgroup which may particularly benefit from more targeted interventions, including low-income adults,[41] adults with obesity,[42] and men.[43]

Features of physical activity intervention targets and measures: Physical activity outcome variables consisted primarily of self-reported or objectively measured minutes of physical activity over a specified time period (i.e., per day or per week), daily step counts, and/or proportion of trips taken using a specific mode of physical activity (e.g., walking, cycling). Few details were provided about the types of physical activities that were prescribed or targeted by the interventions.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

The evidence that theory-based interventions are effective suggests that strategically incorporating intervention components that include theoretical constructs is important. Programming that includes key individual, social, and environmental theoretical constructs that relate to diverse age groups and populations could be potentially useful.

Given the broad availability of physical activity self-monitoring tools (e.g., pedometers incorporated into mobile devices, popularity of wearable devices), theoretically derived behavior change strategies such as self-monitoring are a particularly promising technique for increasing awareness of, and adherence to, physical activity goals and guidelines, and enhancing feedback related to self-behavior.

Peer-Led Interventions

Peer-led interventions are defined as interventions that are delivered in part or full by non-professionals who share similar characteristics, health conditions, or situations as the target population of the intervention.[44]

Source of evidence: Meta-analysis

Conclusion Statement

Moderate evidence indicates that peer-led behavioral self-management interventions are effective in older adults and individuals with chronic disease and produce small but meaningful increases in physical activity when compared with minimal or no-treatment control conditions, particularly over short time periods (i.e., 6 to 12 weeks). **PAGAC Grade: Moderate.**

Review of Evidence

The Subcommittee reviewed one meta-analysis that included 21 studies overall, 17 of which were reviewed meta-analytically.[45] The timeframe reviewed was 1989 to 2015. All studies adopted a self-management approach through employing self-regulatory skill building strategies derived from social cognitive theory to promote self-efficacy (i.e., increased confidence in one's ability to engage in regular physical activity), which in turn was presumed to increase physical activity levels. The vast majority of interventions were group-based, ranged from 1 to 13 sessions in length, and targeted inactive but otherwise healthy older adults, or individuals with multiple sclerosis, arthritis, diabetes, physical limitations, or a mix of chronic conditions.

Evidence on the Overall Relationship

The effectiveness of the interventions was small but consistent when compared to minimal intervention or no-treatment control arms. Best et al[45] reported moderate effects for increases in physical activity overall among the 17 studies where effects sizes were available (SMD=0.4; 95% CI: 0.22-0.55, P<0.001). A more refined analysis of a small number of studies where active control groups were comparators also appeared promising (four studies; SMD=0.3; 95% CI: 0.08-0.43, P=0.004). Fourteen of the 21 studies overall reported significant between-group increases in physical activity relative to control groups. Methodological quality of studies was fair to good overall. The duration of the interventions was typically short (less than 6 months) and variable across studies (range: 1 to 16 weeks). The intensity of the intervention varied from 1 to 3 hours per week of group-based contact. In those studies that included follow-up periods occurring after the intervention was completed, the follow-up duration varied from 2 to 18 months. The maintenance of physical activity improvements was promising in these studies (four studies; SMD=1.5; 95% CI: 0.13-2.83, P=0.03).

Features of physical activity intervention targets and measures: Studies focused primarily on increasing physical activity generally without a particular focus on a specific type or intensity of activity. All studies (N=21) described outcomes from self-reported measures of physical activity only (i.e., minutes per week of moderate-to-vigorous physical activity; MET-hours per week and activity kilocalories per week). A sub-analysis among nine studies that all reported minutes of physical activity per week suggested small but consistent effects for physical activity (SMD=0.2; 95% CI: 0.17-0.29, P<0.001).

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups, adverse events, and the cost-effectiveness of peer-led interventions is currently lacking or infrequently reported.[46]

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

Given their potential for lower costs, peer-led interventions may increase the likelihood of broad dissemination of physical activity promotion strategies among populations with chronic diseases, compared with interventions delivered by trained professionals. The actual cost-effectiveness of such approaches, however, awaits further systematic evaluation. The careful fidelity and process measures contained in a number of the reviewed studies suggest that it is feasible for peer volunteers to be trained to deliver theory-driven interventions with adequate fidelity to ensure program success.

COMMUNITY LEVEL

Community level interventions include multi-component interventions aimed at a defined population (i.e., community-wide interventions) as well as interventions targeting a particular setting. Community settings can be defined generally as those locales where people gather for educational, housing, consumer-related, health-related, or social purposes. Community interventions can be initiated through specific settings that reach people in their homes or other locations (e.g., nurse-based outreach programs), or that span multiple settings or locales (i.e., community-wide interventions). A growing number of such settings have served as potentially convenient points of contact in which to deliver physical activity interventions. Some settings serve as important focal points for reaching diverse portions of the population across a wide age range (e.g., primary care settings, faith-based settings), while others can be useful in targeting specific age groups (e.g., schools, child care settings, senior centers, or housing sites).

Attractive elements of community settings include potential population reach, ability to segment audiences, and the potential convenience of intervention delivery. However, such settings can create challenges for intervention delivery in terms of gaining cooperation of setting-specific decision-makers and stakeholders and responding to turnover of personnel in the setting. In addition, while community settings can be useful intervention delivery sites for those groups who regularly use them, it is important to understand which segments of the population do not visit such venues. Intervention fidelity across different settings is another challenge. Meanwhile, community-wide interventions, which typically span multiple community settings and levels of impact (e.g., individuals, institutions, physical environments) produce their own set of challenges. These include issues of cost, true population reach (i.e., the number and types of people actually receiving the interventions), and sustainability.

Although decades of physical activity promotion research have occurred at the community-wide level as well as across a diverse set of community settings, the robustness of the current evidence in this area continues to be curtailed by the use of less rigorous study designs and assessment methods, uneven application of procedures to enhance intervention fidelity, and relatively short intervention durations. Evidence related to different population segments will be discussed to the extent possible when available. As noted previously, the categories were not identified a priori and were not specifically included as search terms, but, rather, emerged during the broad 2011-2016 evidence search that was undertaken. Such a condensed approach necessarily limits the size and, potentially, the types of evidence considered at this level.

Community-Wide Interventions

Sources of evidence: Meta-analysis, systematic reviews

Conclusion Statements

Moderate evidence indicates that community-wide interventions that employ intensive contact with the majority of the target population over time can increase physical activity across the population. **PAGAC Grade: Moderate.**

Limited evidence suggests that community-wide interventions using strategies that reach a smaller proportion of the target population, employ less intensive contact over time, and focus on a relatively narrow set of strategies are effective in promoting community-wide physical activity change. **PAGAC Grade: Limited.**

Review of the Evidence

Three systematic reviews were included[47-49] along with the PAG Midcourse Report.[26] The systematic reviews included a range of 10 to 33 studies. The systematic reviews covered the following timeframes: inception to June 2013,[47] 1980 to 2008,[48] and 1995 to January 2014.[49]

The included reviews examined the effects of community-wide interventions on physical activity participation. Brown et al[48] examined the effectiveness of stand-alone mass media campaigns to increase physical activity at the population level. The included reviews addressed changes in physical activity levels measured largely through a variety of self-report instruments. The PAG Midcourse Report included a review of reviews of physical activity intervention studies focused on youth ages 3 to 17 years that were published January 2001 through July 2012; a total of 31 reviews containing 910 studies (not mutually exclusive) were included.[26]

Evidence on the Overall Relationship

Evidence on intensive multi-component interventions: The small number of community-wide interventions that reported significant increases in physical activity across the entire target population reported intensive contact with the majority of the population over time. Two such studies, conducted in China, reported significant adjusted relative risk (RR) scores of 1.03 to 1.20 (95% CI: 1.05-1.05 and 1.09-1.31, respectively).[50, 51] Among the strategies included in the Chinese interventions were quarterly door-to-door delivery of instructional handouts, health counselor advising, and identification of high-risk community residents.[49] Several other studies have reported significant physical activity increases in one sex but not the other. For example, significant physical activity improvements were reported in men (*P*=0.047) though not women (*P*=0.15) in a Norwegian study,[52] although the adjusted relative risk for the entire population was 1.10 (95% CI: 0.84-1.43) and was not significant. A U.S. study[53] with an independent cross-sectional survey sample, had similar results with *P* values of 0.004 in men versus 0.237 in women, though with no statistically significant differences found in either sex in the cohort sample of this study. In contrast, significant physical activity improvements were found in women though not men in an Australian study.[54] The latter study, however, is complicated by the observation that the baseline physical activity between the intervention and comparison communities was different.

In a regional cardiovascular disease prevention program in the Netherlands,[55] while both the intervention and control arms reported an overall decrease in leisure-time physical activity across a 5-year period in women, those receiving the intervention had significantly less of a decrease over time than did those in the control arm ($P<0.05$). In addition, when comparing reported walking hours per week over the 5-year period for participants overall, this physical activity variable decreased less in the intervention community than in the control community (adjusted percentage change between the two communities=29.41%).

A similar lessening of the decrease over time in physical activity was reported in the intervention relative to control arm in a study conducted in Ghent, Belgium,[56] with the adjusted percentage change between the two arms reported to be 25.6 percent. This community study also reported statistically significant increases in walking, measured by step-counter and self-reported minutes per week of walking, in intervention versus control arms (adjusted changes of 10.8% and 17.34%, respectively).[56] In a multi-community U.S. study that used a dichotomous physical activity outcome,[57] statistically significant intervention effects for the proportion of the population reporting being regularly physically active during leisure time were found for some measurement time points and methods (e.g., at 1 and 3 years using independent cross-sectional surveys; at 7 years post-intervention using cohort surveys), though not for all time points. For this latter study, the overall adjusted relative risk using data extracted from year zero to the final measurement year was reported to be 1.08 (95% CI: 0.97-12.0) and 1.11 (95% CI: 0.94-1.30) for the cohort and independent cross-sectional data, respectively.[49]

Evidence on other community-wide interventions using less-intensive or fewer-component interventions: For less-intensive community-wide intervention efforts, some evidence of positive effects has been reported when the interventions were specifically targeted to specific populations (e.g., primarily school-based settings[58]) or to specific forms of physical activity (e.g., cycling, walking). In the school-based cluster-RCT of adolescents by Simon et al,[58] for example, the authors reported a statistically significant adjusted mean difference of 1.1 hours per week of leisure-time physical activity favoring the intervention arm at 4-year follow-up. Similarly, while some studies reported significant increases in physical activity in response to specific intervention components (e.g., increases in the use of trails and pathways), such increases did not result in a measurable uptake of physical activity across the community as a whole.[49]

A number of investigations in this area, including more recent studies, lack reliable measures of physical activity and report incomplete data collection. Those studies that did not employ randomization methods often reported baseline differences between study arms and other potential threats to internal validity, leading to an assessment of high or unclear risk of bias. Despite study objectives aimed at community-wide interventions, many of the interventions did not reach a sizable portion of the community, interventions varied considerably with respect to intensity (i.e., amount, frequency, and reach of the interventions into the target population over time), and a variety of continuous and dichotomous physical activity outcomes were employed. In addition, a number of studies included a focus on other health behaviors and outcomes of relevance to chronic disease, which potentially could have interfered with or reduced the successful uptake of the physical activity interventions.

The effects of stand-alone mass media campaigns on population-level physical activity are currently unclear, due to a relatively small number of studies that were often accompanied by poor or inadequate measurement of physical activity and weak designs.[48] In contrast, a national 5-year social marketing-based mass media campaign called VERB™ that used multiple social communication channels and targeted a specific population group, i.e., U.S. youth ages 9 to 13 years, showed increased physical activity awareness as well as reported physical activity participation,[59] described in the PAG Midcourse Report.[26] For additional description of this study, see the *Communication Environment Level: Social Media* section of this chapter.

Evidence on Specific Factors

Evidence in the reviews evaluating intervention effects on different racial/ethnic groups and adverse events is currently lacking or infrequently reported. Although some studies did specifically target underserved or lower income communities, only a few studies specifically evaluated intervention differences by socioeconomic strata, with results found to be indeterminate or inconclusive.[49] When the cost-effectiveness of population-level physical activity interventions was compared systematically among the relatively small number of studies for which this information was available,[47] the most efficient interventions for increasing physical activity were community rail trails, step-counters (pedometers), and school health education programs. In general, smaller scale environmental interventions (e.g., trails) produced lower (better) cost-effectiveness ratios than the most expensive large environmental interventions (a light-rail trail system), although the latter was estimated to produce higher physical activity gains. The evidence indicated that monetary incentives and controlled access to local recreational centers free of charge might be less cost-effective than other strategies.[47]

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

In light of the potential population impact of physical activity interventions aimed across a community as a whole, studies employing various community-level interventions have been conducted across a range of geographic locations and community settings. Several systematic investigations that have employed intensive multicomponent strategies to reach a majority of the target community over an extended period of time have shown success in promoting increases in physical activity. The majority of interventions in this area, however, have been unable to deploy a sufficient number of strategies over time to a large enough proportion of the population to achieve consistent community-wide physical activity increases. Of note, several large-scale interventions were able to achieve smaller decrements in physical activity levels over time relative to control communities—an important finding given prevalent age-related decreases in physical activity levels. In light of the substantial challenges and resources often involved in delivering high-quality community-wide interventions of sufficient intensity, population penetrance, and sustained engagement to produce measurable increases in community physical activity levels over time, more targeted approaches aimed at specific population segments or specific forms of physical activity may be indicated. For example, the national VERB™ multi-component mass marketing campaign was able to report some successes in increasing physical activity among the 9 to 13 year age group for which it was targeted. Alternatively, finding ways to leverage increasingly prevalent information and communication technology platforms as part of community interventions may facilitate higher population penetrance and program sustainability.

Child Care and Preschool Settings

Sources of evidence: Systematic reviews, meta-analysis, published report

Conclusion Statement

Limited evidence suggests that interventions occurring in child care or preschool settings are effective for increasing physical activity in children ages 6 years and younger. **PAGAC Grade: Limited.**

Review of Evidence

One systematic review of 23 studies,[60] one systematic review of 17 studies that included 16 studies in a meta-analysis,[61] and the PAG Midcourse Report[26] were included. Studies included reviews of interventions conducted from inception to September 2014 in center-based and licensed child care settings in children ages 0 to 6 years[61] and inception to May 2013 among children ages 2 to 6 years.[60] The PAG Midcourse Report included a review of reviews of physical activity intervention studies focused on youth ages 3 to 17 years that were published January 2001 through July 2012; a total of 31 reviews containing 910 studies (not mutually exclusive) were included.[26] Intervention strategies included incorporating structured active lessons into classroom activities, play area modifications, scheduling additional play time (indoor and outdoor, structured and unstructured), and parental involvement. Interventions were either led by trained teachers or trained research staff. Several interventions included an additional parent component, primarily consisting of newsletters to parents regarding intervention activities. Several interventions also included physical alterations or redesign of outdoor play space. All of the reviews addressed changes in physical activity. Studies in child care settings primarily used device-based (accelerometer, pedometer, heart rate) measures of physical activity to assess changes in light-, moderate-, and/or vigorous-intensity physical activity. Some studies also assessed sedentary behavior. A few studies used parental assessments to estimate children's physical activity levels or direct observation in classroom or intervention settings.

Evidence on the Overall Relationship

The PAG Midcourse Report concluded that evidence was Suggestive (similar to a grade of "Limited" in the current report) that preschools and child care centers were effective settings for increasing physical activity in children.[26] The PAG Midcourse Report define a grade of "Suggestive" as "reasonably consistent evidence of effect, but cannot make strong definitive conclusions." The conclusion was based primarily on evidence from three reviews focused on childcare settings.[26] Promising strategies deserving of further investigation included: 1) providing portable play equipment on playgroups and other play spaces; 2) providing staff with training in the delivery of structured physical activity sessions and increasing the time allocated for such sessions; 3) integrating physical activity teaching and learning activities into pre-academic instructional routines; and 4) increasing time that children spend outside.

Two additional reviews[60, 61] in preschool and child care settings provided evidence to further support the conclusions from the PAG Midcourse Report.[26] Physical activity outcomes included daily step counts, accelerometer counts, time spent walking, and/or time in sedentary and light-, moderate-, and/or vigorous-intensity physical activity. Although the systematic reviews included a sufficient number of studies from which to draw conclusions, many studies did not provide enough information regarding the magnitude of the effects of the intervention strategies on physical activity behavior change in children. When the magnitude of the effect was presented, effect sizes were reasonably small, with some not reaching statistical significance, and study durations often were relatively brief. One meta-analysis by Finch et al[61] found an overall pooled SMD of 0.44 (95% CI: 0.12-0.76; P=0.007), though pooled effect estimates were no longer significant after an outlier was excluded from the meta-analysis (SMD 0.28; 95% CI: -0.01 to -0.56; P=0.06). SMD estimates ranged from 0.07 to 1.26 based on an analysis of individual study characteristics. When comparing the eight identified pragmatic trials (delivered under "real world" conditions) and the nine identified non-pragmatic trials (explanatory or efficacy trials), pooled analysis results suggested that the pragmatic interventions were not effective for improving physical activity in children (SMD 0.10; 95% CI: -0.13 to 0.33; P=0.40), although the non-pragmatic trials showed a significant effect (SMD 0.80; 95% CI: 0.12-1.48; P=0.02). In their review, Mehtala et al[60] provided limited information on the magnitude of effects or effect sizes, although they noted that 14 of 16 studies that focused on increasing physical activity levels reported significant physical activity changes. When available, mean differences across studies ranged from +4.8 percent to +61 percent for percent time in moderate-to-vigorous physical activity, -5 percent to -26.5 percent for sedentary time, and +3 to +58 minutes for minutes of moderate-to-vigorous physical activity.

With respect to the evaluation of different intervention elements, the Finch et al[61] review noted that although both structured and unstructured active lessons produced statistically significant physical activity-related SMDs, the SMD produced by structured active lessons was larger (SMD 0.53 vs. 0.17, respectively, P<0.05). Including theory-based interventions also showed promise. Theory-based interventions had a larger and statistically significant SMD (0.76, P=0.03) compared with interventions that were not theory-based (0.25, P=0.14). Intervention strategies with no parent component had a statistically significant SMD (0.54), while strategies that included a parent component did not (SMD=0.41). Strategies that included changes to the physical environment produced SMDs that were similar to strategies that did not include changes to the physical environment (SMD 0.41 and 0.73, P<0.05). Expert-led interventions were more effective than teacher-led interventions (SMD 1.26, P=0.02

versus 0.27, *P*=0.19). Interventions lasting 6 or fewer months yielded a statistically significant SMD (0.58, *P*=0.02), while the effect size for interventions lasting more than 6 months was not statistically significant (SMD 0.07, *P*=0.25).

Features of physical activity intervention targets and measures: The most common types of physical activity interventions implemented in child care or preschool settings included group-based interventions lasting 30 or more minutes on 2 to 5 days per week. The types of activities typically included outdoor play activities, activities focused on large muscle or gross motor skills (e.g., jumping, hopping, skipping), dancing, and jogging or running. Physical activity intensity level was typically not defined in intervention descriptions. However, time spent in light-, moderate-, and vigorous-intensity physical activity was listed as common physical activity outcomes of interest.

Evidence on Specific Factors

Populations included in the systematic reviews and meta-analysis included children from low-income communities, children of various races and ethnicities, and males and females. The studies were conducted within and outside the United States. These types of populations may be of interest for subgroup analyses because of reported differences in physical activity levels between groups. Limited evidence was provided to evaluate differences in intervention impact between population groups, with the exception of sex-based differences. Some evidence suggests that intervention strategies focused on increasing playground space were more effective for boys than girls, possibly due to the types of activities (e.g., sports) that occur on playgrounds. Differences between the sexes were not apparent in environments or activities that were not sports-based.[60] Strategies that focused on adding more recess opportunities and reducing playground density appeared to be more effective for girls compared with boys.[60] Evidence in the reviews evaluating intervention effects for children of different races and ethnicities, as well as the reporting of adverse events, are currently lacking or infrequently reported.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

Given that 24 percent of young children are cared for in organized care facilities, and children are in these facilities approximately 8 hours per day,[62] the potential impact of increasing physical activity levels in child care and preschool settings could be substantial. Several studies offered information about promising strategies that deserve further evaluation, including physical activity-specific in-service teacher training, structured active lessons, and theory-based interventions.

Faith Based Community Interventions

Faith-based settings are organizations with religious or spiritual components as part of their mission and decision-making.[63] Programs or interventions delivered in concert with these settings can be faith-"based" (i.e., integrated with religious or spiritual aspects) or faith-"placed" (i.e., delivered within or through these settings).[64]

The reach of faith-based organizations into diverse populations, along with the support and community-connectedness they provide, have made them an appealing milieu for designing, implementing, and evaluating physical activity interventions.[65, 66]

Source of evidence: Systematic reviews

Conclusion Statement

Limited evidence suggests that interventions that are either faith-based or faith-placed may be effective for promoting physical activity. **PAGAC Grade: Limited.**

Review of the Evidence

The Subcommittee considered two reviews.[64, 67] Parra et al[64] included studies from inception to January 2016, and Bopp et al[67] included studies from inception to May 2011. Within the Parra et al[64] review, 18 studies used study designs consisting of either RCTs or quasi-experimental studies with a control or comparison group. Of the 18 studies, 3 were faith-placed and the other 15 were faith-based. Additional inclusion criteria in that systematic review were that the interventions had to be delivered in faith-based organizations and have at least one active physical activity component. Fourteen of the studies were conducted in the United States. The remaining studies were conducted in New Zealand (N=2) and Australia (N=2). Nine of the studies were non-RCTs and nine were RCTs with randomization occurring at the cluster level. The majority of participants in the studies were female and African American. A range of ages were represented in the studies and the intervention length ranged from 8 weeks to 3 years. Half of the studies (N=9) included weekly physical activity intervention sessions and some included training of lay health educators, while others were delivered by the research team.

Bopp et al[67] included 27 articles (19=faith based; 8=faith placed). Similar to the Parra et al[64] review the majority of studies (N=21) targeted African American adults, with two studies including Latino adults and one including children. The Bopp et al[67] review described intervention characteristics by type (faith-based or faith-placed). Briefly, for faith-based studies, the intervention length ranged from 4 weeks to 2 years. Most studies (N=10) were theory based, and most (N=15) had weekly class sessions. Common characteristics across studies included education and a guided exercise session. Studies ranged from 13 weeks to 2 years, with faith-placed studies generally reporting longer intervention durations compared with faith-based studies. Details regarding the theoretical foci of the interventions were limited, with only one of the studies explicitly reporting the theoretical basis, while two others cited specific health promotion frameworks. Intervention content and length were heterogeneous, as was the health focus of the intervention (e.g., some focused on diabetes, some specifically on physical activity).

Evidence on the Overall Relationship

Thirteen of the 18 studies included in the Parra et al[64] systematic review reported on change in physical activity behavior or session attendance, with 7 of the 18 studies (3=RCT; 4=non-RCT) finding significant effects for physical activity behavior when comparing the intervention to control. Of the seven, two were faith-placed and five were faith-based. Some common characteristics of those studies with positive effects included interventions with weekly sessions, a basis in theory (e.g., Social Cognitive Theory, Transtheoretical Model), and trained staff or peer educators. The physical activity outcomes reported were heterogeneous (e.g., moderate-to-vigorous physical activity; session attendance, walking behavior, overall time spent in physical activity).

For the faith-based studies reviewed by Bopp et al,[67] 10 of 19 reported positive changes in physical activity behavior. For the faith-placed studies reviewed by Bopp et al,[67] four of eight reported changes in physical activity behavior.

Evidence on Specific Factors

Evidence in the reviews evaluating intervention effects on different racial/ethnic groups, adverse events, or cost-effectiveness is currently lacking or infrequently reported. None of the studies included in the systematic reviews[64, 67] provided evidence of an increased risk of adverse events.

Features of physical activity intervention targets and measures: Outcomes of interest were change in physical activity assessed both by self-report and accelerometry, and included a range of physical activity targets (e.g., moderate-vigorous physical activity, walking, leisure-time physical activity).

Intervention effects were generally small, ranging from a difference between intervention and control in moderate-intensity physical activity of 2.7 minutes (as measured by accelerometry) to 103 minutes (as measured by interview recall). The intervention durations of the included studies in the Parra et al[64] review were variable, with 8 out of 18 being short-term (less than 6 months), 5 out of 18 medium-term (6 to 11 months) and 4 out of 18 long-term (12 months or more). For the faith-based studies in the Bopp et al[67] review, most had intervention durations between 8 to 12 weeks, with two being 6 weeks or less and four with longer durations (one=16 weeks; one=6 months; one=1 year; one=2 years). The faith-placed studies in the Bopp et al[67] review generally had longer intervention durations compared with the faith-based studies; three were 12 to 14 weeks, two were between 6 and 8 months, two were 1 year, and one lasted 2 years. Specific intervention effects related to study duration were not reported consistently in the Bopp et al[67] review.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

Faith-based organizations provide many individuals with support, guidance, leadership, and connectedness. Many faith-based organizations are sources of health-related information and delivery of health programming and services. Physical activity adoption and maintenance is a natural intervention target for these faith-based organizations as it is synergistic with the view of health as a multifaceted construct incorporating spiritual, physical, and emotional aspects. Delivering physical activity programming through these community systems offers potential for dissemination and long-term sustainability.

Faith-based organizations may be appropriate health promotion partners for improving physical activity in high-risk populations, particularly as 77 percent of Americans affiliate with a religion and 36 percent attend worship services at least once per week, with affiliation and attendance higher for women and for those from some racial and ethnic populations, including African American and Latino populations.[68,69] In addition, faith-based organizations often have physical space to hold activities and tend to be a trusted entity in the community with deep social networks.

Nurse-Delivered Interventions in Home or Other Community Settings

Source of evidence: Systematic reviews

Conclusion Statement

Limited evidence suggests that nurse-delivered interventions in community settings are effective for increasing physical activity in adults. **PAGAC Grade: Limited.**

Review of Evidence

Two systematic reviews were included.[70, 71] These reviews included a range of 8 to 13 studies. Both reviews covered the 1990 to 2015 timeframe. Both reviews[70, 71] examined physical activity intervention studies delivered by a registered nurse or nurse practitioner. Richards and Cai[70] specifically examined studies conducted by a nurse at participants' homes. Richards and Cai[71] included interventions delivered in other community settings (i.e., community centers, senior centers, places of worship, outpatient clinics, health or fitness centers). Both reviews addressed changes in physical activity. They examined physical activity through self-report and wearable devices (e.g., daily step counts measured by pedometer). The reviews also addressed other outcomes, including adherence to exercise.

Evidence on the Overall Relationship

A small number of studies have been conducted on the topic. Studies occurred in several different countries. In the review of community-based interventions,[71] only 5 of the 13 studies were RCTs. Of those five RCTs, three reported significant differences between treatment and control arms, although precise, quantified information regarding the magnitude of the effects of the intervention strategies relative to controls on physical activity behavior change was not included.[72-74] In the review of home-based interventions, only four of the eight studies reviewed were RCTs, and two of the four reported significant differences in physical activity between treatment and control arms, although information on the magnitude of intervention effect was not presented.[75, 76] Follow-up data collection (beyond intervention end) was available for 4 out of 21 (19%) of studies, with reported follow-ups often of 6 months or longer. As reported in the experimental trials, some useful intervention components appear to include nurse involvement in establishing physical activity goals, selecting types of physical activity and related lifestyle improvements, and providing direct physical activity advice and counseling.[75-77]

Features of physical activity intervention targets and measures: Physical activity outcomes varied considerably, and included daily step counts,[75, 78-80] accelerometer-based activity counts,[81] aerobic activity,[72] self-reported frequency of exercise,[82] reported walking and/or minutes per week of moderate-to-vigorous physical activity,[77, 83] self-reported walking frequency,[73] walking frequency and intensity,[84] and total physical activity.[74, 85] Most interventions were not reported as prescribing specific physical activity frequency, intensity, time, and/or type.

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups, adverse events, and cost-effectiveness is currently lacking or infrequently reported.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

Community-based physical activity interventions delivered through nurse outreach can be particularly useful, given their convenience for populations, such as frail adults and those with chronic conditions, who can benefit from clinical oversight and instruction. Nurses can provide the personal contact and program customization that may be particularly beneficial for behavior change with such populations. Nurses who see patients in their home environments also can involve family members and local support networks as part of the intervention, which can facilitate physical activity participation. Continuity of care also may be a benefit of this type of community outreach intervention.

Interventions in Primary Care Settings

Primary care interventions encompass different delivery types and programs, including counseling sessions with primary care providers that range in duration from short (2 to 10 minutes) to long (e.g., 40 minutes). Counseling can be provided by physician contact only as well as in combination with printed materials. Additionally, some primary care interventions focus solely on prescription schemes in which a general practitioner (e.g., nurse or physician) gives a written prescription to a patient to participate in a physical activity program. Primary care interventions, as reviewed here, do not include intensive lifestyle interventions where primary care serves only as a referral source, or interventions that have not tested the delivery of a behavioral intervention within the clinical setting.

Sources of evidence: Systematic reviews, meta-analysis, review of reviews

Conclusion Statement

Limited evidence exists that primary care-based interventions targeting increases in physical activity among adults are effective when compared with minimal or usual care conditions, particularly over medium (i.e., 6 to 11 months) and longer periods (i.e., 12 months or more). **PAGAC Grade: Limited.**

Review of the Evidence

Two meta-analyses,[86, 87] nine systematic reviews,[88-96] and two systematic reviews of previous systematic reviews[97, 98] were included. The meta-analyses included 14[86] and 17[87] studies. The systematic reviews included a range of 3 to 32 studies. The two systematic reviews of previous systematic reviews included 10[97] and 16[98] reviews. Studies overall covered an extensive timeframe, including a number from inception[86, 91, 98] through 2016.[92, 93] The majority of studies examined interventions among generally healthy adults and older adults[86, 87, 89-92, 94, 95] while one examined African American and Latino groups specifically.[87] The majority of studies focused on the efficacy of a varied range of intervention strategies within primary care settings, while one focused exclusively on motivational interviewing techniques.[90]

Evidence on the Overall Relationship

The effectiveness of the interventions was variable when compared to minimal or usual care control arms. The magnitude of the effect was not easy to determine and many systematic reviews and review of reviews did not report effect sizes. Orrow et al[86] reported small to medium effects for likelihood of achieving 30 minutes of moderate-intensity physical activity on 5 days per week (odds ratio (OR)=1.42; 95% CI: 1.17-1.73) and increases in overall physical activity behavior (SMD=0.25; 95% CI: 0.11-0.38) in previously inactive adults and older adults. The majority of these studies were short in duration (i.e., less than 6 months). Ramoa Castro et al[92] reported increases in physical activity from 5 percent to 26 percent relative to controls in studies of 6 to 12 months in length. However, it should be noted that the magnitude of the effects varied widely, as both of these reviews reported that the majority of studies reviewed had null or non-significant improvements in physical activity. Morton et al[90] reviewed studies implementing motivational interviewing techniques, a common intervention strategy in clinical settings, to increase physical activity. Only 11 of 22 studies reviewed showed significant improvements in physical activity (length of intervention periods was not reported). However, the authors noted that strategies that combined motivational interviewing with other strategies (e.g., vouchers for an exercise facility) tended to be the most effective. For those studies focusing on physical activity prescription schemes in particular, 37 studies were included. Studies were conducted in 11 different countries (United Kingdom=13; Sweden=7; Netherlands=2; Denmark=3; Finland=1; Spain=2; Germany=1; Canada=2; United States=3; New Zealand=1; Australia=1).

Several characteristics were important to the design of prescription-based programs, including the reason for referral, prescriber (e.g., general practitioner or other health professional), location of physical activity implementation (i.e., community facility or home), type of activity, and cost.[96] These characteristics varied by country, particularly in relation to referral reason and cost.[96] Of the studies included from European countries, all except those from the Netherlands had a disease (e.g., cardiovascular disease, diabetes) as the reason for referral, with sedentary lifestyle being a consistent reason for referral across all countries. General practitioner was listed as a prescriber across all countries, although other health professionals were included in the United Kingdom, Sweden, Australia, and New Zealand. All countries included a specific facility in which the recommendation would be implemented, although Sweden, Australia, New Zealand, and the United States included both facilities and home-based locations. In all countries except Spain and Canada, participant payments were required, although a reduced price was noted for the U.K.-based studies. Meta-analyses showed small effects for physical activity adherence (i.e., proportion participating in greater than or equal to 80% of the prescription recommendations: I-squared=98.4%; P=0.000; effect sizes ranged from -0.53 to 0.58).[96] One study of more than 6,600 adults found of those referred, 79 percent attended their first appointment.[96] However, such positive effects were not found for self-reported physical activity behavior (I-squared=34.5%; P=0.081; effect sizes ranged from -10.34 to 2.12). Many studies in this area were of short duration (less than 6 months), with a few that were of medium (6 to 11 months) or longer-term (12 months or more) duration.[96]

Support for the supplementation of physical activity advice with written prescriptions was mixed, and the amount of contact time spent between the provider and the patient did not appear to have a significant effect on physical activity behavior. More promising effects were observed for those brief interventions with short-term follow-ups (4 to 12 weeks), and those that included motivational interviewing approaches.[98]

Features of physical activity intervention targets and measures: Most of the studies reported that brief advice by the healthcare provider was given, although the nature of the advice was not clearly described. Some studies described brief follow-up with a physical activity specialist,[95] while others clearly described systematic approaches to the delivery of motivational interviewing techniques for increasing physical activity.[90] Briefly, these techniques were specific to motivational interviewing (e.g., empathetic counseling, active or reflective listening, use of “importance” and “confidence” rulers or metrics) as well as other common behavior change techniques (e.g., goal setting, social support, action planning, and feedback). The majority of studies reported outcomes from self-reported measures of physical activity (i.e., minutes per week of moderate-to-vigorous physical activity; MET-hours per week, and activity kilocalories per week) and amounts of walking, with a few studies that reported pedometer-derived step counts and/or accelerometer-derived activity. For prescription schemes specifically, physical activity adherence to recommendations was a prevalent outcome assessed.[87]

Evidence on Specific Factors

Melvin et al[89] reported on a limited number of studies specifically involving African American (N=2) and Latino (N=2) adults and found no significant increases in physical activity.

Orrow et al[86] described one study that reported on adverse events. This study observed small increases in musculoskeletal injury (7%) and falls (11%), relative to usual care, in women ages 40 to 74 years.

One study,[99] reviewed by Gagliardi et al,[95] provided a cost analysis, estimating that an initial monthly cost for adding a physical activity counseling into a primary care practice would be $91.43 (in Canadian dollars) per month. Another study found favorable cost effectiveness for prescription schemes, relative to usual care, in inactive individuals without a medical condition, inactive individuals with obesity, inactive individuals with hypertension, and inactive individuals with depression.[96] Although not analyzed systematically, factors noted to be of potential importance for prescription schemes were the reasons for referral and participant-related payments. Health status was a reason for referral in most of the European studies included, but not for all countries. The fees associated with access to locations and exercise professionals also were found to vary across countries and were not consistently reported or analyzed.[87]

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

The primary care setting may be an appealing venue for offering physical activity counseling or referral. Despite increasing demands upon clinical providers during primary care visits, the primary care setting represents a scalable opportunity to influence population-level physical activity if effective approaches can be implemented. The current state of the evidence suggests that brief interventions in the context of a clinic visit have limited efficacy for significantly increasing physical activity. Intervention efficacy may be enhanced by providing more standardized interventions (e.g., delivered in a similar manner across providers and health care systems) and more robust strategies (e.g., strategies beyond brief advice that include messaging from one or more members of the provider team using motivational interviewing or other theory-based approaches). Such strategies can be supplemented with written "prescriptions" involving specific physical activity recommendations.

School Interventions

Sources of evidence: Meta-analyses, systematic reviews

Conclusion Statements

Strong evidence demonstrates that interventions that affect multiple components of schools are effective for increasing physical activity during school hours in primary school-aged (typically ages 5 to 12 years) and adolescent youth. **PAGAC Grade: Strong.**

Strong evidence demonstrates that interventions that revise the structure of physical education classes are effective for increasing in-class physical activity in primary school-aged and adolescent youth. **PAGAC Grade: Strong.**

Limited evidence suggests that interventions that modify the designs of school playgrounds or that change recess sessions in other ways are effective for increasing physical activity in youth. **PAGAC Grade: Limited.**

Review of the Evidence

A total of nine documents—five systematic reviews,[100-104] two meta-analyses,[105, 106] one scientific statement (report),[107] and the PAG Midcourse Report[26] —were included. The systematic reviews included a range of 8 to 129 studies. The systematic reviews covered the following timeframes: 1900 to May 2012,[101] 1986 to May 2011,[102] January 2000 to April 2011,[103] 2001 to 2010,[104] and July 2008 to December 2010.[100] The meta-analyses included a range of 13 to 15 studies, and covered an extensive timeframe: from inception to March 2012[105] and January 1950 to April 2015.[106] The Population Approaches to Improve Diet, Physical Activity, and Smoking Habits. A Scientific Statement from the American Heart Association (AHA Scientific Statement) covered January 1, 2007 to publication.[107] The PAG Midcourse Report included a review of reviews of physical activity intervention studies focused on youth ages 3 to 17 years that were published January 2001 through July 2012; a total of 31 reviews containing 910 studies (not mutually exclusive) were included.[26]

The included reviews examined the effects of physical activity interventions carried out in school settings. Four reviews[26, 101-103] assessed interventions to increase physical activity during school recess. Lonsdale et al[105] and the PAG Midcourse Report[26] examined interventions aimed at increasing moderate-to-vigorous physical activity in physical education (PE) lessons. Mears and Jago[106] examined physical activity interventions in after-school programs.

All of the reviews addressed changes in physical activity levels. Five reviews[26, 101, 105-107] examined individual-level time spent in vigorous-intensity physical activity and/or moderate-to-vigorous physical activity. Saraf et al[104] also assessed changes in sedentary activity.

Evidence on the Overall Relationship

Evidence on multi-component interventions: The PAG Midcourse Report found sufficient evidence that multi-component school-based interventions—those in which two or more intervention strategies are concurrently implemented—increase physical activity levels during school hours.[26] Effective combination of strategies include the following: 1) providing enhanced PE that increases lesson time, is delivered by well-trained specialists, and emphasizes instructional practices that provide substantial moderate-to-vigorous physical activity; 2) providing classroom activity breaks; 3) developing activity sessions before and/or after school, including active transportation; 4) building behavioral skills related to physical activity participation; and 5) providing after-school activity space and equipment.

Two prominent multi-component school-based intervention trials—the Child and Adolescent Trial for Cardiovascular Health (CATCH) and Sports, Play, and Active Recreation for Kids (SPARK)—provide examples of programs that were effective and have been disseminated into communities. CATCH involved a large number of schools, a multi-component behavioral intervention over three grades, and children of diverse backgrounds. The CATCH interventions include school-based (school food service, PE, classroom curricula) and home-based (home curricula, family-fun activities) components.[108] Results showed that vigorous physical activity was significantly higher among intervention students (Mean (M)=58.6 minutes) compared to controls (M=46.5 minutes) (P<0.003).[109]

The SPARK interventions include a physical education component (including dedicated time for health-fitness and skill-fitness activities) and a self-management program to promote physical activity outside of school. SPARK also provides on-site staff development, and extensive follow-up support.[110] Among its findings are that students spent more minutes per week being physically active in teacher- and specialist-led classes compared to controls (33 minutes, 40 minutes, and 18 minutes, respectively, P<0.001), although PA did not increase outside of school.[110]

Evidence on physical education interventions: The PAG Midcourse Report found sufficient evidence that PE interventions increase physical activity levels during PE classes.[26] Important strategies include the following: 1) developing and implementing a well-designed PE curriculum; 2) enhancing instructional practices to provide substantial moderate-to-vigorous physical activity; and 3) providing teachers with appropriate training.

A meta-analysis[105] evaluating the evidence on PE classes found moderate evidence that interventions that modified the structure of PE classes can be effective for increasing youth physical activity levels during PE. The meta-analysis indicated an absolute difference of 10.37 percent (95% CI: 6.33-14.41) of lesson time spent in moderate-to-vigorous physical activity in favor of the interventions over controls. This estimated difference of 10.37 percent of lesson time corresponds to 24 percent more active learning time in the intervention groups compared with the control condition (SMD=0.62; 95% CI: 0.39-0.84). Age, sex, and intervention duration did not moderate intervention effects.

Effective intervention strategies included teacher learning focused on class organization, management and instruction and supplementing standard PE classes with high-intensity activity (i.e., fitness infusion). Additional strategies included in some studies were cognitive components (e.g., knowledge, motivation), adding more PE lessons in addition to modifying or enriching PE, and changing elements of the PE environment to promote more activity.

Demetriou and Honer[100] conducted a systematic review of the effectiveness of school-based interventions with a physical activity component by measuring changes in total physical activity. Forty-two of 74 studies (56.8%) reported positive results in favor of the intervention group, whereas five studies (6.8%) reported a negative effect. One study by Lubans and Sylva[111] found a significant effect on moderate-to-vigorous (minutes per week) in favor of the intervention group with a small effect size of d=0.12.

The AHA Scientific Statement concluded that, with few exceptions, school-based interventions that focused on improving PE curriculum, often in combination with other school- or home-based physical activity components, showed improvements in objectively measured school-based and total physical activity.[107]

Evidence on school recess interventions: Studies on school recess interventions included pre-school and school-aged youth (typically ages 3 or 4 to 11 years, although the PAG Midcourse Report[26] included age groups up to 17 years). The literature available consists of a small number of studies that often lack rigor (i.e., relatively few RCTs demonstrating between group differences) or adequate reporting of study methods. Studies typically employed interventions of short duration (e.g., 4 weeks) and/or included small sample sizes. This has led to a high risk of bias and heterogeneity of results. Escalante et al[101] reported on only one pre-school intervention study,[112] and it did not significantly increase physical activity. In school-aged children, Escalante et al,[101] Parrish et al,[103] and Ickes et al[102] reviewed many of the same articles. They found in several studies that playground markings,[113, 114] playground redesign[115] and, in some instances, game equipment[116] significantly increased children's recess and lunchtime moderate-intensity physical activity, vigorous-intensity physical activity, and/or moderate-to-vigorous physical activity compared with controls. However, overall a small magnitude of effect was seen (no effect sizes reported). For example, Stratton and Mullan[113] found that playground markings encouraged greater moderate-to-vigorous physical activity within the intervention group (2.4% and 6.9% in early and late primary school, respectively) and vigorous-intensity physical activity (1.6% and 4.1% in early and late primary school, respectively). Game equipment increased girls', but not boys', moderate-to-vigorous physical activity within the experimental group by 3.9 percent.[116] This work is supported by the AHA Scientific Statement, which concluded that effective school-based approaches to improve physical activity include increasing the availability and types of playground spaces and equipment.[107]

Features of physical activity intervention targets and measures: Physical activity outcomes varied, but were often reported as light-intensity physical activity, moderate-to-vigorous physical activity, or steps per day. Assessment approaches used to capture physical activity varied considerably and included estimated physical activity from heart rate,[113] or use of accelerometers[115-117] or pedometers.[118] Descriptions of specific physical activity frequency, intensity, duration, and/or type were generally lacking in the reviews.

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups, adverse events, and cost-effectiveness is currently lacking or infrequently reported. Although in some cases participant ethnicity or income distributions were reported, the results typically were not reported by ethnic/racial or income subgroups.[117, 119] Some studies reported recruiting children within low-income areas,[113, 115] but results were not reported by income stratification.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

Schools represent a universal setting for reaching youth across different locales, age subgroups, and sociodemographic strata, making them a potentially powerful venue for implementing physical activity promotion interventions. This is particularly the case given emerging evidence linking physical activity interventions to positive behavioral and academic outcomes in children.[120] However, different types of school-based interventions exhibit a significant degree of heterogeneity in intervention effectiveness. Strong evidence demonstrates that multi-component school-based interventions are effective for increasing physical activity. Of relevance to this conclusion, the new Comprehensive School Physical Activity Program framework outlines a multi-component approach that provides opportunities for children to engage in physical activity throughout the school day. The approach includes physical activity before and after school, physical activity during the school day, a comprehensive and required physical education curriculum, family and community engagement, and staff involvement.[121] Given that each state has compulsory school attendance laws and most states require 180 days of instruction, opportunities to intervene on physical activity for nearly 50 percent of each year are available.[122]

PE classes have been one of the most common modes for delivering physical activity interventions in school-based settings. Given the prevalence of PE classes in primary and secondary education districts across the United States, the promise of PE-based interventions that actively promote movement and physical activity during the PE class period is substantial. The *2016 Shape of the Nation* report indicated that nearly all states have adopted their own standards for PE programs.[121]

Effective and sustainable strategies for delivering physical activity interventions through PE classes that meet national physical activity guidelines for children could be beneficial for achieving adherence to guidelines. Studies of PE that have included teacher education focused on class organization, management, and instruction and on supplementing PE classes with high-intensity activity have shown particular promise. Evidenced-based programs, such as SPARK[110] and CATCH,[108] offer curricula, training, equipment, certification, and technical support for teachers and recreation leaders serving students from Pre-K through 12th grade.

Strategies for before- and after-school physical activities or informal physical activity during the school day (e.g., recess, activity breaks) have been relatively understudied and warrant attention. SHAPE America recommends schools provide at least one 20-minute recess period daily.[123] Data suggest that children who are least likely to get daily recess include those from urban areas, children who live below the poverty line, and children who are struggling academically.[124] Additionally, some studies have highlighted the benefits of classroom activity breaks, which could be a particularly beneficial strategy in low income and/or under-resourced schools, or schools in urban or congested areas without dedicated playgrounds.[125, 126]

Worksite Interventions

Source of evidence: Systematic reviews

Conclusion Statement

Limited evidence suggests overall that worksite interventions are effective for increasing physical activity in adults, particularly over medium (i.e., 6 to 11 months) and longer periods (i.e., 12 or more months). **PAGAC Grade: Limited.**

Review of the Evidence

Six systematic reviews[127-132] were included. The systematic reviews, which included a range of 9[131] to 58[127] studies, covered an extensive timeframe, including from inception,[130, 131] from 1950,[127] and through 2014.[131] The majority of studies examined interventions delivered broadly across workplaces among generally healthy adults,[127-129] while others focused exclusively on men,[130] nurses,[131] and university and college staff.[132]

Evidence on the Overall Relationship

Studies included reviews of worksite-based physical activity interventions delivered alone or combined with other behaviors (e.g., nutrition), or that were part of broader wellness interventions. The general methodological quality of the evidence varied considerably and included randomized and cluster-randomized designs as well as quasi-experimental and demonstration project (e.g., pretest-posttest) designs. The studies reviewed focused on walking programs to increase overall levels of physical activity as well as programs aimed at increasing structured exercise (e.g., aerobic classes, strength training). Interventions that included actual physical activity participation (e.g., active travel, stair walking interventions, exercise classes) as well as those featuring counseling, health promotion, or information messaging approaches (e.g., health checks, signage in the workplace, education classes) demonstrated moderate levels of efficacy across a wide range of intervention lengths (i.e., 6 weeks to 4 years).[127] Approaches that focused broadly on wellness (with physical activity elements included) and those that included onsite exercise classes demonstrated more limited efficacy.[127, 128] Walking-based programs, where the primary outcomes were either steps or overall physical activity, were generally more efficacious than structured exercise classes.[127] The length of the interventions was typically short in duration (less than 6 months), with longer-term interventions (12 months or more) demonstrating mixed efficacy. Although the systematic reviews included a sufficient number of studies from which to draw conclusions, most studies did not provide precise information regarding the magnitude of the effects of the intervention strategies on physical activity behavior change.

Features of physical activity intervention targets and measures: The worksite interventions varied in intervention delivery mode, intensity, and duration. The most common intervention strategies used were goal setting, action planning, and prompted self-monitoring of behavior. Physical activity was largely measured by self-reported activity (i.e., minutes per week of moderate-to-vigorous physical activity, MET-hours per week, and activity kilocalories per week).

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups and adverse events is currently lacking or infrequently reported. The cost-effectiveness of worksite physical activity interventions, when reported, was mixed.[128] The evidence for specific employee groups such as men,[130] nurses,[131] and university and college staff[132] all showed limited efficacy.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

Worksites represent a pervasive setting for reaching a broad segment of the adult population, particularly given the amount of time many people spend at their place of work. However, identifying the most effective ways of leveraging workplace environments to promote discernable and sustainable increases in physical activity in response to worksite interventions remains challenging. Promising strategies include counseling-based approaches, health promotion messaging in the workplace, and worksite-based walking programs,[127] whereas interventions focused on other forms of structured exercise during work time have had more limited efficacy.[127-129]

COMMUNICATION ENVIRONMENT LEVEL

The communication environment encompasses a broad array of information and communication technologies (ICT) that have the potential to span locations and sociodemographic conditions. ICT are generally defined as those technologies that use computerized information or communication interfaces and/or that allow people and organizations to interact in the digital world.[133] They include remote (as opposed to in-person) communication channels, such as telephone or computer-tailored print; wearable sensors and activity monitoring devices; interventions delivered over the Internet (i.e., the networking infrastructure connecting computers worldwide) or the web (i.e., information-sharing models that are built on top of the Internet); mobile phone applications (apps); text-messaging (i.e., short message service); social media (e.g., social network platforms); and interactive video games promoting active play or exercise.

The diverse types of ICTs currently available coupled with their accessibility and reach across increasingly representative segments of the U.S. youth and adult populations, have made them an attractive platform upon which to evaluate physical activity interventions. Despite this growing interest among the scientific community, the current evidence base in this area remains constrained in terms of less rigorous study designs of short duration and small and often highly selected samples that lack heterogeneity. Evidence related to different population segments will be discussed to the extent possible when available.

The evidence that was reviewed fell within seven broad technology intervention domains: 1) wearable activity monitors; 2) telephone-assisted interventions; 3) web-based or Internet-delivered interventions; 4) computer-tailored print; 5) mobile phone programs; 6) social media; and 7) interactive video games promoting active play or exercise.

As noted earlier, the categories were not identified a priori and were not specifically included as search terms, but rather emerged during the broad 2011-2016 evidence search that was undertaken. Such a condensed approach necessarily limits the size and, potentially, the types of evidence considered at this level.

Wearable Activity Monitors

Sources of evidence: Meta-analyses, systematic reviews

Conclusion Statements

Strong evidence demonstrates that wearable activity monitors, including step counters (pedometers) and accelerometers, when used in conjunction with goal-setting and other behavioral strategies, can help increase physical activity in the general population of adults as well as in those who have type 2 diabetes. **PAGAC Grade: Strong.**

Moderate evidence indicates that these monitors can help increase physical activity in adults with overweight or obesity. **PAGAC Grade: Moderate.**

Limited evidence suggests that wearable activity monitors may help increase physical activity in adults with musculoskeletal disorders. **PAGAC Grade: Limited.**

Review of the Evidence

A total of seven reviews, including four systematic reviews[134-137] and three meta-analyses,[138-140] were included. The systematic reviews included a range of 5 to 14 studies. Reviews covered the following timeframes: from inception of the database to February 2014,[136] inception to August 2016,[137] and 2000 to January 2015.[135] Funk and Taylor[134] did not report the timeframe searched. However, the included studies were published between 2004 and 2011. Each of the included meta-analyses examined 11 studies. All meta-analyses covered an extensive timeframe: from inception to July 2015[138] and 1994 to June 2013.[139, 140] All of the included reviews examined interventions using activity monitors. Four reviews[134, 136, 139, 140] specifically examined pedometer-based interventions, while Goode et al[135] examined the use of accelerometers.

Evidence on the Overall Relationship

All included reviews addressed changes in physical activity. Five reviews[134, 136, 137, 139, 140] specifically examined changes in the number of steps per day. de Vries et al[138] examined steps per day, total moderate-to-vigorous physical activity minutes per time unit, walking MET-minutes per week, and kilocalories expended in physical activity per week. Across this area, study durations were usually short (i.e., less than 6 months).

Data indicate that, in **general adult populations***,* interventions that include step-counters or accelerometers within a structured program (e.g., individually-based interventions, coaching, group-based interventions) can have a small but positive effect on physical activity levels when compared with usual care or minimal-attention control arms. For example, in one systematic review and meta-analysis,[135] accelerometry interventions across 12 trials resulted in a small but significant increase in physical activity levels (SMD=0.26; 95% CI: 0.04-0.49). The effects of these wearable activity monitors may be accentuated when specific physical activity goals are provided. The type of goal (e.g., self-identified goals versus a 10,000-step goal) may make little difference with respect to effectiveness in helping to promote physical activity change. The additional benefit of activity monitors (step-counters or accelerometers) when compared with an active comparison arm (e.g., a physical activity intervention without activity monitors) is less clear (SMD in accelerometer intervention studies using an active comparison arm=0.17; 97% CI: -1.09 to 1.43).[135] This review reported that they could find no head-to-head comparison of the use of accelerometers versus step-counters in promoting regular physical activity.

In a meta-analysis of patients with **type 2 diabetes**,[139] step-counter use significantly increased physical activity by a mean of 1,822 steps per day (7 studies, 861 participants; 95% CI: 751-2,894 steps per day). In this patient population, use of a step-counter in combination with setting a specific physical activity goal resulted in significantly more steps per day compared to control arms (weighted mean difference (WMD) of 3,200 steps per day; 95% CI: 2,053-4,347 steps per day), whereas step-counter use without a goal did not significantly increase physical activity relative to control arms (WMD of 598 steps per day; 95% CI: -65 to 1,260 steps per day). Use of a step diary or log also was related to a statistically significant increase in physical activity (WMD=2,816 steps per day), whereas when a step diary was not used, physical activity did not increase significantly (WMD=115 steps per day). This meta-analysis of step counter use in type 2 diabetes looked at heterogeneity between studies and found that setting physical activity goals explained the heterogeneity between study results, whereas sample size, intervention duration, and intervention quality did not.

In a somewhat smaller meta-analysis of adults with **overweight or obesity**,[138] a significant positive intervention effect for steps per day was found for behavioral physical activity interventions that included an activity monitor when compared with wait-list or usual care interventions (N=4) (SMD=0.90; 95% CI: 0.61-1.19, $P<0.0001$). A similar intervention comparison also found a significant positive effect for total moderate-to-vigorous physical activity minutes per time unit (N=3) (SMD=0.50; 95% CI: 0.11-0.88, $P=0.01$). Meanwhile, although a positive trend was found for total moderate-to-vigorous physical activity minutes per time unit when an activity monitor was added to existing interventions relative to when it was not, the failure to reach statistical significance obtained in the latter analysis, which included three studies, renders conclusions less certain (SMD for total moderate-to-vigorous physical activity minutes per time unit=0.43; 95% CI: 0.00-0.87). In a meta-analysis of a similar intervention comparison (i.e., the addition of an activity monitor to an existing intervention versus when it was not added) using the mean difference for walking MET-minutes per week as the outcome and involving only two studies (both of which included women only), a statistically significant positive effect was found (mean difference for walking MET-minutes per week=282; 95% CI: 103.82-460.18, *P*=0.002). The authors reported that no adverse events related to the interventions were noted, and no statistically significant negative effects on physical activity outcomes were found. The somewhat more variable results and fewer studies reported with overweight or obese adults led to the evidence grade of "Moderate" as opposed to "Strong."

In a systematic review of seven RCTs of step-counter-based walking interventions in **patients with musculoskeletal disorders**,[136] five of the seven study interventions reported a significant increase in steps over baseline averaging 1,950 steps per day, but the magnitude of the change varied markedly across studies (range=818-2,829 steps per day), and only two studies reported significant improvements relative to the control arm.

Features of physical activity intervention targets and measures: The major physical activity outcomes reported were steps (based on step-counters) and/or accelerometry-based minutes per day or week of moderate-to-vigorous physical activity, with little mention of frequency or duration. Physical activity intervention targets focused mostly on step counts, with step targets often set at 10,000 steps per day or as a percent increase in steps per day. In studies that used accelerometers, intervention targets often focused on moderate-to-vigorous physical activity, with behavioral targets ranging from 120-250 minutes per week.

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups, adverse events, and cost-effectiveness is currently lacking or infrequently reported. Many of the studies in this area consist of reasonably short intervention periods, with the impacts of activity monitor use over longer time periods less clear.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

In adults, step-counters and other wearable activity monitors represent a useful adjunct to physical activity programs that include other behavioral strategies (e.g., goal-setting, coaching). The daily feedback that activity monitors provide can enhance efforts to increase walking and other types of physical activity. The increasing availability of a diverse range of activity monitors, a growing number of which have been shown to have good reliability and validity, makes them a promising intervention tool for population-wide physical activity promotion. Figure F11-2 illustrates by showing how a pedometer can be used to track walking.

Figure F11-2. Using a Pedometer to Track Walking

For adults who prefer walking as a form of aerobic activity, pedometers or step counters are useful in tracking progress toward personal goals. Popular advice, such as walking 10,000 steps a day, is not a guideline *per se*, but a way people may choose to meet the *Physical Activity Guidelines*. The key to using a pedometer to meet the Guidelines is to first set a time goal (minutes of walking a day) and then calculate how many steps are needed each day to reach that goal.

Episodes of brisk walking that last at least 10 minutes count toward meeting the Guidelines. However, just counting steps using a pedometer doesn't ensure that a person will achieve those episodes. People generally need to plan episodes of walking if they are to use pedometer step goals appropriately.

As a basis for setting step goals, it's preferable that people know how many steps they take per minute of a brisk walk. A person with a lower fitness level, who takes fewer steps per minute than a fit adult will need fewer steps to achieve the same time of walking.

One way to set a step goal is the following:

1. To determine usual daily steps from baseline activity, a person wears a pedometer to observe the number of steps taken on several ordinary days with no episodes of walking for exercise. Suppose the average is about 5,000 steps a day.

2. While wearing the pedometer, the person measures the number of steps taken during a walk of 10 minutes. For this person, suppose this is 1,000 steps. For a goal of 40 minutes of walking, the goal would total 4,000 steps (1,000 X 4).

3. To calculate a daily step goal, add the usual daily steps (5,000) to the steps required for a 40 minute walk (4,000), to get the total steps per day (5,000 + 4,000 = 9,000).

Then, each week, the person gradually increases the number of total steps a day until the step goal is reached. Rate of progression should be individualized. Some people who start out at 5,000 steps a day can add 500 steps per day each week. Others, who are less fit and starting out at a lower number of steps, should add a smaller number of steps each week.

Source: 2008 Physical Activity Guidelines for Americans.[2]

Telephone-assisted Interventions

Sources of evidence: Systematic review, meta-analysis

Conclusion Statement

Strong evidence demonstrates that telephone-assisted interventions, including those lasting 1 year or longer, are a safe and effective means for increasing physical activity in general adult populations, including older adults. **PAGAC Grade: Strong.**

Review of the Evidence

Two systematic reviews were included.[141, 142] The systematic reviews included a range of 11 to 27 studies that examined the effects of telephone-based interventions on levels of physical activity. Foster et al[141] covered an extensive timeframe, from inception to October 2012, while Goode et al[142] covered 2006 to April 2010.

Evidence on the Overall Relationship

The majority of high-quality studies in this area produced effect sizes indicating a moderate or better intervention effect (i.e., d>0.5). The evidence indicates that longer-duration interventions (i.e., 12 months or more) are associated with greater effectiveness. At least two large-scale dissemination studies of mid-life and older adults have been conducted, with results from these studies showing pre-post intervention increases in regular physical activity levels across a year commensurate with those obtained in RCTs. The majority of participants in the study samples have been Caucasian and well-educated,[141] although the two large-scale dissemination studies included more ethnically and regionally diverse groups of mid-life and older adults.[142] In the small number of telephone-assisted interventions that have combined physical activity and dietary interventions, the evidence suggests that including a focus on dietary changes (e.g., increasing fruit and vegetable intake, decreasing dietary fat) may in some circumstances hinder physical activity changes in the adult and older adult populations that have been studied.[142]

Features of physical activity intervention targets and measures: The physical activity outcome measures varied across studies, and included self-reported continuous physical activity variables (e.g., estimated energy expenditure in kilocalories per day, mean minutes per week of moderate-to-vigorous physical activity, mean number of physical activity episodes in the past 4 weeks), percentage of the sample meeting national physical activity guidelines, and accelerometry-derived physical activity variables. Types of physical activity included walking as well as other participant-chosen forms of moderate-to-vigorous physical activity. A large proportion of interventions were at least 6 months in duration, with a number that were 12 months or more.

Evidence on Specific Factors

The Cochrane review,[141] which included nine RCTs involving telephone support lasting at least a year in generally healthy adults, reported no evidence of an increased risk of adverse events. Evidence evaluating intervention cost-effectiveness is limited, but in two studies in which cost analyses were conducted, results supported the cost effectiveness of telephone-delivered interventions.[142]

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

Given the pervasiveness of phone ownership across the U.S. population as well as globally, phone-based interventions represent an effective strategy for increasing physical activity in adult populations that can be broadly disseminated. Promising methods for dissemination include automated telephone interventions (e.g., interactive voice response systems) and trained peer advising by phone.

Web-based or Internet-delivered Interventions

Sources of evidence: Meta-analysis, systematic reviews

Conclusion Statements

Strong evidence demonstrates that Internet-delivered interventions that include educational components have a small but consistently positive effect in increasing physical activity levels in the general adult population, particularly in the shorter-term (i.e., less than 6 months), when compared with interventions that do not include Internet-delivered materials. **PAGAC Grade: Strong.**

Limited, early evidence suggests that web-based or Internet-delivered interventions may have some efficacy in increasing short-term physical activity levels in individuals with type 2 diabetes. **PAGAC Grade: Limited.**

Review of the Evidence

A total of four reviews, including three systematic reviews[141, 143, 144] and one meta-analysis,[145] were included. The systematic reviews included a range of 7 to 15 studies and covered an extensive timeframe: from inception to October 2012,[141] 1966 to April 2011,[143] and 1991 to March 2013.[144] The meta-analysis[145] included 34 studies published between 1990 and June 2011. The included reviews examined interventions delivered remotely over the Internet or a web page. One systematic review[145] assessed studies that used the Internet, email communication, or a combination. Foster et al[141] assessed web 2.0 and remote interventions that at times used the Internet in combination with other types of mediated interventions.

The majority of studies have been conducted in the general adult population, and most did not screen for initial physical activity status as one of the study enrollment criteria. Participants have been primarily Caucasian, well-educated, and middle-aged, and the majority of participants have been female.

For individuals with type 2 diabetes, the overall quality of studies for this subpopulation has been mixed. The impacts of web-based or Internet-delivered interventions on population subgroups with chronic diseases other than type 2 diabetes are currently unclear,[143] given that available studies often report high participant attrition levels and relatively short intervention time periods (often less than 6 months).

Evidence on the Overall Relationship

Overall effect size estimates indicate a small but positive intervention effect on physical activity in the **general adult population** (*d*=0.14).[145] Studies that initially screened participants and enrolled only those classified as sedentary or insufficiently active produced larger effects (*d*=0.37) relative to studies that did not screen participants for physical activity level (*d*=0.12).[145] The Davies et al[145] meta-analysis, which targeted either physical activity only (N=21) or physical activity and additional health-related behaviors, such as nutrition or weight management behaviors (N=13), found that the two different types of interventions produced similar effect sizes.

In a systematic review of nine web-based physical activity interventions in individuals with **type 2 diabetes**,[144] six studies reported significant short-term increases (less than 6 months, typically) in physical activity when compared with a control arm. The overall magnitude of the physical activity increases reported in this review ranged from 3 percent to 125 percent. In a systematic review of seven self-guided web-based physical activity intervention trials among patients with a range of chronic disease conditions (e.g., multiple sclerosis, heart failure, type 2 diabetes mellitus, physical disabilities, metabolic syndrome),[143] three studies reported significant physical activity improvements relative to controls, while four studies reported nonsignificant differences between groups.[143] Effect sizes ranged from 0.13-0.56, with wide variability in physical activity change across studies.

Features of physical activity intervention targets and measures: Physical activity outcome variables consisted mainly of self-reported total (overall) physical activity or leisure time physical activity. Physical activity intervention targets were in general not specified.

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups, adverse events, and cost-effectiveness is currently lacking or infrequently reported. One article of remote and web 2.0 interventions[141] noted that the seven studies reviewed, which totaled 2,892 participants, showed no evidence of an increased risk of adverse events.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

Given the increasing access to and reach of the Internet as well as web-based programs and tools across diverse populations, these modes of intervention delivery have the potential for affecting a sizeable portion of the population. Thus, the small but significant physical activity increases that can occur from widely accessible interventions like these can have a potentially meaningful public health impact at the population level. Finding ways to continue to engage users over the longer term (i.e., beyond 3 to 6 months) is strongly indicated.

Computer-tailored Print Interventions

Source of evidence: Systematic reviews

Conclusion Statement

Moderate evidence indicates that computer-tailored print interventions, which collect user information through mailed surveys that is then used to generate computer-tailored mailings containing personalized physical activity advice and support, have a small but positive effect in increasing physical activity in general populations of adults when compared with minimal or no-treatment controls, particularly over short time periods (e.g., less than 6 months). **PAGAC Grade: Moderate.**

Review of the Evidence

Two systematic reviews were included.[141, 146] The systematic reviews included a range of 11 to 26 studies and covered an extensive timeframe: from inception to October 2012[141] and inception to May 2010.[146] The included reviews examined interventions using computer-tailored printed materials. Short et al[146] also assessed the effectiveness of materials constructed using different health behavior theories. Studies typically tailored the intervention materials on psychosocial variables (e.g., perceived barriers, motivational readiness to change physical activity), with a few tailoring on behavioral, demographic, and environmental variables. Many studies did not adequately define their tailoring variables. The majority of studies delivered the tailored print materials through the mail using either a standard letter or newsletter.

Evidence on the Overall Relationship

The majority of studies in this area produced effect sizes that were small (i.e., Cohen's *d* ranging from 0.12 to 0.35) when compared to minimal or no-intervention control arms. Effects of computer-tailored print interventions have been more variable when compared with other active interventions (e.g., targeted print, tailored websites), although no clear evidence currently indicates that more intensive web-based interventions are generally better than tailored print. One factor that is common among successful computer-tailored print interventions is that they entail multiple contacts with users (as opposed to single-contact interventions). The impacts of intervention factors other than multiple contacts (e.g., inclusion of action plans or environmental information) are less clear. Some evidence suggests that participants' pre-intervention physical activity levels may not greatly influence responses to computer-tailored print interventions, although this participant characteristic deserves further evaluation. Interventions that were explicitly derived from theory were reported to be more effective generally than those in which use of theory was not explicitly described. The most frequently used tailoring variables were psychosocial and behavioral variables (e.g., perceived barriers). Most studies in this area were of short (less than 6 months) to medium (between 6 to 11 months) duration.

Features of physical activity intervention targets and measures: Physical activity outcome variables consisted primarily of either self-reported or accelerometry-derived minutes per week of primarily moderate-to-vigorous physical activities, as well as the proportion of the sample reaching national physical activity guidelines. For single-contact interventions, a variety of physical activity types were targeted as part of the intervention, including leisure time, transport, sport activities, and moderate-to-vigorous physical activity more broadly. For multiple-contact interventions, the general type of physical activity targeted in the interventions consisted predominately of moderate-to-vigorous physical activity, with participants allowed to choose specific activities.

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups and adverse events is currently lacking or infrequently reported. In the few studies that have compared the cost-effectiveness of computer-tailored print to other tailored interventions (e.g., tailored Internet, computer-tailored phone delivery of information), the delivery of the computer-tailored print intervention was reported to be more cost-efficient at 12 months compared to these other modalities. Some studies evaluated interventions that included both physical activity and another health behaviors (e.g., dietary change), with mixed results. The mixed results may be due in part to the use of single-contact only print interventions in most of the multiple-health behavior studies, which was found to be linked with weaker intervention effects overall.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

Computer-tailored print interventions represent a potentially useful strategy for delivering tailored physical activity information to population segments with sufficient reading skills, particularly those who may not be able to or be interested in accessing personalized information through other technology-based or mediated platforms, such as the Internet, mobile phone applications, or phone-assisted interventions. Such subpopulations may include individuals with lower computer or technology literacy and those living in remote areas where other communication channels are lacking or unreliable. Based on the evidence, a more contact-intensive print interaction schedule may result in increased effectiveness over time, depending upon the target audience, relative to a less dense interaction schedule (e.g., one or two tailored print interactions only). The lag time typically experienced between users mailing back their informational surveys for physical activity tailoring purposes and their subsequent receipt of the print-based advice (which was, in some cases, 4 weeks) needs to be taken into account when using this intervention delivery mode.

Mobile Phone Programs

Sources of evidence: Meta-analyses, systematic reviews

Conclusion Statements

Moderate evidence indicates that mobile phone programs consisting of or including text-messaging have a small to moderate positive effect on physical activity levels in general adult populations. **PAGAC Grade: Moderate.**

Strong evidence demonstrates that the use of smartphone applications increases regular physical activity in children and adolescents. **PAGAC Grade: Strong.**

Limited evidence suggests that smartphone applications increase regular physical activity in the general populations of adults. **PAGAC Grade: Limited.**

Review of the Evidence

A total of eight reviews, including five systematic reviews[147-151] and three meta-analyses,[152-154] were included. The systematic reviews included a range of 9 to 30 studies. Reviews covered the following timeframes: from inception to October 2011,[147] inception to September 2013,[148] inception to March 2015,[149] 2000 to 2012,[150] and 2006 to October 2016.[151] The meta-analyses included a range of 11 to 74 studies. One analysis[154] covered from inception to October 2011, and Fanning et al[153] covered 2000 to July 2012. Brannon and Cushing[152] did not report the timeframe searched. The included reviews examined the effects of mobile phone interventions. The interventions used smartphones, mobile wireless devices, or personal digital assistants in a variety of ways to promote health behavior change. Two reviews[151, 152] specifically examined the use of smartphone applications (apps), while Buchholz et al[147] and Head et al[154] assessed text messaging interventions. Almost all of the studies reviewed were of short duration (i.e., less than 6 months).

Evidence on the Overall Relationship

Features of physical activity intervention targets and measures: In most studies, physical activity was measured by wearable devices (accelerometers or step-counters), or with a combination of device-based and self-reported measurement instruments. Physical activity intervention targets were focused mostly on increasing steps per day of walking, with some studies using more general forms of moderate-to-vigorous physical activity as an intervention target.

Evidence on Specific Factors

Evidence on text-messaging interventions: A systematic review[147] as well as two meta-analyses[153, 154] that examined text messaging interventions aimed at **general adult populations** found significant positive effect sizes, relative to controls, that were on average 0.40 or greater, with a median effect size in one systematic review of 0.50.[147] Studies ranged in duration from 4 to 52 weeks. However, a relatively small number of RCTs of text-messaging have been conducted to date. Although successful studies in this area have been conducted on four continents, the populations that have been studied have been primarily young to middle-aged women who were well-educated. In a number of these studies, text-messaging was used primarily to provide cues or simple messages for becoming more active, either as a primary target or as part of a weight loss program. Only a modest number of studies have occurred to date involving text-messaging interventions in persons with chronic diseases (e.g., cardiovascular disease) and no systematic reviews were found during the 2011-2016 evidence review period evaluating text-messaging interventions in youth.

Evidence on smartphone app interventions: Strong evidence exists for the efficacy of smartphone apps in **youth**. Interventions in youth have occurred in school settings as well as in other community settings, and have studied diverse populations, including Caucasian, African American, Hispanic, southeast Indian, Moroccan, Turkish, and European samples. Interventions have been reported to have small to moderate effects in both girls and boys, with one systematic review reporting Cohen's *d* coefficients ranging from -0.36 to 0.86.[152] When the effects of different behavior change strategies that comprise the smartphone apps have been investigated systematically (i.e., through meta-analysis and meta-regression techniques), different types and combinations of strategies were found to be particularly effective in increasing physical activity levels in children versus adolescents.[152] In children, general encouragement and modeling of appropriate behavior have been found to be significant predictors of positive physical activity effects. In adolescents, providing consequences for behavior change, providing information related to others' approval, self-monitoring, and the use of behavioral contracts have been found to be significant predictors of positive physical activity effects. Of note, providing adolescents with specific instruction has been reported to diminish the effects of the intervention.[152] As part of these meta-regression analyses, investigators were able to explain 45 percent of the variability in physical activity effect size among children and 62 percent of the variability in physical activity effect size among adolescents.[152]

In contrast, relatively few rigorously controlled studies have been reported evaluating the use of smartphone applications (apps) to promote regular physical activity in **adult populations**. Although a recent systematic review did not provide effect size estimates,[151] 11 of 21 RCTs or comparison arm studies that included a smartphone app intervention aimed at physical activity promotion reported a significant positive effect on at least one physical activity variable relative to a control or comparison arm. However, the average study duration was short (i.e., typically less than 6 months). Studies that combined the use of a smartphone app with other intervention strategies (e.g., telephone coaching, short message service (SMS), motivational emails) were more likely in general to report significant improvements on behavioral outcomes than those studies using stand-alone apps.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

In light of their accessibility across diverse mobile phone platforms and their ability to generate moderate to strong increases in physical activity among at least some segments of the population, text-messaging and smartphone applications represent promising public health strategies that should be targeted further for investigation and intervention translation. In addition to being used alone in some population subgroups, they may serve as potentially useful adjuncts to other physical activity interventions.

Social Media

Sources of evidence: Meta-analyses; systematic reviews

Conclusion Statement

Limited evidence suggests that physical activity interventions based on or including social media are effective for increasing physical activity in adults or youth. **PAGAC Grade: Limited.**

Review of the Evidence

A total of three reviews, including one systematic review[155] and two meta-analyses,[156, 157] and a governmental report[26] were included. The systematic review[155] included 10 studies published between 2000 and December 2012. The meta-analyses included a range of 16 to 22 studies. Mita et al[156] covered 2000 to June 2014 and Williams et al[157] covered 2000 to May 2013. All of the included reviews examined health behavior interventions using web-based social media or social networking platforms. The reviews addressed changes in physical activity levels, including exercise behaviors. One review[155] also addressed physical inactivity and mediators of behavior changes, such as physical activity self-efficacy. The PAG Midcourse Report included a review of reviews of physical activity intervention studies focused on youth ages 3 to 17 years that were published January 2001 through July 2012; a total of 31 reviews containing 910 studies (not mutually exclusive) were included.[26]

Evidence on the Overall Relationship

In two meta-analyses,[156, 157] the reported SMD did not reach statistical significance (SMD=0.07; 95% CI: -0.25 to 0.38, 8 studies; SMD=0.13; 95% CI: -0.04 to 0.30, 12 studies, respectively), although the overall pattern of results for the studies targeting physical activity generally favored the intervention arm.

The available literature consists of a small number of studies that often lack rigor or the adequate reporting of study methods. This has led to a high risk of bias due to incomplete reporting of outcome data as well as study attrition rates. When reported, study attrition rates were frequently high despite often short intervention periods (i.e., less than 6 months). Study interventions were highly variable and the populations studied consisted primarily of Caucasian women of higher socioeconomic status. To date, many of the available studies have used social media platforms with relatively low levels of media richness and social presence (e.g., bulletin boards, discussion boards, message forums), as opposed to richer social media platforms (e.g., social networking sites).

The literature to date suggests that intervention effectiveness may be enhanced through focusing on social media features with stronger social presence and media richness (e.g., media content that people can share through social networking sites).

In contrast to the above web-based social media or social networking platforms, a national multi-cultural, 5-year social media/social marketing campaign called VERB™,[59] described in the PAG Midcourse Report,[26] delivered educational and motivational messages about physical activity aimed at U.S. youth ages 9 to 13 years ("tweens") and their parents through a diverse range of social communication channels. Media messages were delivered through television, radio, Internet, print media, and through school and community promotions. Among the successes of the VERB campaign were high levels of campaign awareness—approximately three-quarters of tweens surveyed were aware of the campaign, and that awareness was associated with increased likelihood of reporting being physically active relative to those who were unaware of the campaign. A significant dose-response effect was found in that greater reported exposure to campaign messages was associated with a greater percentage of children reporting physical activity on the day before the assessment interview (gamma statistic=0.19, CI 0.11-0.26, $P<0.05$), and a greater median number of weekly physical activity sessions during free-time (gamma statistic=0.09, CI 0.04-0.13, $P<0.05$).[59] At the 2004 assessment time point, there was a 22 percent difference in median number of weekly physical activity sessions during free-time among those children reporting an awareness of VERB relative to children reporting no awareness of VERB.[59] Effect sizes for the VERB awareness effect on physical activity behavior ranged from 0.06 to 0.12.[59] In addition, exposure to the VERB campaign during the tween years had carry-over value into adolescence (ages 13 to17 years).[26]

Features of physical activity intervention targets and measures: Physical activity was measured using a variety of largely self-reported variables, including estimated energy expenditure per week, moderate-intensity physical activity per week, moderate-to-vigorous physical activity per week, and total minutes of physical activity per week. Relatively few studies specified physical activity intensity targets as part of the intervention. When they were noted, they consisted of either moderate or moderate-to-vigorous physical activities.

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups, adverse events, and cost-effectiveness is generally lacking or infrequently reported.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

Given the growing popularity of social media, it is likely that additional rigorously designed and longer-term intervention studies will emerge over the coming years, which will provide much needed scientific information on this increasingly prevalent communication platform. Given the diversity of uses and the substantial population reach of social media platforms across broad age ranges and socioeconomic groups, this technology has the potential to affect population levels of physical activity. Intervention effectiveness may be enhanced by considering additional social media platforms (e.g., Twitter, Snapchat, Instagram) that could increase population reach. In addition, using multiple, complementary social media and communication channels, as was done in the VERB campaign, may increase the overall penetrance and impact of physical activity messages and programs for specific population groups.

Interactive Video Games Promoting Active Play or Exercise

Source of evidence: Systematic reviews

Conclusion Statements

Limited evidence suggests that active video game interventions used in structured community-based programs are effective for increasing physical activity in healthy children. **PAGAC Grade: Limited.**

Limited evidence suggests that technology-based exercise programs (i.e., “exergames”) are a potentially acceptable and safe approach for use in programs aimed at increasing physical activity levels in adults ages 60 years and older. **PAGAC Grade: Limited.**

Review of the Evidence

A total of three systematic reviews were included.[158-160] The systematic reviews included a range of 22 to 54 studies. Two systematic reviews covered an extensive timeframe: from inception to May 2015,[158, 159] while the third review covered 2000 to August 2013.[160] Two of the included reviews examined the effects of active video game interventions among children.[158, 160] Valenzuela et al[159] examined technology-based interventions among older adults, with the majority of studies using a gaming console. Included reviews addressed changes in physical activity levels. Liang and Lau[160] assessed the immediate physical activity effects (energy expenditure or physical activity levels during active video game play) as well as the habitual physical activity or change in physical activity levels. No systematic reviews dating from 2011 to 2016 were found for interactive video game interventions in general populations of adults.

Evidence on the Overall Relationship

In one systematic review of school-based active video game use to increase physical activity in **youth younger than age 18 years**,[158] 9 of 14 studies reporting physical activity outcomes found some increases in light-intensity physical activity and/or moderate-to-vigorous physical activity assessed primarily through activity monitors or questionnaires. However, several of these studies did not report significance testing or used uncontrolled pre-posttest designs. In at least five studies, higher levels of physical activity in the school setting were found in the control arm relative to the intervention arm. Two studies found that the significant increases in moderate-to-vigorous physical activity during the school-based active video game sessions did not extend to the rest of the school day or to home activity. This latter finding is supported in a second systematic review of 21 physical activity promotion studies,[160] which reported no overall effects of active video game play alone on physical activity levels in the home setting. In this systematic review, the explicit use of behavioral theory in intervention development was associated with reported improvements in physical activity in four of the five studies reporting their use.

A systematic review of 22 studies evaluated the use and acceptability of active video games among **older adults** (mean age range from 67 to 86 years) living at home or in independent living units, retirement settings, or low-care residential care facilities.[159] Active video game participation rates across the relatively short intervention periods (i.e., 3 to 20 weeks) were reported as high across delivery sites, delivery modes, and levels of supervision (median=91.3%). However, these studies have rarely reported overall physical activity behavior change as an outcome. They have been focused primarily on physical function outcomes (i.e., balance, strength, endurance, fitness). Studies in this area have been constrained by weak designs, limited reporting of study attrition, and short intervention periods.

Features of physical activity intervention targets and measures: Physical activity outcome variables included time spent during the active video game in light-intensity and/or moderate-to-vigorous physical activity, assessed primarily through either activity monitors or questionnaires. The physical activities used in the active video games were designed to mimic dance, sports (e.g., tennis, boxing, bowling), or aerobic fitness classes.

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups and cost-effectiveness is currently lacking or infrequently reported. With respect to safety, in a systematic review of 22 studies of older adults,[159] only one study reported minor adverse events.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

For youth, even though study quality to date generally has been poor, this work provides some indication that the use of active video games that involve structured physical activity programming in some community settings (e.g., schools) could potentially be useful in increasing physical activity levels during the in-school period. Such observations require more rigorous evaluation, including assessment of potential compensation effects (e.g., increased sedentary behavior) during post-school home and leisure time.

For older adults, even though initial short-term evaluations of active video games have reported them to be a potentially acceptable, feasible, and safe exercise modality in suitably screened and supervised groups of older adults, few data currently exist related to their effectiveness in increasing overall physical activity levels.

PHYSICAL ENVIRONMENT AND POLICY LEVEL

Environmental- and policy-level interventions broadly include those that focus on features of a locale that relate directly to the built environment (e.g., access to parks, trails, or recreational facilities; pedestrian or bicycling infrastructure), or to laws, local ordinances, organizational policies, and institutional practices that can influence physical activity levels. Relevant types of interventions or physical activity-inducing features typically have included point-of-decision prompts to promote stair use, as well as features of land use or design (e.g., proximity and access to parks, trails, and natural spaces; mixed land use and infrastructure to promote active commuting; levels of street connectivity and residential density).[161-163] Other neighborhood characteristics, including perceptions of neighborhood walkability, aesthetics, and perceptions of safety or crime, also have been studied.[107, 161-163] Some physical activity interventions that could be included at the environmental and policy level have been reviewed elsewhere in this report, most notably those occurring in school-based settings, such as the availability of outdoor playground spaces and equipment, and environmental features supporting active recess.

In contrast to other levels of impact, environmental and policy approaches are, by their nature, constrained by the inherent difficulties and challenges in conducting this type of contextually complex research. Because of this, the Subcommittee weighed size and consistency of results along with the use of longitudinal and quasi-experimental designs more heavily in this evidence area relative to the other evidence areas where experimental designs are more feasible. Notably, although a large amount of the evidence to date has used cross-sectional designs, investigators have made a concerted effort in recent years to advance the field through employing stronger longitudinal, quasi-experimental, and natural experimental designs such as the Residential Environments Project (RESIDE) conducted in Australia.[164] These combinations of evidence have brought increased scientific rigor to the evaluation of the field.

For each of the types of environmental- and policy-level interventions reviewed here, evidence evaluating differences in exposure to environmental interventions by different racial/ethnic groups or intervention strategies tailored to specific racial or ethnic populations was generally scarce or absent. Individual studies cited in the review for point-of-decision prompts did at times focus on culturally relevant messaging or signage, although not consistently.[107, 165]

As noted earlier, the categories were not identified a priori and were not specifically included as search terms, but rather emerged during the broad 2011-2016 evidence search that was undertaken. Such a condensed approach necessarily limits the size and, potentially, the types of evidence considered at this level.

Point-of-Decision Prompts to Promote Stair Use

Sources of evidence: Systematic reviews and reports

Conclusion Statement

Strong evidence demonstrates that interventions that target point-of-decision prompts to use stairs versus escalators or elevators are effective over the short term in increasing stair use among adults. **PAGAC Grade: Strong.**

Review of the Evidence

Two systematic reviews[165, 166] and the AHA Scientific Statement[107] were included. The systematic reviews included a range of 6 to 67 studies. The following timeframes were covered in the systematic reviews: inception to July 2015,[166] 1970 to 2012.[165] The American Heart Association Scientific Statement covered January 1, 2007 through publication.[107]

The included reviews examined different approaches to increasing stair use as a means of promoting physical activity behavior. Most studies used a single strategy of signage, placed at the decision point for choosing to take the stairs or an escalator or elevator. The signage messages typically included health and weight control benefits, such as the amount of calorie expenditure accompanying stair use, or distance traveled. Other strategies included music, artwork, or other methods for improving stairwell attractiveness.

Outcomes focused on stair use or stair climbing assessed largely through behavioral observation methods. A few studies used technology-based methods, such as counting machines or videotaping.

Evidence on the Overall Relationship

Evidence for this category comes largely from quasi-experimental studies, with controlled before-and-after studies or interrupted time series designs.[107, 166] Few RCTs have been conducted.[107] Studies were conducted in different community settings (e.g., transit hubs, worksites, hospitals, shopping malls). Most studies were short term, with one systematic review finding that most ranged from 4 to 12 weeks.[165] In another review,[166] two of three studies had durations of 12 or fewer weeks. In one systematic review of 67 studies, 77 percent reported increases in stair use.[166] For those studies with significant effects (N=55 studies), the percent stair use increase ranged from 0.3 percent to 34.7 percent. When odds ratios were reported, they ranged from 1.05 (95% CI: 1.01-1.10) to 2.90 (95% CI: 2.55-3.29).[166] According to Jennings et al,[166] a variety of intervention characteristics (i.e., single versus multiple intervention strategies; single versus multiple messages; poster size) yielded similar effects. Other characteristics (i.e., inclusion of text and images [89%] versus text-based only [75%]; a focus on time [88%] and fitness [85%] versus health [78%] messages) appear to be promising areas to explore further. Improvements in stair use were found across different settings, such as public (80% reported significant improvements) and worksite settings (67% reported significant improvements). Several studies have reported that positive point-of-decision prompt effects were observed across population subgroups varying in different characteristics, such as age, sex, and weight status. One study included in the reviews[167] found a stronger positive effect for participants estimated to have overweight than those having normal weight status. Two studies that were reviewed found an interaction between sex and age such that older women were the least likely to use the stairs.[168, 169]

Built Environment Characteristics That Support Active Transport

Sources of evidence: Systematic reviews, reports

Conclusion Statement

Moderate evidence indicates that built environment characteristics and infrastructure that support active transport to destinations (e.g., Safe Routes to School programs, street connectivity, a mix of residential, commercial, and public land uses) are positively associated with greater walking and cycling for transport among children, adults, and older adults compared to environments that do not have these features. **PAGAC Grade: Moderate.**

Review of the Evidence

Three systematic reviews,[165, 170, 171] one meta-analysis,[172] and two reports[107, 161] were included. The systematic reviews and reports included a range of 12 to 42 studies. *The Guide to Community Preventive Services*[161] included seven studies that reported on transportation-related walking and cycling. The following timeframes were covered in the systematic reviews: inception to December 2016,[161] January 2000 to September 2016,[172] inception to June 2009,[170] inception to November 2014,[171] and 1970 to 2012.[165] The AHA Scientific Statement covered January 1, 2007 through publication.[107]

Environmental characteristics being evaluated consisted of geographical information systems (GIS)-assessed or self-reported environmental factors, including land-use mix, pedestrian and cycle routes, road design, and urban planning policies (e.g., provision of parks, trails, or open space). The studies represented a mix of cross-sectional and longitudinal study designs. Two studies examined interventions to promote active transport. Examples included a walking school bus program (i.e., a group of children walking to school with one or more adults), Safe Routes to School programs,[165] RCTs evaluating support for active commuting,[171] pre-post designs examining polices such as Ride to Work Day, and changes in cycle infrastructure.[171]

Outcomes included self-reported transport physical activity (e.g., total walking for transport, within-neighborhood walking for transport, cycling for transport, total active travel). Outcomes also included changes at an aggregate population level (e.g., percent cycling to work, number of days cycling, percent walking or cycling to school, overall physical activity).

Evidence on the Overall Relationship

Longitudinal evidence described in The Community Guide highlights the results of a large natural experiment (RESIDE)[164] and multiple smaller prospective quasi-experimental studies finding significant increases in active transport over time in response to supportive environmental characteristics (e.g., walkability, land-use mix or destinations). The RESIDE study examined changes in physical activity based on built environment characteristics among those who moved to new neighborhoods compared with those who did not. Longer-term follow-up (i.e., 7 years) of this natural experiment indicated increases in active transportation, with perceptions of safety and the environment related to physical activity change. These results indicated, for example, that each unit increase in perceived safety from crime was associated with 3.2 minutes per week more of transport physical activity. In addition, the association remained similar (3.6 minutes per week increases with unit increases in perceived safety from crime) when also controlling for built environmental characteristics such as residential density, streets connectivity, and number of local destinations, which together comprise many walkability indices.

The above experimental and quasi-experimental studies notwithstanding, a large proportion of the evidence in this area comes from cross-sectional studies. A number of such studies also support the relationship between environmental characteristics and active transport behavior in general adult populations. Of the cross-sectional studies reported in The Community Guide, 18 out of 27 studies (66.6%) found higher transport walking or cycling to be associated with more favorable walkability indices.[161] In addition, of 11 cross-sectional studies that compared residents in more versus less activity-supportive environments, the Community Guide found that those living in more activity-supportive environments had higher transport-related walking (median=37.8 minutes) and recreational walking (median=13.7 minutes) per week.

The AHA Scientific Statement found evidence in favor of land-use mix, identifying at least 18 cross-sectional observational studies finding a relationship with physical activity in adults.[107] Those studies that included specific outcomes for active transport found a similar pattern. For example, one study[173] found that adults reporting more destinations (i.e., 7 to 13) within a 5-minute walking distance were more likely to walk for transport than those who did not report any destinations within a 5-minute walking distance (OR=2.4; 95% CI: 1.3-4.3). A similar pattern emerged when number of destinations was captured using environmental audit tools. Those data indicated that persons living in neighborhoods with more non-residential destinations had higher transport-related walking than those living in neighborhoods with fewer such destinations (OR=3.5; 95% CI: 2.3-5.5). For youth, eight systematic reviews were included, with positive associations found between land-use mix and children's physical activity (OR ranged from 1.8 (95% CI: 1.05-3.42) to 3.46 (95% CI: 1.6-7.47)), particularly when active commuting to school was included. Some studies examined safety (i.e., traffic and crime) and its associations with walking to school or other neighborhood destinations among children or adolescents. Across two individual systematic reviews[174, 175] that were included in the AHA Scientific Statement,[107] six of nine studies that examined traffic safety found a significant association between road safety and active travel. These systematic reviews[174, 175] also included 12 studies that examined crime-related safety assessed through parental perception and active transport. Four out of 12 studies found a significant inverse association. One such study found that lower parent safety concerns were associated with a 5.2 higher odds of active commuting to school.

Among older adults, consistent links have been found between both perceived and objectively assessed neighborhood characteristics and active transport.[172] A meta-analysis of 42 quantitative studies found significant positive associations among a number of environmental variables and active transport behaviors, including residential density and urbanization, walkability, easy access to building entrances, and access to and availability of services and destinations. A weak, negative association was found between neighborhood disorder (e.g., litter, vandalism and decay) and total walking for transport.

Fraser and Lock[170] examined relationships among active transport policies, such as those relating to cycle paths or routes and other urban planning features (e.g., road design, provision of parks or trails), as well as policies supporting Safe Routes to School programs. Twenty-one studies were reviewed, of which 16 were cross-sectional surveys (with 8 of those using GIS), 3 included some longitudinal information, 1 was observational and examined cycle routes, and 1 was a secondary analysis of census information. Eleven of the 21 studies found a positive association between environmental factors and cycling. Fraser and Lock[170] included seven studies examining active transport patterns and environmental factors associated with active commuting to school programs among children. An example of one such program was the California Safe Routes to School program. A cross-sectional evaluation of this program reported that when the program was part of children's normal routes to school, 15.4 percent of children walked or cycled versus 4.3 percent of children for whom it was not present.

Two reviews examined specific policy or environmental interventions to promote active transport. Stewart et al[171] reviewed 12 studies from six countries, including two RCTs and 10 pre-intervention or post-intervention designs. Seven of the studies examined individual or group-based interventions conducted through community and workplace settings (e.g., cycle training, ride to work days, materials such as maps, activity diaries), and five involved environmental interventions, such as construction of a bridge or changes in cycling infrastructure. Of the seven individual or group interventions, six of seven found increases in cycling for transport; however, only three of six of those studies reached statistical significance. The environmental interventions were found to have small positive effects. Reynolds et al[165] specifically examined 10 active transport interventions (e.g., Safe Routes to School, walking school buses, workplace-based active transport interventions) and reported support for an increased prevalence of walking to school and distance walking to school across the interventions.

Community Design and Characteristics That Support Recreational Physical Activity

Sources of evidence: Systematic review, reports

Conclusion Statement

Moderate evidence indicates that community design and characteristics that support physical activity, such as having safe and readily usable walking and cycling infrastructure and other favorable built environment elements are positively associated with greater recreational forms of physical activity among children and adults compared to environments that do not have these features. **PAGAC Grade: Moderate.**

Review of the Evidence

One systematic review,[162] one scientific statement,[107] and one report[161] were included. Brennan et al[162] reviewed 396 study groupings (i.e., articles reporting on the same type of intervention were collapsed) (N=600 total studies). The AHA Scientific Statement included 19 studies (15 systematic reviews/meta analyses that included 7 for children and 8 for adults) and 7 original articles (4 for children and 3 for adults) that focused on sidewalk and street design.[107] The Community Guide included 11 studies that assessed the effects of changes to characteristics of the built environment ("construction projects"), 6 studies related to sprawl and activity supportive environments, 7 studies of pre-defined neighborhood types (i.e., ones that are more versus less supportive of physical activity), and 66 studies of summary scores of existing built environments or comparisons across communities.[161] The following timeframes were covered: inception to December 2016,[161] 2000-2009,[162] and January 1, 2007 through publication.[107]

The included reviews examined the relationships between recreational physical activity and a number of different environmental features, including pedestrian infrastructure (e.g., sidewalk availability) street design (e.g., street connectivity), GIS-measured characteristics of the environment, self-report of various environmental characteristics, construction or other changes to the built environment, and neighborhood walkability indices.

Outcomes included associations with measured total physical activity, recreational walking and cycling, moderate-to-vigorous physical activity, and, in some instances, change in physical activity over time.

Evidence on the Overall Relationship

The Community Guide summarized the results of larger and smaller scale longitudinal studies.[161] Longitudinal evidence from these investigations, including the large RESIDE study,[164] has provided valuable information concerning the impacts of environmental characteristics on recreational physical activity over time. The results from RESIDE indicated that each unit increase in perceived safety from crime was associated with 13.5 minutes per week more of recreational physical activity over a 7-year follow-up period. This amount of increase remained similar (13.7 minutes per week) when also controlling for additional built environmental characteristics (i.e., residential density, streets connectivity, and mix of local destinations).

In addition to RESIDE, the Community Guide reviewed 10 smaller-scale longitudinal studies that focused on neighborhood or community projects.[161] For recreation-related walking and cycling, two of two studies showed favorable results. For moderate-to-vigorous physical activity overall, including recreational activity, two of two studies showed favorable results.

Additionally, The Community Guide reviewed 11 cross-sectional studies comparing environments that were more versus less supportive of physical activity, finding that adults in neighborhoods that were more environmentally supportive of physical activity reported a median of 50.4 more minutes per week of moderate-to-vigorous physical activity and averaged about 13.7 minutes more of recreational walking compared with neighborhoods that were less supportive.[161]

Walkability indices (i.e., summary scores reflecting a combination of built environment characteristics, such as street connectivity, residential density, and land-use mix) also have been used in a number of cross-sectional studies to evaluate recreation-related walking and cycling. Based on a review of 16 such studies in The Community Guide that used walkability indices to capture the built environment, 10 of 16

(62.5%) showed favorable associations, such that higher levels of recreation-related walking and cycling were associated with higher walkability indices. This finding was consistent when moderate-to-vigorous physical activity was used as the physical activity outcome, with 12 of 19 (63.2%) studies finding higher levels of moderate-to-vigorous physical activity to be associated with higher walkability indices.

In addition to studies that specifically measured recreational physical activity, some studies reported on more general categories of physical activity that included recreational physical activity. Studies included in the AHA Scientific Statement examined such outcomes separately for children and adults.[107] Of the seven systematic reviews focusing on children or adolescents, all seven included outcomes related to pedestrian infrastructure and all reported evidence to support significant associations. Characteristics of the pedestrian infrastructure and type of outcome varied, with some examining presence of sidewalks, while others examined sidewalk improvements or bicycle and walking trails. Outcomes included walking or cycling for transport or recreation. Of the seven systematic reviews, four included outcomes related to street design, and found street connectivity to be positively associated with general physical activity levels. Among adults, of the nine systematic reviews/meta analyses, eight focused on pedestrian infrastructure, with mixed results. For example, the presence of sidewalks was significantly associated with physical activity behavior (i.e., walking, meeting physical activity guidelines) in about half.

Similarly, Brennan et al[162] reviewed 396 study groupings (N=600 studies) for 24 policy or environmental intervention strategies for physical activity and obesity. Their review provided an additional assessment related to neighborhood design and infrastructure, from which they positively categorized activity-supportive community design (i.e., land use, commercial or residential proximity that supports physical activity) and street design (i.e., pedestrian, bicycle or transit oriented design to support physical activity).

In the Community Guide,[161] of the 18 studies that reported on total walking, assessed through questions which typically included leisure time or recreational physical activity, 12 (66.6%) reported positive associations with walkability indices. Among those assessing total physical activity, 4 of 14 studies (28.6%) were reported as significant. Five studies examined the percentage of individuals reaching recommended levels of moderate-to-vigorous physical activity, with three out of five studies (60%) reporting significant associations with walkability indices.

In addition, for adults, the largely cross-sectional studies reviewed by the AHA Scientific Statement generally indicated a significant relationship between neighborhood aesthetics and leisure-time physical activity, walking, or meeting physical activity recommendations (ORs ranged from 1.13 to 2.6).[107]

Neighborhood safety and crime are environmental factors that have been explored in several different ways. These include the associations between parent perceptions of neighborhood safety and child physical activity, and associations between personal- and crime-related safety as well as traffic-related safety among adults. For children, the findings generally support a positive association between parental perceptions of safety and child recreational physical activity. For adults, in one meta-analysis[176] cited by the AHA Scientific Statement,[107] absence of heavy traffic was associated with more walking and leisure-time physical activity (OR=1.22; 95% CI: 1.08-1.37). No effect sizes were provided for crime-related safety.

Access to Indoor and/or Outdoor Recreation Facilities or Outlets

Sources of evidence: Systematic reviews, report

Conclusion Statement

Moderate evidence indicates that having access to indoor (e.g., gyms) and/or outdoor recreation facilities or outlets, including parks, trails, and natural or green spaces, is positively associated with greater physical activity among adults and children compared to environments that do not have these features. **PAGAC Grade: Moderate.**

Review of the Evidence

Three systematic reviews,[177-179] and one report[107] were included. The systematic reviews and reports included a range of 12 to 90 studies. The following timeframes were covered in the systematic reviews: inception to October 2013,[178] inception to July 2014,[179] and 1990 to June 2013.[177] The AHA Scientific Statement covered January 1, 2007 through publication in 2012.[107] The variables included in this section were exposure to indoor and outdoor facilities in which to participate in physical activity. Access measures included objective (e.g., number of facilities, distance from park) and perceived measures of access. Outcomes included primarily walking, cycling, and total physical activity.

Evidence on the Overall Relationship

The AHA Scientific Statement found evidence to support improved accessibility to indoor and outdoor recreational facilities for physical activity promotion.[107] Greater access generally was shown to be related to more physical activity among adults (OR 1.20; 95% CI: 1.06-1.34).[176] Among children, 9 of 13 cross-sectional studies supported the relationship between accessibility and youth physical activity, particularly for girls.

For the specific case of access to parks and trails, some evidence (four of nine studies) supported the implementation of built environment interventions for encouraging use specifically of urban green space. More promising evidence (three of three studies) exists for a combined approach (i.e., changes to the built environment such as building a new footpath and a physical activity promotion campaign or skills development program).[179] Other studies indicated more mixed associations between exposure to parks and green space and physical activity levels.[177, 178] In one review of 20 studies, 5 (25%) reported a positive association between parks and physical activity.[177] Some factors noted by Bancroft et al[177] for the inconsistency of effects across these studies were heterogeneity in reporting standards, including variations in the distances used to categorize density of and proximity to parks, and a mix of objective and self-reported physical activity measures.

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups and adverse events is currently lacking or infrequently reported. One systematic review[180] examined 27 studies to summarize the cost-benefit or cost-effectiveness of environmental and policy-related interventions. Of the 27 studies, 8 focused on community and built environments for physical activity. Some of the types of interventions related to physical activity included physical activity equipment in parks, access to recreation and fitness centers, bicycle or trail networks and infrastructure, and Open Streets programs (i.e., urban streets and pathways made more accessible for walking, cycling, and other forms of physical activity through temporarily reducing motor vehicle access). Most of the studies reported economic benefit for these types of interventions. For example, the cost-benefit ratio of the Open Streets program in four international cities ranged from 1.02 to 1.23 in Guadalajara, Mexico, to 2.23 to 4.26 in Bogotá, Colombia.[181] Another study included in the McKinnon et al[180] systematic review calculated a cost-benefit ratio of 2.94, such that every $1 of investment in bicycle or pedestrian trail development resulted in a calculated $2.94 direct medical or health benefit (i.e., estimation of direct medical cost difference for active versus inactive).[182]

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact of All Physical Environment and Policy Level Interventions Reviewed

Given the ubiquitous nature of the environmental contexts surrounding "place-based" behaviors, such as physical activity, the ramifications of identifying and promoting the types of environments that are most conducive to supporting and facilitating regular physical activity across the population are immense. The evidence indicates that a diverse array of environmental factors and features can influence physical activity levels across different age groups and community settings, including schools, worksites, transit hubs, parks, neighborhoods, and residential settings. Most of this evidence, however, has focused on urban environments, with relatively little information currently available related to environmental features that may influence physical activity behavior in rural settings.

In addition, because environmental and policy level approaches are often inextricably intertwined, systematic reviews of these two approaches were considered together. Relatively little systematic evidence was found during the 2011 to 2016 evidence search period evaluating the effects of specific policies related to urban sprawl, land-use mix, and other factors on different types of physical activity and for different population segments. Only one review was located during this time period that focused specifically on policy approaches for physical activity promotion.[162] This review was primarily descriptive in nature, and characterized land use policies and school physical activity policies as among the most promising of those policy domains that have been studied.[162] A few other policy-specific studies were described briefly as part of other reviews, including one prospective study using a time-series analysis, described in The Community Guide,[161] which reported positive impacts of urban sprawl curtailment policies on physical activity levels.[183] The Community Guide also reviewed five cross-sectional studies that used sprawl indices to examine the relationship between urban sprawl and physical activity behavior. Four of the five studies (80%) found a relationship between less sprawl and higher physical activity across various physical activity domains (transport, recreation, total physical activity, and walking). In contrast, the AHA Scientific Statement[107] reported finding little evidence evaluating the effectiveness of such regulatory approaches for promoting physical activity. Taken together, these reviews suggest that while the policy intervention literature does not currently have sufficient evidence to receive an evidence grade, their potentially far-reaching impacts, both alone and in combination with environmental and related interventions, merit further systematic investigation.

Question 2. What interventions are effective for reducing sedentary behavior?

As described in *Part F. Chapter 2. Sedentary Behavior,* a sufficient body of evidence now exists to substantiate the role of sedentary behavior patterns on an array of health outcomes. In light of the detrimental effects of extended patterns of daily sedentary behavior on the public's health, a growing evidence base is aimed at developing and evaluating interventions targeted specifically at reducing prolonged sitting and related sedentary behaviors in youth and adults. Sedentary behavior interventions are defined as those strategies that target reductions in sedentary behavior outcomes, which may include self-reported or context-specific forms of sedentary behavior (e.g., television viewing), accelerometer- or movement-based outcomes, or posture-based outcomes (e.g., lying or seated behaviors at less than 1.5 METs). These behaviors are ubiquitous, habitual, and socially-reinforced in modern societies. In addition, a number of the environmental, social, and individual-level determinants of sedentary behavior appear to be distinct from those associated with physical activity. The presence of unique determinants that influence sedentary behavior supports the development and testing of specific intervention strategies and approaches to reducing sedentary time—a number of which may be separate from methods aimed directly at increasing physical activity.

The 2011 to 2016 evidence review yielded three primary domains of evidence about interventions aimed at reducing sedentary behavior. These domains include youth interventions (i.e., interventions targeting populations ages 3 to 18 years with the primary goal of reducing television and other screen-based behaviors), adult interventions (i.e., interventions aimed at adult populations with the primary goal of reducing overall and context-specific forms of sedentary behavior such as television viewing or transport-related sedentary time), and worksite interventions (i.e., interventions targeting sedentary behavior in the work place).

As noted earlier, the categories were not identified a priori and were not specifically included as search terms, but rather emerged during the broad 2011 to 2016 evidence search that was undertaken. Such a condensed approach necessarily limits the size and, potentially, the types of evidence considered for this question. It should be noted that, given the relative newness of the sedentary behavior interventions field, the overall evidence base was smaller for this field compared to the physical activity promotion field. However, this newer evidence base tended toward more rigorous methods (i.e., meta-analysis of RCTs).

YOUTH INTERVENTIONS

Sources of evidence: Meta-analyses, systematic reviews

Conclusion Statement

Moderate evidence indicates that interventions targeting youth, primarily through reductions in television viewing and other screen-time behaviors in primarily school-based settings, have small but consistent effects on reducing sedentary behavior. **PAGAC Grade: Moderate.**

Review of the Evidence

Four meta-analyses[184-187] and five systematic reviews[158, 188-191] were included. The meta-analyses included a range of 13 to 34 studies. The systematic reviews included a range of 10 to 22 studies. Studies overall covered an extensive timeframe, including a number from inception through 2015. The majority of studies reviewed focused on youth ages 3 to 18 years. Although most reviewed studies focused primarily on the school setting,[158, 184, 186-188, 190] some included other clinical, community, or home settings.[185-187, 189, 190] The majority of studies reviewed were at least 6 months in duration, although study duration ranged from 3 weeks to 4 years. The majority of studies targeted television and other screen-time behaviors as the primary outcome of interest, while some quantified changes in overall[158] and school-based sedentary time.[191] Interventions were delivered by educators, parents or families, healthcare providers, and researchers.

Evidence on the Overall Relationship

Studies varied in intervention targets—some interventions focused on sedentary behavior exclusively and others targeted multiple health behaviors simultaneously. As a whole, the studies reviewed showed small but consistent effects on sedentary behavior reduction (e.g., mean difference was −20.44 minutes per day; 95% CI: -30.69 to -10.20),[185] with no trends evident for greater efficacy from either multiple behavior change interventions (i.e., sedentary behavior plus physical activity and/or dietary interventions) or sedentary behavior-only interventions. The studies had a small trend for community- or home-based interventions to show somewhat greater efficacy compared to interventions in other settings (e.g., school settings), as well as a trend for accelerometer-based studies to show somewhat greater efficacy than studies with self-reported outcomes.[187] School-based interventions focused primarily on reducing screen time in children through in-class or after-school curricula, and typically included messages targeting screen time as well as other health behaviors (e.g., exercise, diet). Such interventions had small but consistent effects in reducing sedentary time, particularly for those lasting longer than 6 months (e.g., mean difference was −0.25 hours per day; 95% CI: -0.37 to -0.13).[184] Accelerometer-based studies generally showed greater reductions in sedentary behavior than did studies with self-reported outcomes. It was not clear from the evidence reviewed, given the general lack of health outcomes assessed in a number of the intervention studies, whether the small but consistent reductions in sedentary behavior were large enough to produce or maintain positive health outcomes. In addition, although the studies suggested that longer-term interventions were able to maintain their efficacy, few studies measured or demonstrated sustainability of sedentary reductions once the intervention ended.

Evidence on Specific Factors

Evidence in the reviews evaluating effects in different racial/ethnic groups, adverse events, and cost-effectiveness is currently lacking or infrequently reported.

Features of sedentary behavior intervention targets and measures: Interventions commonly employed school-based counseling or tailored feedback to reduce screen time behaviors. Parental involvement also was often implemented, including sending newsletters home or inviting parents to attend workshops. Most school-based programs were integrated into existing curricula and were delivered over extended time periods. Less common strategies included the installation of sit-stand desks in classrooms. The most commonly reported outcome was self-reported screen time behaviors (e.g., watching television, DVD or video viewing, electronic gaming, computer-based activities, and small screen activities) in minutes per day. Other less commonly reported outcomes were steps per day (pedometer) and accelerometer-based energy expenditure changes.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

Given the rapid growth of new and varied platforms for media consumption and growing concerns about prolonged sedentary time and sitting among youth, interventions targeting reductions in screen time are appealing and have the potential for widespread and substantive decreases in overall sedentary time across the day. The overall conclusion that these types of approaches have small but consistent effects suggests opportunities for increasing the intensity and/or robustness of the intervention approaches to enhance overall efficacy. Although the vast majority of studies focused primarily on school-based settings, a small number of studies suggested potentially promising effects on screen time using home-based interventions. Also of note was the extended length of the interventions (i.e., 6 months or more) and the similar efficacy found for interventions that targeted screen time solely versus those focused on multiple behaviors. These findings support the feasibility of carrying out these types of interventions over sustained periods of time, either alone or in combination with other important health behavior intervention targets (e.g., physical activity, diet).

ADULT INTERVENTIONS

Sources of evidence: Meta-analyses, systematic reviews

Conclusion Statement

Limited evidence suggests that sedentary behavior interventions targeting decreases in overall sedentary time in general adult populations are effective. **PAGAC Grade: Limited.**

Review of Evidence

Four meta-analyses[154, 192-194] and one systematic review[151] were included. The meta-analyses included a range of 19 to 36 studies. The systematic review included 30 studies. Studies overall covered an extensive timeframe, with most including studies from inception through 2015. The studies reviewed included adults ages 18 to 94 years, and focused on general behavioral change approaches for reducing sedentary time[192, 193] or technology-mediated interventions.[151, 154, 194] Most interventions reviewed were of short duration (less than 3 months).

Evidence on the Overall Relationship

Behavior interventions targeting some combination of physical activity, diet, and/or sedentary behavior had small and variable effects in adults for reducing sedentary time (e.g., in one review only 6 of 20 studies showed significant effects, with a mean difference of -24.18 minutes per day [95% CI: -40.66 to -7.70]).[193] Interventions targeting sedentary behavior exclusively had the most promising effects (e.g., mean difference= -41.76 minutes per day [95% CI: -78.92 to -4.60]). However, these studies were of short duration (less than 3 months), had limited follow-up, and were of poor scientific quality due to lack of blinding and large effect variability.[193] Interventions targeting physical activity exclusively had limited to no effect on overall sedentary behavior (e.g., only 6 of 19 studies showed significant effects, with a mean difference of -0.22 hour per day [95% CI: -0.35 to -0.10]).[192] Evidence on the use of technology-mediated approaches to reduce sedentary behavior in adults (e.g., smartphone apps, text messages) was reported to be scarce.[151, 154, 194]

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups, adverse events, and cost-effectiveness is currently lacking or infrequently reported.

Features of sedentary behavior intervention targets and measures: Interventions included education/behavioral approaches to reducing sedentary time, either alone or in combination with interventions aimed at increasing physical activity and/or changing dietary intake. Sedentary behavior reduction strategies included the use of television-limiting devices, smartphone apps, and text messaging services that delivered sedentary behavior reduction advice and education, and behavioral strategies such as goal setting and action planning. Sedentary behavior was measured using a variety of objective and self-report methods. Most studies used a self-reported estimate of total sedentary time, and expressed reductions in sedentary time in minutes per day or hours per day. Some studies also reported context-specific reductions in sedentary time (i.e., television viewing, transport-related sedentary behavior). Few studies used accelerometer-measured reductions in energy expenditure, number of sitting breaks, and number of prolonged sitting events.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

The evidence is currently limited for approaches that target overall sedentary time in adults. This is due largely to variability in the number of behaviors being targeted in interventions that report outcomes on sedentary time and the varied approaches implemented. Substantial evidence shows strategies targeting solely increases in physical activity are not effective at reducing sedentary time. Multiple behavior change approaches showed mixed and inconsistent results, while the most promising approaches were those that targeted sedentary behavior exclusively.

WORKSITE INTERVENTIONS

Source of evidence. Meta-analyses, systematic reviews

Conclusion Statement

Moderate evidence indicates that interventions targeting sedentary behavior in worksites—particularly among workers who perform their job duties primarily while seated—have moderate to large short-term effects in reducing sedentary behavior. **PAGAC Grade: Moderate.**

Review of Evidence

Two meta-analyses[195, 196] and two systematic reviews[197, 198] were included. The meta-analyses included a range of 8[196] to 21[195] studies. The systematic reviews included 15[198] and 40[197] studies. Studies reviewed were from inception through 2015. The ages of the individuals in the studies were primarily 18 to 64 years, and most were office workers who performed their job duties primarily while seated. The interventions reviewed included educational or behavioral and environmental strategies (e.g., motivational or educational signage placed in public locations, moving printers and/or waste bins to more central locations farther away), physical changes to work stations (e.g., sit-stand workstations, treadmill desks, portable pedal machines), stair use promotion, and worksite-supported policy changes (e.g., walking meetings). Most interventions reported lasted 3 to 6 months.

Evidence on the Overall Relationship

Interventions that focused on providing educational or motivational support showed only small and inconsistent effects on sedentary behavior (e.g., mean difference was -15.52 minutes per 8-hour workday [95% CI: -22.88 to -8.16]).[195] Interventions that targeted physical changes to work stations (i.e., predominantly the addition of sit-stand workstations, with a few that used treadmill desks or portable pedal machines) had consistently medium to large effects (e.g., mean difference was -72.78 minutes per 8-hour workday [95% CI: -104.92 to -40.64]). Additionally, these effects were stronger when these types of work station changes were combined with educational and behavioral support (e.g., mean difference was -88.80 minutes per 8-hour workday [95% CI: -132.69 to -44.61]).[195] A number of these studies used less rigorous nonrandomized designs, shorter-term follow-ups (3 to 6 months), and small sample sizes.[196] Walking workstations and cycle ergometers appeared to have more limited efficacy compared to sit-stand workstations in reducing sedentary time (i.e., sitting) in the workplace.[196]

Evidence on Specific Factors

Evidence in the reviews evaluating different racial/ethnic groups, adverse events, and cost-effectiveness is currently lacking or infrequently reported.

Features of sedentary behavior intervention targets and measures: Intervention strategies were varied, with the most prominent intervention strategy being the addition of a sit-stand workstation at the employee's primary work location. Other strategies, tested singly or in combination, were education or behavioral approaches, computer prompts, mindfulness instructions related to sedentary time, e-newsletters, walking strategies, and environmental or policy changes in the workplace. The primary measure of sedentary behavior was device-measured sedentary or sitting time during work hours, typically expressed in 8-hour units for comparability across varying work times. Fewer studies included self-reported total sedentary time and reported sitting time, with some of these studies using a text message-based experience sampling methodology.

For additional details on this body of evidence, visit: https://health.gov/paguidelines/second-edition/report/supplementary-material.aspx for the Evidence Portfolio.

Public Health Impact

Given that working adults—particularly those who perform their job functions while seated—spend a substantial portion of their overall day sitting at work, a strong rationale exists for targeting reductions in sedentary time through the workplace. These workplace interventions also are appealing because they may complement physical activity interventions and can be implemented during times when physical activity is generally not feasible. The evidence suggests moderate to large short-term effects for some sedentary behavior intervention approaches. More specifically, it appears that environmental supports (e.g., sit-stand workstations) may be needed to achieve substantive changes in sedentary time in work settings, particularly among office workers and those with similar job types. Educational and behavioral support approaches alone do not appear robust enough to produce substantive impacts on workplace sedentary behavior. However, combining environmental, education or behavioral, and policy changes aimed at reducing prolonged sedentary behavior in the workplace yielded the strongest effects. The quality of the reported evidence (i.e., short duration interventions, nonrandomized designs) prevented a stronger evidence grade. However, it should be noted that two recent large-scale cluster RCTs of 3-month[199] and 12-month durations[200] that were not able to be included in this evidence review demonstrated similar efficacy to the studies reviewed here.

NEEDS FOR FUTURE RESEARCH

The evidence review in this chapter highlights a number of research needs across the different intervention areas highlighted in the review. It should be noted, however, that given that the evidence review was not comprehensive, a number of other intervention areas were not captured in this evidence review that also undoubtedly merit further research.

In light of some unique aspects of scientific intervention development specific to the Information and Communication Technologies area, the research needs that are broadly applicable to all topic areas contained in this chapter are presented first, followed by an additional set of research needs specific to the fast-growing information and communication technologies intervention arena.

Research Needs that are Broadly Applicable to All Topic Areas Presented in this Chapter

1. Broaden enrollee targets in randomized controlled trials and other research in this area to incorporate diverse population subgroups, including broader age groups, men as well as women, diverse racial/ethnic groups, and vulnerable and underrepresented population groups (e.g., lower-income residents, patient subgroups).

   Rationale: In order to develop interventions that have the potential for having a public health impact at the population level, it is critical to ensure that diverse age, sex, racial/ethnic, cultural, geographic, and income groups are included in the experimental research designs that can most effectively advance the field. Data collected across these various subgroups of the population will inform how to adapt interventions to subgroup needs through formative and iterative intervention design methods, and can help strengthen interventions through ensuring that they are targeted effectively for specific subgroups as well as tailored to individual preferences and requirements.

2 Test physical activity and sedentary behavior interventions over longer time periods (i.e., more than 12 months) to better understand how to sustain their positive effects.

   Rationale: Because many of the positive health effects of regular physical activity and reduced sedentary time can accumulate over time and require regular engagement across time, methods for maintaining regular physical activity and reduced sedentary patterns are critical. Yet, as pointed out in this chapter, relatively few interventions have been systematically tested across time periods lasting several years, and knowledge concerning how best to foster sustained physical activity maintenance in different subgroups over time remains inadequate.

3. Report, in experimental and quasi-experimental investigations of physical activity interventions, intervention-related dose-response relations and adverse events to aid intervention evaluation, translation, and dissemination.

   Rationale: Experimental investigations in this area can benefit from consistent inclusion of information related to intervention dose-response (e.g., how does the intensity of the intervention, in terms of the type of communication delivery channel being used [e.g., in-person, mediated], as well as number, length, or schedule of contacts, affect the amount of physical activity change?). In addition, adverse events related to the intervention are important for determining intervention safety and appropriateness for various population subgroups, but are rarely reported in a systematic fashion.

4. Develop efficient methods for collecting cost data on all interventions being tested to inform cost-benefit and cost-effectiveness comparisons across the physical activity intervention field as a whole. For those intervention areas that are further developed, use comparative effectiveness designs to more efficiently advance the study and translation of interventions to promote physical activity and reduce sedentary behavior.

   Rationale: In an increasingly cost-conscious health environment, it is important for the public and decision-makers alike to gain a better understanding of the costs of different interventions relative to their effectiveness to make more informed decisions in relation to intervention choice. In those intervention areas with evidence grades of Moderate or Strong, the use of comparative effectiveness experimental designs, in which interventions that have been shown to have merit are tested “head-to-head,” will advance knowledge more rapidly than designs that continue to use weaker controls or comparisons (e.g., minimal or no intervention, wait-list controls). In addition, further systematic evaluation of potentially cost-efficient intervention delivery sources (e.g., peer-led interventions) and delivery channels (e.g., automated behavioral counseling systems, virtual advisors), either as adjuncts to or replacements for more staff-intensive interventions, is warranted.

5. Develop standards in the field for choosing the most appropriate comparator arms with which to compare emerging physical activity interventions when evaluating their efficacy and effectiveness.

   Rationale: Similar to other health behavior fields, advancing the physical activity promotion field along the continuum of science, from discovery of promising interventions through dissemination of interventions that work, will require investigators to employ the most relevant comparator arms to answer the specific questions of interest that are being pursued. Relatively little consensus currently exists, however, concerning the most appropriate comparators to use to answer the various types of questions reflected across the different levels of impact described in this chapter. The field as a whole would benefit from building general consensus concerning the most appropriate types of comparators, along with design parameters, to be considered, based on the current state of the evidence and the most critical questions emanating from it.

6. For those intervention topic areas receiving a Strong or Moderate evidence grade, develop and systematically test methods for effectively implementing such physical activity promotion and sedentary behavior change approaches in real-world settings.

   Rationale: Although the current evidence review identified a number of physical activity promotion approaches and strategies that are effective in increasing physical activity behavior, few such approaches have been systematically disseminated across the U.S. population. In light of the sizable portion of the population that could benefit from increasing their regular physical activity levels, the development and systematic testing of potentially effective implementation methods and strategies are critical.

7. Develop and systematically test multi-component interventions that span multiple levels of influence to increase intervention impact and potential sustainability of behavior change.

   Rationale: It is clear that health behaviors such as physical activity and sedentary behavior are influenced by an array of individual, sociocultural, community, and environmental factors, yet many of the interventions that have been tested contain elements centered primarily on one level of impact (e.g., personal factors; institutional factors; built environment factors). Increasing the effectiveness and robustness of interventions likely could occur through targeting people within their environmental and social contexts (i.e., person-environment interactions). An example of such multi-level interventions includes combining individual-level behavioral skill-building strategies with neighborhood-level built environmental interventions to promote increased walkability.

8. Test, using experimental methods, strategies for promoting regular physical activity and reduced sedentary behavior across key life-course transitions, when such health behaviors potentially result in deleterious outcomes.

   Rationale. Common life-course transitions and the changes in role expectations and social and environmental contexts that often accompany them, can lead to negative impacts on physical activity levels and other health behaviors. Such transitions include changes from school to the workforce; changes in marital status and family roles and configurations; and physical transitions occurring at puberty, menopause, or with the onset of a chronic conditions. Systematic testing of methods and approaches for facilitating regular physical activity and reduced sedentary behavior during and following such common transitions could have significant, population level impacts.

9. Conduct experimental research aimed at testing systematically how best to combine physical activity interventions with other health behavior interventions, such as sedentary behavior, sleep quality, or dietary change interventions, to promote optimal physical activity change within the context of such multi-behavioral interventions.

   Rationale: Given the potential health-related synergies that can accrue when both physical activity and sedentary behavior change, or physical activity and dietary changes are implemented, systematic investigations of how best to combine these important health behaviors in different population subgroups are strongly indicated. Currently, little is known concerning the best approaches for combining health-enhancing physical activity with sedentary behavior change or dietary interventions, regardless of intervention modality, to facilitate sustainable behavior changes in both health behaviors. The few randomized controlled trials in this area are intriguing, however.[10] For example, some evidence exists suggesting that, in some population subgroups, introducing dietary interventions along with physical activity interventions may reduce the amount of physical activity change observed.[11] Further systematic evaluation of potential behavioral compensation effects between physical activity and sedentary behaviors is also warranted to ensure that physical activity increases during one portion of the day do not result in increased sedentary behavior in other portions of the day.

10. Increase the scientific utility of systematic reviews and meta-analyses to inform future research directions in the physical activity promotion and sedentary behavior reduction fields.

    Rationale: Although the number of systematic reviews has exploded across virtually all physical activity promotion and sedentary behavior areas, a number of such reviews lack specific types of quantitative information that can be useful in obtaining an accurate summation of a research area upon which future research can be applied. Such information includes the following:

    - Inclusion, whenever possible, of quantitative estimates of effect sizes or other magnitude of effect statistics for the articles included in the review, as opposed to simply *P* values;

- Clear descriptions of statistical outcomes for between-arm comparisons for all controlled or comparison arm studies along with specific notations when authors did not report such between-arm comparisons;
- Inclusion in each study, whenever possible, of the net physical activity differences achieved between intervention and control arms (e.g., with respect to mean step increases per day or mean minutes per week of moderate-to-vigorous physical activity achieved) over the specific time period under investigation;
- Inclusion of subgroup analyses based on key sociodemographic characteristics (e.g., sex, socioeconomic status, race/ethnicity, age) to identify which interventions might require specific targeting to be effective in different population subgroups.
- Reporting of adverse events and any unintended consequences of the interventions.

Research Needs Specific to Information and Communication Technologies Level Evidence

1. Employ additional types of experimental designs and methods that will allow for more rapid testing of information and communication technology interventions.

   Rationale: In light of the rapid evolution of the information and communication technologies interventions discussed in this chapter, traditional 2-arm parallel-arm trial designs may not easily allow researchers to keep up with the technology innovations that are occurring in this area. Further use of more advanced experimental designs, such as fractional or multi-level factorial designs and just-in-time adaptive interventions, is warranted.

2. Further explore methods and pathways for systematically exploiting the vast amounts of commercially available physical activity-relevant data and interventions that already reside in this area.

   Rationale: Millions of people representing a diverse and growing segment of the population are currently using commercial technologies aimed at physical activity behavior. Such databases have vast potential for accelerating our knowledge concerning the most effective ways of promoting physical activity among different population groups, yet remain relatively untouched. Exploring appropriate avenues for using these naturally-occurring databases provides a potentially paradigm-shifting approach to accelerate scientific advances in this area and the attendant public health benefits that can be gained.[201]

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