Physical Activity Behavior Change: Issues in Adoption and Maintenance

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The many benefits of participation in regular moderate- or vigorous-intensity physical activity are well established, yet more than 60% of the population is sedentary or insufficiently active. Published studies have revealed that behavior modification and cognitive–behavior modification can be successfully used to assist patients, healthy adults, and youth in the adoption of physically active lifestyles. However, few studies with adults and youth have examined the maintenance of physical activity behavior beyond 6 months of adoption of this behavior. Maintenance of physical activity is critically important because ongoing participation in the behavior is necessary to sustain health benefits. Knowledge of effective intervention strategies for long-term maintenance of physical activity is at an early stage. The authors provide a summary of what is known about the maintenance of physical activity behavior in adults and youth and how physical activity behavior relates to other health behaviors such as smoking, as well as recommendations for research on physical activity behavior change and maintenance.

Key words: physical activity, exercise, behavioral interventions, maintenance

The many benefits of engaging in regular physical activity are now generally accepted (Bouchard, Shephard, & Stephens, 1994; U.S. Department of Health and Human Services [USDHHS], 1996). Physical activity affects many aspects of health, including protection against premature mortality, coronary heart disease, hypertension, diabetes mellitus Type 2, osteoporosis, colon cancer, depression, and anxiety (Bouchard et al., 1994; USDHHS, 1996). Despite these benefits, much of the population is sedentary or underactive. Although several trials demonstrated success in encouraging adoption of physical activity in both patient and healthy populations, few studies examined the maintenance of this behavior. Maintenance is a noteworthy endeavor given that individuals must continue to be physically active to sustain its full health benefits. Knowledge of effective intervention strategies to change and maintain physical activity behavior in free-living settings is still at an early stage. It was not until 1996 that the first U.S. surgeon general’s report documenting the benefits of physical activity was published. This is a document comparable to the first publications of the surgeon general’s recommendations for smoking and nutrition published in 1964 and 1988, respectively. The purpose of this article is to summarize what is known about the maintenance of physical activity behavior in adults and youth and to recommend directions for research on physical activity behavior change and maintenance.

Definitions, Criteria, and Prevalence of Physical Activity Behavior Change

Who Should Receive Intervention?

All individuals older than 2 years benefit from incorporating at least 30 min of moderate- to vigorous-intensity physical activity into their daily lives (USDHHS, 1996). Before pubescence, most children seem to be naturally active, and their physical activity is often enhanced through physical education classes, youth sports, and recreational activities. As a result, children tend to be the most active segment of the U.S. population. However, physical activity levels begin to decline at about 6 years of age and continue to decline throughout the life cycle (Malina, 1996). Nearly half of America’s youth (ages 12–21 years) are not vigorously active on a regular basis. Physical inactivity is more
prevalent among girls than boys (13.8% vs. 7.3%), among African American youth than Caucasian youth (15.3% vs. 9.3%), and among African American girls than Caucasian girls (21.4% vs. 11.6%; USDHHS, 1996). Physical activity declines dramatically during adolescence, when active environments such as physical education and youth sports become less available and when school, work, and less active leisure pursuits become more prominent. Therefore, the teenage years may be a critical period for intervention (Stone, McKenzie, Welk, & Booth, 1998; USDHHS, 1996).

The recommended level of physical activity for adults is the accumulation of 30 min or more of moderate-intensity physical activity (e.g., brisk walking) on 5 or more days each week (Pate et al., 1995) or 20 to 60 min of vigorous-intensity physical activity (e.g., jogging) at least 3 days per week (American College of Sports Medicine, [ACSM], 1990). However, more than 60% of American adults are not meeting either criterion, and approximately 25% of all adults are not active at all (USDHHS, 1996). Certain segments of the U.S. adult population tend to be more sedentary than others and, therefore, are in greater need of intervention. Specifically, sedentary behavior is more prevalent for women (30.7% vs. 26.5% of men), older adults (38.2% of men 75 years or older and 50.5% of women 75 years or older vs. 18.9% and 25.4% of men and women, respectively, in the 18- to 29-year age group), the less educated (46.5% of individuals younger than 12 vs. 17.8% of college graduates), the poor (41.5% of the population with a yearly income <$10,000 vs. 17.8% of those with incomes > $50,000), and ethnic minorities (African Americans: 38.5%; Hispanics: 34.8%; Caucasians: 26.8%; Centers for Disease Control, 1992). People with disabilities and chronic illness are also less likely than those without disabilities to report regular moderate physical activity (27.2% vs. 34.4%) and less likely to report regular vigorous activity (9.6% vs. 14.2%; USDHHS, 1996).

**Definition of Attempts to Change**

Attempts to change physical activity behavior have not been officially defined. In various studies, indicators of progression toward physical activity adoption have included advanced stage of motivational readiness for physical activity adoption (e.g., Calfas et al., 1996; Dunn et al., 1997), increased intention to be physically active (e.g., Wimbush, MacGregor, & Fraser, 1998), and increases in actual physical activity behavior (e.g., A. C. King, Haskell, Young, Oka, & Stefanick, 1995). When attempting to adopt physical activity, many individuals appear to go through various stages, often including the resumption of a sedentary lifestyle, before activity is readopted and maintenance occurs (Sallis & Hovell, 1990; USDHHS, 1996). No systematic data are available for prevalence of attempts to change physical activity in the U.S. population.

**Criteria for Successful Change**

There are no established criteria for successful change in children. For adults, a successful change is typically said to occur when a previously sedentary individual meets Centers for Disease Control (CDC)/ACSM recommendations for regular physical activity for at least 6 months (Pate et al., 1995).

No national studies have been conducted to examine the prevalence rates of successful change in physical activity without formal intervention. However, some data do suggest that intensity of physical activity is a factor in its adoption and maintenance for adults (Dishman & Buckworth, 1996; USDHHS, 1996). In a study examining moderate- and vigorous-intensity physical activity in adults over a 1-year period, more men than women were currently vigorously active or in the process of adopting vigorous activity. Approximately equal numbers adopted and quit vigorous exercise across both genders. However, both men and women were more likely to adopt and maintain moderate-intensity activity (Sallis et al., 1986).

Preliminary analyses were conducted to examine maintenance of activity in a six-visit cohort (approximately 1 year between visits) of 4,827 men and 1,106 women who visited the Cooper Clinic from 1979 to 1997 and who were initially healthy (Marcus, Cheng, Dunn, & Blair, 1999). Activity was defined as regular weekly participation in at least one exercise activity or sport in the preceding 3 months (Kohl, Blair, Paffenbarger, Macera, & Kronefeld, 1988). If men were sedentary at the first visit, 27% were found to remain sedentary at all five follow-up visits, whereas 9% were found to become active and remain active at all five follow-up visits. For women who were sedentary at the first visit, 49% remained sedentary at all five follow-up visits, and only 5% of initially sedentary women became active and remained active at all five follow-up visits. If men were active at the first visit, 7% became sedentary and 26% remained active at all five follow-up visits. However, if women were active at the first visit, 2% became sedentary and 13% remained active at all five follow-up visits. These data suggest that men have a greater likelihood of maintaining their activity compared with women. Also women seem far more likely to remain sedentary compared with men. The sample consisted of primarily well-educated (80% college graduates) Caucasian individuals; further studies are needed to address whether these results are generalizable to other population groups.

Interventions designed to improve rates of successful change do appear helpful. A meta-analysis examining physical activity interventions to improve physical activity adoption found that success rates improve from 50 to 67% after some types of physical activity interventions (Dishman & Buckworth, 1996). Effect sizes did not differ according to gender, race, or age, although they were greater among healthy samples compared with patient groups. Interventions using behavior modification strategies, emphasizing lower intensity activity, and using a mediated delivery approach were found to be most effective. In summary, physical activity interventions can successfully increase rates of successful change.

**Successful Maintenance**

A criterion for successful maintenance has not been officially established. Intervention studies typically operation-
alyze maintenance as engaging in regular physical activity for at least 6 months after cessation of intervention (e.g., Dunn et al., 1999); similarly, individuals who increase their activity on their own (without participating in a formal intervention) and perform regular physical activity for at least 6 months are viewed as successful maintainers. Typically, researchers in this area focused on successful maintenance of physical activity rather than successful maintenance of physical activity change. Thus, individuals who are currently engaging in regular activity and have always engaged in physical activity are considered successful maintainers. This differs from the way in which successful maintenance is conceptualized in the area of weight control and smoking, in which the focus is on maintenance of change.

The prevalence of successful maintainers for either criterion is unknown. In national surveys such as the National Health Interview Survey (National Center for Health Statistics, [NCHS], Benson & Marano, 1994), the Behavioral Risk Factor Surveillance System (CDC, 1992), and the Third National Health and Nutrition Examination Survey (NCHS, 1994), the prevalence of regular activity was assessed but not the length of time for which those surveyed were regularly active. As a result, the prevalence of maintenance of regular physical activity was not determined. Current self-report measures of physical activity behavior often assess a brief interval of time (e.g., last 7 days or previous 2 weeks), and it is not clear how well this represents people's general activity levels over several months or years.

**Lapse–Relapse Curve**

Early exercise adherence studies, conducted mostly with high participants at risk for cardiovascular disease (CVD), suggested that a 50% dropout rate was not uncommon. Looking back on these earlier studies, we do not know the extent to which these findings reflect the designs of the trials, the types of participants, and the frequency of measurements rather than the influence of other variables such as health complications or declining motivation for exercise. The use of a dichotomous measure for adherence also limited interpretation of the data because “dropout” from a supervised program did not always correspond to cessation of exercise. Moreover, this dropout rate may reflect the fact that many of these earlier studies focused on structured exercise programs rather than a lifestyle approach to physical activity. More recent studies are more likely to report percentage of adherence to specified criteria (Dunn et al., 1999; A. C. King et al., 1995; Martin & Dubbert, 1982) to specify whether adherence includes unsupervised home-based exercise and to report findings based on intention to treat.

Although adherence has been measured in different ways and at different intervals across studies, more recent data from trials, including home-based interventions, are consistent with earlier conclusions that adherence decays over time. What has become clearer is that subgroups can be identified that have widely varying rates of adherence. For example, in the Stanford-Sunnyvale Health Improvement Project (SSHIP) study, high adherers (those randomized to home-based exercise who had low levels of stress) continued to complete 70% or more of their prescribed exercise at 2 years, whereas low adherers (those randomized to structured exercise who had a high body mass index) had a much lower level of adherence in the early phase of the study and were completing only about 20% of their prescribed exercise at 2 years (A. C. King et al., 1997). More studies of this nature will help greatly in understanding when and why people become less active over time.

Furthermore, we know very little about the impact of activity interruptions on long-term adherence. The relapse prevention model was developed in the context of attempting to understand the psychosocial determinants of addictive behaviors (Marlatt & Gordon, 1985). In this model, inadequate coping skills for difficult or “high-risk” situations contribute to the return to unhealthy behavior patterns. Instead of the “lapse” becoming an opportunity to learn better coping, all too often an “abstinence violation effect” occurs, in which guilt and perceived loss of control lead to total relapse. Consistent with the model, Simkin and Gross (1994) found that college women who listed fewer coping strategies for likely problem situations were more likely to experience a lapse from attendance at an aerobics class. However, failure to exercise during any given period of time is not a single identifiable event analogous to violating an “abstinence” rule in substance abuse recovery (Dubbert & Stetson, 1995). For example, when should failure to exercise be perceived as a lapse or relapse? Dubbert and Stetson (1995) found that community exercisers’ perceptions of whether they had “dropped out” of exercise were significantly related to both the amount of time they failed to exercise and their previous exercise experience. Those who had been exercising regularly for the longest time before their period of inactivity reported longer periods of inactivity before they perceived themselves as having dropped out. These results suggest that studies of exercise lapse and relapse in adults as well as adolescents need to assess participants’ perceptions.

Observational data suggest that, at least with vigorous exercise, interruptions in exercise are the rule rather than the exception. In a study of exercise relapse in 7,135 YMCA members, 81% had a lapse during the year (J. M. Jakicic, personal communication, June 18, 1998). A lapse was defined as not attending the YMCA for at least 7 consecutive days. The average number of lapses per member was 4.8 per year; 36 days was the average length of the lapse. These data are currently undergoing additional analysis to identify when individuals are most likely to experience a lapse. Another observational study found that 20% of regular exercisers reported experiencing a relapse (defined as no exercise for at least 3 months) three or more times, 20% reported one or two relapses, and 60% reported no relapses (Sallis et al., 1990).

**Intervention Studies to Enhance Physical Activity Maintenance**

We now examine intervention studies that included at least 6 months of follow-up data collected after cessation of
the active intervention so that maintenance of physical activity after the intervention could be assessed. Different measures of physical activity behavior were used across studies, making it difficult to make interstudy comparisons. Given the paucity of reports on maintenance and the inconsistent measurement methods across studies, our goal is to highlight some of the key studies of physical activity maintenance in youth, healthy adults, and patient populations rather than to provide a comprehensive review (reviews of physical activity intervention studies segmented by population, setting, and type of intervention can be found in the American Journal of Preventive Medicine, 1998, Volume 16). Often studies with evidence of successful maintenance did not report the specific intervention strategies used to achieve maintenance, but we attempt to identify critical intervention components when possible.

**Youth Studies**

Most youth intervention studies have been conducted in school environments, particularly in elementary schools. The most common strategy has been to modify physical education (PE) classes. The most effective school PE interventions entail an active curriculum, staff development (i.e., in-service training), and on-site follow-up (McKenzie et al., 1996; McKenzie, Sallis, Kolody, & Faucette, 1997; Stone et al., 1998). Only a few studies included substantial postintervention follow-ups with youth cohorts (Stone et al., 1998). The longest follow-ups were 12, 7, and 3 years, respectively, for the Oslo Youth Study (Klepp, Oygard, Tell, & Vellar, 1993; Tell & Vellar, 1987), the Class of 1989 Study (Kelder, Perry, & Klepp, 1993), and the Child and Adolescent Trial for Cardiovascular Health (CATCH; Luepker et al., 1996; McKenzie et al., 1996; Nader et al., 1999). All three showed declining effects over time but still reported significant increases in physical activity for intervention students versus the control students.

CATCH was the most extensive study of maintenance and was the first multicenter randomized school-based research study to use the fundamentals of clinical trials (Stone et al., 1996). CATCH tested the effectiveness of changes in PE classes, school food service, classroom curricula, family activities, and school policies related to cardiovascular health (1991–1994). Ninety-six elementary schools in four states were randomized to intervention or control conditions. The baseline cohort comprised 5,106 ethnically diverse third graders who were monitored through fifth grade during the main trial. The students were from California, Louisiana, Minnesota, and Texas, and almost half were boys (51.8%). The racial-ethnic groups represented Caucasian (69.1%), Hispanic (13.9%), African American (13.2%), and others (3.8%).

Results from systematic analysis of 2,096 PE lessons indicated students in intervention schools engaged in more moderate- to vigorous-intensity physical activity during PE lessons than those in control schools (51.9% vs. 42.3% of lesson time, p = .002). This represented a 39% increase in physical activity from baseline for intervention schools, whereas controls increased by 23%. In addition to school level measures of PE, total daily activity was assessed in fifth grade. Intervention students reported significantly more vigorous activity than controls (Luepker et al., 1996; McKenzie et al., 1996).

The CATCH Cohort Tracking Study (1995–1998) was conducted to assess the differences through eighth grade in physical activity, diet, and related health indicators of CATCH students. Students were assessed in sixth, seventh, and eighth grades. Seventy-three percent (3,714) of the initial cohort of 5,106 students participated in the follow-up tracking study (Nader et al., 1999). The 3-year follow-up, without further intervention, showed that the behavioral changes initiated in the upper elementary school years were maintained through early adolescence for self-reported physical activity and dietary behaviors (Nader et al., 1999). Percentage differences for vigorous activity between intervention and control groups were maintained even though the absolute levels of vigorous activity minutes per day declined in both groups. At the end of the CATCH trial during fifth grade, the significant difference reported for daily minutes of vigorous activity between intervention and control students was 13.6 min (23% of the control mean). This was a substantial difference equal to more than 1.5 hr (92.3 min) of vigorous activity per week. At the end of sixth grade, the difference was 21.1% (11.2 min); at the end of seventh grade, 26.5% (10.8 min); and at the end of eighth grade, 29.1% (8.8 min; Nader et al., 1999). More than 8 min per day equals 1 hr additional vigorous activity per week, even with the decline in maintenance 3 years after intervention. A decline in activity participation with age, especially during adolescence, has been previously documented (Malina, 1996; Stone et al., 1998; USDHHS, 1996) and points to the need for interventions during middle school.

**Healthy Adult Studies**

Interventions with healthy adults included different approaches, among them structured activity, home-based programs, lifestyle activity programs, intermittent exercise bouts, and environmental changes. Programs have been carried out in fitness centers, community settings, physicians' offices, and workplaces (e.g., Dishman & Buckworth, 1996). Although more than 100 intervention studies with healthy adults have been conducted, very few studies included at least 6-months of follow-up data on physical activity maintenance. Two key studies that included follow-up through 24 months are highlighted.

Choice of physical activity format and intensity appears to be a key factor in long-term exercise participation for adults. The 2-year SSHP trial was the first to examine people's preference for structured home-based moderate and vigorous activity versus structured group-based vigorous activity (A. C. King et al., 1995). Adults aged 50 to 65 years were randomized to a high-intensity structured exercise group held in a community senior center and a community college (3 days/week), a high-intensity telephone-supervised home-based physical activity program (3 days/week), a moderate-intensity telephone-supervised home-based physical activity program (5 days/week), or an assessment-only condition.
All intervention groups were given an ACSM exercise prescription for meeting a target heart rate criterion.

Intervention components in the telephone-supervised, home-based groups included physical activity assessment, information giving, physical activity instruction, physical activity feedback, goal setting, support for activity, and general support. When compared with the traditional group-based exercise program, the home-based programs focusing on either moderate- or vigorous-intensity activity had significantly greater adherence at the 1-year assessment. After 2 years of active intervention, however, the high-intensity home-based program had higher adherence rates than the lower-intensity home-based program. The authors speculated that it is more difficult for individuals to schedule exercise for 5 days as opposed to 3, indicating the need for further study of interventions for promoting moderate-intensity physical activity. Other analyses found the participants with the greatest probability of exercise maintenance at the 2-year assessment tended to be those who were less educated, assigned to supervised home-based interventions (higher or lower intensity), less stressed, and less fit at baseline (A. C. King et al., 1997).

In response to low prevalence rates of regular vigorous-intensity physical activity and the accumulated evidence from epidemiological and exercise training studies, organizations such as the American Heart Association (Fletcher et al., 1992), Centers for Disease Control and Prevention, and ACSM (Pate et al., 1995) issued public health recommendations for accumulating at least 30 min of moderate-intensity activity on most, and preferably all, days of the week. These public health recommendations resulted in the development of alternatives to structured, prescriptive exercise approaches, including multiple short bouts of moderate-intensity activity and lifestyle physical activity.

Project Active was a 2-year randomized trial that compared a lifestyle physical activity intervention with a traditional structured exercise program (Dunn et al., 1997, 1999). Both programs entailed 6 months of active treatment and 18 months of maintenance intervention. The lifestyle group members met for hourly meetings each week that gradually decreased in frequency beginning at 4 months. By learning behavioral skills, participants were encouraged to select a variety of moderate to vigorous activities and to integrate them into their daily routine. The structured group participants were given a 6-month membership to a state-of-the-art fitness center and met with an exercise trainer, working up to 5 days a week of activity. At 6 months, both groups became significantly more active (Dunn et al., 1998). Although the groups did not differ on meeting CDC/ACSM criteria and both groups significantly increased fitness, the structured group was more physically fit than the lifestyle group. At 24 months, after 18 months of minimal follow-up intervention, 20% of participants in each group were meeting or exceeding CDC/ACSM criteria, and both groups still showed significant improvement in energy expenditure and cardiorespiratory fitness from baseline (Dunn et al., 1999). This indicates that a behaviorally based lifestyle approach can provide a useful alternative in meeting individual and public health recommendations for physical activity. In addition, the 24-month assessment indicated that, although both groups declined in physical activity and cardiorespiratory fitness during the 18 months after active intervention, there was a greater decline in the lifestyle group, suggesting that this group was not able to maintain its physical activity routine as effectively as the lifestyle group. Additionally, regression analyses indicated that, for all outcomes, those who responded that they were regularly active 70% or more of the time during the 18-month follow-up phase had at least twice as much improvement compared with those who did not.

An important component of the lifestyle group was the curriculum, developed to target specifically cognitive and behavioral strategies for change based on the stages of change model (Prochaska & DiClemente, 1983) and social-cognitive theory (Bandura, 1986). Analyses indicated that change in some of these strategies (i.e., enlisting social support, rewarding yourself, reminding yourself) was predictive of meeting the CDC/ACSM criterion for physical activity at 24 months. Thus, it appears that a behavioral-based lifestyle physical activity intervention increases the use of these strategies for change, and this increase is associated with maintaining physical activity (Dunn et al., 1999).

From these two studies and other trials targeting healthy adults, intervention components associated with better maintenance of physical activity appear to be home-based programs or the option of such a program; a mediated delivery approach, that is telephone (e.g., Chen et al., 1998; A. C. King, Taylor, Haskell, & DeBusk, 1988; A. C. King et al., 1995), mail (Fries, Bloch, Harrington, Richardson, & Beck, 1993; A. C. King, Frey-Hewitt, Dreon, & Wood, 1989), and print materials (Brown & Lee, 1994; Mayer et al., 1994; Reid & Morgan, 1979); interventions delivered in community settings (Osler & Jespersen, 1993); and self-management instruction (i.e., frequent self-monitoring, goal setting; Kriska et al., 1986). Maintenance interventions such as frequent contact with participants during the maintenance phase seem to be important, although it has yet to be demonstrated what needs to happen during contacts, how often they need to occur, and at what point intervention is no longer necessary.

Cardiac Rehabilitation and Hypertension Studies

Some research on maintenance of physical activity is also available for patient populations from cardiac rehabilitation programs and hypertension prevention and treatment trials. Data from pulmonary rehabilitation programs are not discussed here because they only provide up to 6 months follow-up, which does not permit comparison with studies of CVD or healthy populations. A review of CVD secondary prevention studies located 24 studies with 12 or more months of follow-up (Simons-Morton, Calfas, & Oldenburg, 1998). In most of these studies, the intervention was initiated in a clinical setting and involved vigorous exercise three
times a week. Some studies included efforts to establish activity in community settings. In 14 studies, participants were postmyocardial infarction patients, whereas in other studies, participants had some form of coronary heart disease. Participants in most studies were men. Ethnicity and socioeconomic data were often not available. It also should be noted that the majority of these studies focused on multiple risk factors; however, the following discussion pertains to physical activity findings only.

Effective components in studies that found improved fitness or superior adherence at 12 months, compared with control treatment groups, included supervision of exercise, loaning equipment, more frequent contact with program staff, inclusion of a behavioral component, promotion of moderate-intensity activity, and specific maintenance interventions. Eighteen studies used the ACSM (1990) exercise prescription guidelines, and two used the moderate-intensity recommendation for physical activity (Pate et al., 1995). Several studies reported participation at greater than or equal to 50% at 12 months, but early dropouts were typically excluded from these analyses. Two of three studies with long-term follow-up reported that participation continued at 50% or greater at 2 years. Interpretation of long-term adherence in the cardiac rehabilitation literature is difficult, however, because investigators in early studies did not report findings based on intent to treat, and several well-designed studies reported only overall maintenance averaged across the entire follow-up period. Ornish et al. (1990) reported excellent adherence across a 1-year trial requiring a minimum of 3 hours per week of exercise in selected coronary artery disease (CAD) patients. Haskell et al. (1994) found improved fitness across 4 years of study follow-up for CAD patients in a multiple risk factor reduction program, including physical activity counseling to increase daily activity by walking, household chores, and stair climbing as well as a tailored endurance training program. These results suggest it is feasible to achieve clinically important adoption and maintenance rates in high-risk CVD patients, although adherence decays over time, especially when there are no maintenance interventions.

In a more recent study, Friedman, Williams, and Levine (1997) examined compliance and efficacy of cardiac rehabilitation and risk factor modification in the medically indigent. Thirty-six indigent patients were compared with 29 medically insured patients in a 12-week rehabilitation program of three weekly sessions. Individualized instructions were given at the end of 12 weeks, including a plan for maintenance at home (e.g., mall walking, stair climbing, neighborhood facilities). By self-report, the percentage of adhering patients was greater than 90% in both groups at the 12-month follow-up, and improvement in submaximal work capacity was maintained. Success was attributed to a small intimate program, a creative approach to overcoming transportation problems, and an individualized approach.

Increases in aerobic physical activity, especially moderate-intensity walking, have often been specifically encouraged in hypertension prevention and treatment trials. These physical activity interventions are typically linked to weight reduction interventions, and individual counseling by a nutritionist is the most common intervention modality. More recent trials also used group classes. The most detailed report of the results of physical activity interventions in hypertension trials is available from the Treatment of Mild Hypertension Study (Elmer et al., 1995). More than 900 men and women were randomized to lifestyle intervention plus placebo or one of five drug treatments. The lifestyle intervention began with 6 months of intensive treatment, including 13 individual or group sessions with nutritionists. Participants were encouraged to increase energy expenditure through unsupervised home-based activity. Specific intervention components included individual counseling every 6 to 12 weeks throughout follow-up, newsletters on physical activity and nutrition, activity outings and competitions, daily self-monitoring, unsupervised physical activity, behavior modification (e.g., stimulus control, goal setting, cognitive restructuring, identification of high-risk situations), and an invitation to spouses to attend sessions. Self-reported energy expenditure increases of 86% for men and 81% for women were maintained at 2 years. Increases of 50% over baseline were maintained at 4 years without maintenance intervention. Findings from this study suggest that people at risk because of elevated blood pressure can also be assisted to increase their physical activity and maintain a change for several years.

Multiple Risk Factors

Although many of the secondary prevention studies used interventions targeting multiple health behaviors, in recent years there has been great interest in understanding the optimal ways to intervene in nonpatient populations with multiple risk factors such as smoking, overweight, and sedentary lifestyle and how maintenance across these different domains is related.

Some of the first multiple risk studies that included comparison groups and follow-up assessment were community-wide cardiovascular risk reduction campaigns such as the Stanford Five-City Project (Young, Haskell, Taylor, & Fortmann, 1996) and the Minnesota Heart Health Program (Luepker et al., 1994). Findings from these studies revealed only modest improvements in physical activity participation, which generally declined across years of follow-up assessment (Marcus, Owen, Forsyth, Cavill, & Frideringer, 1998). However, in these studies, it is not clear how much intervention effect was placed on physical activity relative to other behaviors such as smoking cessation and weight loss. In addition, stage of motivational readiness for change was not addressed.

In a cross-sectional study, cognitive and motivational factors were assessed in 332 smokers at two workplaces (T. K. King, Marcus, Pinto, Emmons, & Abrams, 1996). Findings showed that positive attitudes about physical activity were significantly related to negative attitudes about smoking. Self-efficacy to change one behavior was significantly related to self-efficacy to change another risk behavior. Smokers who were actively working on quitting smoking were significantly more confident in their ability to exercise than smokers who were just thinking about quitting.
Smokers who were exercising regularly were significantly more confident in their ability to refrain from smoking.

The contribution of physical activity to weight loss and weight maintenance is well established (National Institutes of Health, National Heart, Lung, and Blood Institute, [NHLBI], 1998; Pronk & Wing, 1994). A recent 18-month trial examined the role of exercise prescription, specifically that of accumulated physical activity, for achieving and maintaining weight loss (Jakovljevic, Winters, Lang, & Wing, 1999). During weekly meetings, overweight women were taught behavioral strategies to assist them in making healthful changes in their eating and exercise behaviors. In addition, all women received a 1,200 to 1,500 kcal/day eating plan, were instructed how to reduce fat intake to 20% of their total calories, and were placed on a structured exercise program that varied in whether exercise was continuous or accumulated. Participants were randomized to receive an exercise prescription for home-based physical activity in long bouts, multiple daily short bouts, or short bouts with the provision of home exercise equipment. Participants were given the freedom to participate in activity at times convenient for their lifestyle.

Results from baseline to 6 months showed that a similar number of participants in each group were averaging at least 150 min of exercise per week, and no significant differences between the groups were found. However, the groups assigned to short exercise bouts or performing short exercise bouts with home equipment were averaging approximately 180 min of exercise per week, whereas the group assigned to long exercise bouts was averaging approximately 150 min per week. Despite this difference in exercise between the groups, there was no difference in weight loss. All groups showed a decrease in weight of approximately 20 pounds. From Months 7 to 12, exercise participation decreased in all groups. The long bout group averaged approximately 110 min of exercise per week, whereas the short bout and short bout with equipment groups averaged 130 to 140 min of exercise per week. Despite the decrease in the number of individuals maintaining an average of 150 min of exercise per week in each group, a subset of participants did maintain at least 190 min of exercise per week during Months 7 to 12. This group maintained their weight loss (approximately 20 pounds), whereas those who did not achieve an average of 150 min of exercise per week regained approximately 15 to 30% of the weight they had lost.

Another study investigated whether participation in vigorous exercise improved the efficacy of a cognitive—behavioral smoking cessation treatment program for initially sedentary women smokers (Marcus, Albrecht, et al., 1999). This trial compared women assigned to a regular, on-site, supervised vigorous physical activity program with a control group. All participants also participated in 12 weekly group-based cognitive—behavioral smoking cessation sessions. Participants randomized to exercise achieved significantly higher levels of continuous abstinence during treatment compared with those randomized to contact control, and these findings held through 12 months of follow-up. In addition, the women in the exercise condition who quit smoking gained approximately half as much weight as their peers in contact control.

Although the results of Marcus, Albrecht, et al. (1999) are compelling, little is known, using rigorous designs, about whether physical activity directly facilitates improvements in other health behaviors. Additionally, these two studies illustrate the importance of considering the ultimate goals for each targeted behavior. Although the goal for most physical activity interventions is to assist people in meeting the CDC/ACSM criterion of 150 min of activity per week, Jakovljevic’s study indicated that the participants who were able to maintain their weight loss long term were exercising about 190 min per week. Thus, for certain subgroups of the population, minimum public health recommendations may not be adequate for maintaining some other health outcomes. Intervention strategies need to take these factors into account when targeting multiple risk behaviors.

Conclusions and Future Directions

The physical activity intervention literature suggests cause for optimism but much to learn concerning where we go from here in meeting public health challenges across the life span. To understand and improve maintenance of activity, it will be important to conduct more studies with maintenance intervention that monitor people through at least 24 months of follow-up like the SSffiP (A. C. King et al., 1995) and Project Active trials (Dunn et al., 1997, 1999). Additionally, trials are needed that monitor participants for 5 to 10 years so that patterns of maintenance of physical activity can be established. Moreover, there is an urgent need for consistent measurement of physical activity behavior so that findings from different investigations will be more comparable.

It appears to be important to explore differences in maintenance among various age groups because there seem to be points of vulnerability for increased sedentary behavior at different developmental stages. For example, girls approaching puberty show increases in television watching (Andersen, Cresp, Bartlett, Cheskin, & Pratt, 1998) and a decline in physical activity (USDHHS, 1996). College students making the transition into the workforce seem to be at high risk for becoming sedentary as suggested by notable increases in body weight that tend to occur at this time (Williamson, Kahn, Remington, & Anda, 1990). Current studies suggest that there are different challenges for short-term versus long-term behavior change. Some behavioral strategies may be more important for the maintenance phase compared with initiation of physical activity. In this regard, it is critical that future studies provide information on the greatest barriers to the initiation of activity and short-term, and long-term maintenance of physical activity behavior. We have yet to discover the pattern of starting and stopping activity in which most people engage, although data reveal that people start and stop exercising repeatedly. Once these patterns are better understood, it is important to use this information to maximize the effectiveness of our interventions. Additionally, it is essential to investigate successful strategies for behavior change by gender, age, ethnicity, baseline activity, and risk status. “One-size-fits-all” pro-
grams are rarely as effective as programs that tailor treatment to at least some aspects of the individual or group (Marcus, Bock, et al., 1998).

**Research Recommendations**

1. Examine the predictors, mediators, and correlates of maintenance of physical activity over time periods up to 5 years and in diverse populations.
   - (a) Investigate factors associated with differential patterns of adoption and maintenance of physical activity. For example, are there critical periods when physical activity becomes part of a lifestyle? In the absence of intervention, what is the natural history of change?
   - (b) Determine factors associated with maintenance after an intervention.
   - (c) Compare individuals who maintain physical activity with those who relapse.
   - (d) Develop a registry to study individuals who are successful at long-term physical activity participation.
   - (e) Conduct follow-up assessments of participants previously involved in physical activity intervention trials to examine their long-term physical activity participation.

2. Design and evaluate interventions to promote maintenance of physical activity behavior.
   - (a) Conduct randomized, controlled trials to determine the delivery channels that are most effective and practical for improving long-term maintenance of physical activity behavior. This should include research on use of print materials, telephone intervention, Internet and electronic mail technologies, and face-to-face interventions. Issues related to the amount of intervention needed and the interaction between delivery channel and participant characteristics should be addressed.
   - (b) Test maintenance intervention delivery in various settings (e.g., physician offices, work sites, school settings) for different subgroups of individuals such as children, ethnic minorities, and the elderly, and for primary versus secondary prevention.
   - (c) Determine the intensity, frequency, duration, and types of physical activity that maximize long-term adherence.
   - (d) Examine behavioral and cognitive strategies to promote long-term exercise adherence.

3. Explore the usefulness of various theoretically based intervention models for conceptualizing and maintaining physical activity behavior change.
   - (a) What is the potential of models such as behavioral choice and social–ecological theory for designing and testing the effectiveness of maintenance interventions?
   - (b) What other theoretical models describe the process of physical activity maintenance?
   - (c) Why is increasing physical activity helpful in maintaining other types of health behavior changes?

4. Evaluate early influences on physical activity adoption and maintenance.
   - (a) Conduct studies with children to learn the critical periods for physical activity adoption and maintenance.
   - (b) Examine the influence of parents, family, and school PE and environment on the promotion of physical activity.

5. Develop methods to study patterns of physical activity and energy expenditure appropriate for adult and youth populations.
   - (a) Explore various technologies to measure the accumulation of moderate-intensity and vigorous-intensity physical activity in adults because no national data currently exist.
   - (b) Standardize definitions and methods of assessing maintenance for use in national surveys.
   - (c) Validate existing measures of physical activity and develop new validated measurement tools as technology advances.

6. Develop and evaluate the effectiveness of environmental interventions.
   - (a) Conduct quasi-experimental studies in workplaces, schools, and other defined settings or groups within communities.
   - (b) Design policy and environmental change to enhance maintenance of physically active lifestyles at the state and national levels.

**Additional Recommendations to Facilitate Progress**

The following additional recommendations should facilitate implementing the prior research recommendations: (a) Develop initiatives and funding mechanisms to study maintenance issues that would allow for longer follow-up, including additional support for existing grants; (b) establish postdoctoral training mechanisms to promote the study of physical activity maintenance; (c) find ways to study the behavioral contributions of multiple risk factors and interventions, which may require joint effort by several sponsoring agencies (e.g., NHLBI, National Institute for Diabetes and Digestive and Kidney Diseases, National Cancer Institute) to fund large multiple-risk factor studies in various settings testing different delivery channels; and (d) foster research recommendations and dissemination of findings through conferences on physical activity measures and psychometrics of instruments, scientific roundtables (e.g., ACSM) on maintenance of effects of physical activity interventions, and joint researcher and practitioner meetings.

**References**


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