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Interventions to Promote Physical Activity by Older Adults

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Physical inactivity has been established to be an independent risk factor for a range of chronic diseases and conditions that threaten the health of the nation. However, only a minority of the population is currently meeting the recommended levels of regular physical activity, which have been linked with important health and quality-of-life benefits. Older adults are at particular risk for leading sedentary lifestyles. This article provides an overview of factors associated with physical activity for older adults and also describes potentially promising interventions for promoting regular physical activity in this growing population segment. Examples of interventions undertaken at personal and interpersonal as well as broader levels of analysis (e.g., environmental) are provided. Major issues currently facing the field are discussed, including the ongoing challenge of developing assessment tools that are sensitive to the more moderate-intensity physical activities favored by older adults and the formidable task of combining clinical approaches with environmental and policy strategies aimed at combating this public health problem.

MORE than 4 decades of epidemiological, clinical, and laboratory-based research have established the role of regular physical activity as an important determinant of health and functioning as people age (1–3). However, the scientific database underlying the understanding of factors of greatest importance in promoting regular physical activity in older populations remains in its infancy (2,4). It has become increasingly clear that one of the major public health challenges facing the United States and other industrialized societies is to reverse the patterns of increasing inactivity that threaten the health and functional independence of older adults (5–8).

This article provides an overview of factors that appear to be associated with physical activity as people age (i.e., determinants) in addition to highlighting potentially promising interventions for promoting regular physical activity by older adults. In accord with the recent World Health Organization guidelines for promoting physical activity and fitness by older adults (6), as well as with recommendations made by other health organizations (9), studies targeting persons aged 50 years and older are included in this review. The article concludes with suggestions for future directions in the field.

Determinants of Physical Activity for Older Adults

An understanding of the factors associated with physical activity or inactivity for the aging adult may result in the development of effective interventions for promoting regular physical activity. Although a number of reviews of the factors associated with physical activity have been published over the past decade (10–12), few have focused specifically on older adults (4,13,14), largely because the focus of research on the physical activity determinants has been on middle- and younger-aged populations (10). When older adults are included in a study sample, evaluations of potential determinants specific to that age segment are often not provided. In addition, a number of studies have used a cross-sectional rather than a prospective design, making it impossible to gather information on potential causal relationships between factors and physical activity participation (10,11).

These constraints notwithstanding, some insights related to factors that may influence physical activity participation by older adults are beginning to emerge. Such factors can be grouped into the following categories: personal characteristics, program or regimen-based factors, and environmental factors (11).

Personal Characteristics

Personal characteristics include demographic and health variables; an individual's knowledge, attitudes, and beliefs related to physical activity; and the psychological and behavioral attributes and skills that may facilitate or impede efforts to participate in physical activity regularly (11). The current determinants literature identifies some demographic and health variables associated with physical activity participation by younger and older adult populations. These include sex (with women often found to be less active than men), younger age, smoking status (smokers less active than nonsmokers), educational attainment and income (lower levels associated with less physical activity), and overweight (more overweight associated with less physical activity) (15–22). In addition, lack of past experience with physically active pursuits may also be associated with lower levels of current physical activity (23), particularly for older women (24,25). Attitudinal, psychological, and behavioral factors that appear to be operative in older as well as in younger populations include the following motives: desire to improve physical fitness and appearance through physical activity, positive beliefs concerning the value of physical activity for improving health and fitness, fewer perceived barriers to being physically active, and exercise-related self-efficacy (e.g., one's confidence in being able to successfully

undertake regular physical activity) (15–17,20,22,23,26–33). There is some indication that initial exercise self-efficacy levels in middle- and older-aged adults can predict subsequent exercise participation rates independent of previous rates, particularly during the adoption phase (i.e., first 6 months) of participation (30). However, in at least one cross-sectional study of women aged 20 to 85 years, in which a population-based recruitment technique (i.e., random-digit telephone dialing) was used, age was negatively related to exercise self-efficacy levels for all exercises except walking (28). Similarly, younger nonexercising women had more positive attitudes toward exercise than did older nonexercising women, although the relationship between attitudes and age was not present for currently exercising women (28). Age was unrelated to self-motivation for exercise in this sample (28). Even for older adults who reported positive attitudes and beliefs toward physical activity, such attitudes alone usually were insufficient for increasing physical activity participation (34).

In addition to self-efficacy and the other personal characteristics described previously, an individual's motivational readiness to adopt an exercise regimen has been found to be associated with current physical activity levels across a number of different populations (35), including at least some older populations. For example, in a population-based study of 286 Australian women aged 50 to 64 years, women who were in the precontemplation stage of motivational readiness to exercise (i.e., reported no interest in increasing their level of exercise) were older, had lower exercise knowledge, expected fewer psychological benefits from exercise, and perceived lower levels of family support for exercise than did women who were currently exercising (36).

Some personal characteristics appear to be particularly influential determinants of physical activity for older adults. For instance, poor physical condition and health have been reported to be frequent barriers to physical activity participation in older age groups (14,19,29,37,38). Other personal characteristics that may be especially important in shaping physical activity patterns for older adults include medical concerns and fears of injury (14,16,19,20), as well as attitudinal barriers, such as perceived lack of ability and misconceptions or erroneous beliefs about exercise (e.g., that it must be strenuous or uncomfortable to be efficacious) (19,24,34,39). How much the latter factors reflect a cohort effect specific to the present group of older adults is unclear. In addition, although participation in physical activity in the recent past has been found to be a strong predictor of current and future participation by older and younger adults alike (30,40), there appears to be little relationship between youth or college sport involvement and adult physical activity levels (40).

Program or Regimen-based Factors

Program-related factors include the structure, format, complexity, intensity, convenience, and financial as well as psychological costs associated with the activity (11). The amount of current information on older adults relevant to this domain remains small. Available evidence suggests that the programs that may particularly appeal to older adults are more moderate in intensity, simple and convenient to engage in, relatively inexpensive, noncompetitive, and—particularly for older women—contain a social component (14,19,41–43). Exercise programs having inconvenient locations or schedules have been associated with decreased participation by older adults (44). In addition, at least one study suggests that older adults who sample a number of different physical activity options may be more likely to remain active than those who do not (45). However, much of the information gathered in such areas has come from training studies or samples composed primarily of currently active participants. We know relatively little about program-based preferences for more representative and diverse segments of the population.

Three population-based community surveys and one population-based work-site survey of middle- and older-aged adults suggest that a substantial proportion of older women and men, regardless of current physical activity levels, may actually prefer physical activities undertaken outside of a formal class or group setting (percentages preferring such formats ranged from 64% to 69%) (36,43,46,47). In addition, preliminary results from the recently completed U.S. Women's Determinants Study (48) indicate that the preference for exercising on one's own with some instruction rather than in a group with an exercise leader, across the over 2900 women aged 40 and older who were interviewed by telephone, was approximately 64%, regardless of ethnicity (i.e., white, African American, American Indian/Pacific Islander, and Hispanic) and current physical activity level (i.e., inactive, underactive, or active) (49). Such preferences for formats that free the older adult from the demands of having to attend a structured exercise class regularly merit continued investigation, particularly because most formal physical activity programming for older adults currently offered in the community consists of structured exercise classes or groups. Reluctance on the part of at least some older women to attend community gyms and fitness centers or use public changing facilities was reported in other studies targeting this age group (36).

At least one study of postmenopausal women and similarly aged men suggests that the psychological costs (e.g., social embarrassment and self-consciousness) of attending a structured exercise class may result in particularly poor adherence rates among the overweight (defined in this study as a body mass index [BMI] >27) (50). In this investigation, less than 8% of the overweight subgroup was still attending the exercise class 2 years later (compared with a significantly greater percentage—28%—of their normal-weight peers) (50).

Environmental Factors

Social and physical environmental factors have been associated with physical activity participation in a number of observational studies, although most have focused on adults under age 60 (11). In studies that have targeted or included older individuals, supports from family members, friends, program staff, and other exercise participants have been found to be significant correlates or predictors of physical activity (20,40,51–53). Although the type or amount of physical activity–related social support usually received differs by ethnicity, sex, and physical activity type (e.g., lei-

sure time and sport) for young adults (54), less is known about such patterns for older adults. In addition, at least one study has suggested that the source as well as the amount of social support preferred by the older individual (i.e., from family and friends vs exercise staff) may differ depending on the phase of the physical activity regimen (e.g., initial adoption or maintenance) (53). In this study, significant baseline variables predicting increased adherence to a prescribed exercise program during the initial 6-month period included an initial preference for less support from exercise staff—perhaps indicating a greater level of intrinsic motivation to adopt the exercise regimen. In contrast, greater 6-month levels of support reported from family and friends, as well as increased levels of support received from exercise staff, significantly predicted exercise adherence levels during the second 6 months of the program (53). Although similar to findings from other studies (11), smokers had generally poorer adherence rates than did nonsmokers (55); nonsmokers who were divorced had adherence rates during the initial 6-month period (49.3%) that were substantially lower than those of other nonsmokers and more similar to those of smokers (53). Being divorced may be related to lower levels of family-based support, which could have a detrimental effect on adherence.

Physical activity advice from an individual's personal physician appears to be another potentially important, though underused, source of support and motivation for middle- and older-aged adults (11,56–59). Although detailed algorithms for exercise prescription have been available in the literature since the 1970s (60,61), many physicians do not discuss exercise practices with their patients (62). Among the barriers to providing such regular advice and support are lack of time, limited reimbursement for such services, and physicians' lack of confidence in their ability to counsel patients effectively about physical activity (57,59,63,64).

Other environmental factors that have received some systematic support are the ease of access to appropriate exercise facilities (33) and the use of environmental cues, prompts, and incentives encouraging physical activity (40), although these factors have been investigated less in older populations. These environmental factors continue to be understudied relative to other determinants domains, yet likely have a substantial effect on efforts to successfully adopt and maintain regular physical activity (65,66).

Summary of Physical Activity Determinants Literature for Older Adults

Although some factors have begun to emerge as potentially important correlates of physical activity participation in older populations, a number of issues remain to be addressed. These issues include an improved understanding of the phase-specific influences of determinants with respect to the initial adoption as opposed to the longer-term maintenance of physical activity (15,53,67). For example, knowledge concerning physical activity type and amount may be particularly important in the adoption phase of a more active lifestyle (11,68). Levels of exercise-related self-efficacy have also been found to be related more strongly to the adoption as opposed to maintenance of a physical activity regimen (30,69). Similarly, we know relatively little concerning how physical activity determinants vary for different types (e.g., endurance vs strengthening exercises) or dimensions of physical activity (e.g., frequency, intensity, and duration) (15,29).

Finally, relatively little systematic work has been undertaken in the determinants field with different subgroups of older adults. Subgroups of particular interest—because of the dearth of information about them as well as their current levels of sedentary behavior—are different ethnic groups, the oldest-old adults (i.e., ≥85 years [y]), rural elderly adults, elderly adults with specific chronic conditions, and elderly adults who are depressed or socially isolated (4,34). Previous efforts to understand interaction effects among different factors defining such subgroups have been hampered, at least partly, by the use of standard multiple regression techniques. The use of such techniques is constrained by the types of assumptions that usually must be made about the data (e.g., data must be linear, additive, and normally distributed, and interaction terms must be specified by the investigator) (70). However, recent applications of signal detection methodology to predict changes in health behaviors (70,71), including physical activity (50), offer promise in addressing some of these limitations (72).

Signal detection methods can be used to define, through recursive partitioning, distinct subgroups of people who differ in how successful they are in an exercise program (50). For example, in a 2-year physical activity intervention trial of adults aged 50 to 65 years, signal detection methods identified two subgroups that were highly successful in achieving adequate 2-year exercise adherence rates (65%–69% of people in the two groups were successful), two subgroups that were modestly successful in achieving adequate 2-year exercise adherence rates (approximately 33% in both subgroups achieved adequate adherence), and one subgroup with poor success rates with respect to achieving adequate 2-year exercise adherence (only 7.7% succeeded) (50). Combinations of baseline factors that differentiated the five subgroups included the type of exercise format to which they were assigned (class-based vs home-based), BMI, perceived stress levels, and initial fitness levels based on treadmill exercise duration scores. The results emphasize the importance of taking into account how variables across different biobehavioral domains may interact in the identification of subgroups at greater or lesser risk of program failure.

Interventions to Promote Physical Activity by Older Adults

A recent review of research involving interventions to promote increases in physical activity participation by older adults (defined as ≥50 y) identified 29 studies fitting the authors' criteria for experimental rigor (randomized controlled studies or quasi-experimental designs with an appropriately matched comparison group) (4). The results of the review emphasized that although advances have been made in our understanding of how to promote physical activity by older age groups, much remains to be learned in this important public health arena.

Interventions that appear to be particularly promising for facilitating increased physical activity participation by older adults can be organized by level of impact, from individual

and interpersonal approaches through environmental and societal-level interventions (73).

Personal and Interpersonal Approaches to Physical Activity Intervention

A recent review of physical activity interventions targeting older adults (4) underscored the utility of implementing behavioral strategies based on social learning theory and its derivatives (74) in promoting physical activity increases by older adults. Effective interventions used behavioral or cognitive-behavioral strategies rather than health education, exercise prescriptions, or instruction alone (75–78). The strategies used included goal setting, self-monitoring, feedback, support, stimulus control, and relapse-prevention training (40). At least one study with patients who had chronic obstructive pulmonary disease found that the intervention that used both cognitive (positive self-talk focused on walking) and behavioral (goal-setting, contingency management, and relaxation techniques) approaches produced greater physical activity adherence, both during the 3-month adoption phase and the 3-month maintenance phase, than did interventions using either cognitive modification or behavioral modification alone (79).

The cognitive-behavioral strategies being targeted have been delivered through a range of formats, including individual face-to-face contact (80), group instruction (78), and mediated channels such as the telephone (55,81,82). Ongoing telephone supervision of the physical activity program was found to be an effective alternative or complement to on-site instruction in at least seven studies involving older adults (4). When compared directly using randomized designs, telephone instruction, usually combined with home-based physical activity programs, has been as good as or better than face-to-face instruction in promoting ongoing adherence in samples of cardiac patients and healthy older adults (55,83). At least one of these studies found telephone-supervised home-based physical activity programs to be superior to class-based programs using identical exercise prescriptions across a 2-year period (84). In addition, at least one study showed that when given an exercise prescription that included a combination of class-based and home-based formats, adults aged 65 years and older had significantly better adherence across a year to the home-based portion of their exercise prescription, regardless of the type of physical activity being prescribed (i.e., a combination of endurance and strengthening exercises or stretching and flexibility exercises) (81).

Several studies suggest that instruction in behavioral and cognitive strategies to promote physical activity can foster continued physical activity participation even when formal staff-initiated contact and instruction is terminated (78,85). Although few studies have evaluated fully mediated approaches to physical activity change by older adults, individual instruction using home videotapes (29,86) or telephone-linked computer systems (87–89) has shown encouraging short-term results.

Applications of Interpersonal Approaches to Clinical Settings

In light of the observation that physician advice to increase physical activity may help in motivating adults in general and older adults in particular to become more active (57–59), systematic efforts to train primary care physicians to deliver brief, individualized physical activity advice have begun to be developed (59). Recent efforts, such as Project Physician-based Assessment and Counseling for Exercise (PACE), demonstrated that primary care physicians can be trained to deliver a brief (approximately 5 minutes) physical activity instructional message to patients that can result in measurable increases in patient physical activity levels over the subsequent 6-week period (90). However, the study primarily included younger adults (mean age, approximately 39 y). Adults up to the age of 75 years were included in the Activity Counseling Trial, which adapted the PACE model for delivery in a shorter time (2–4 minutes) (57). The Activity Counseling Trial evaluated the effects of three different levels of health educator follow-up in conjunction with physician counseling on 2-year physical activity participation rates for primary care patients recruited from three different regions of the United States. All groups increased their physical activity levels across the 2-year period (57). In addition, the recently completed Physically Active for Life project, which evaluated physician-based physical activity advice aimed specifically at older patients, observed short-term (i.e., 6-week) improvements in motivational readiness for physical activity in intervention relative to control patients (91). However, this effect was not maintained at the 8-month follow-up, and the intervention did not achieve significant changes in measured physical activity levels (91). Because older adults carry by far the greatest proportion of chronic disease burden, disability, and health care use (9,92), continued efforts to take advantage of the clinical setting and health care provider interactions to promote physical activity in all groups of older adults remain strongly indicated.

Targeting Other Settings for Physical Activity Promotion

Work sites and places of worship have also been targeted for developing physical activity interventions for adults (73). In one work-site intervention study aimed at automotive plant employees, outreach counseling by trained staff led to greater physical activity rates across a 3-year period compared with offering on-site physical activity classes or building an on-site exercise facility (93). In other efforts, the use of work-site-based physical activity contests and challenges that combined group- and individual-based incentives with management support and similar behavioral strategies have yielded promising short-term results (94–97). The challenge remains to expand some of these approaches to retirees, who are responsible for a disproportionate amount of the health care costs incurred by industry.

Similarly, places of worship offer a potentially promising avenue for encouraging physical activity participation and other positive lifestyle behaviors, particularly for certain underserved subgroups of the older adult population (e.g., African Americans) (98,99). Other community settings frequented regularly by older adults that may offer additional avenues for physical activity intervention include pharmacies and beauty salons.

Environmental and Societal Physical Activity Interventions

As noted in the determinants section, physical activity participation depends at least in part on the availability and

proximity of attractive, safe, and low-cost environments that facilitate movement and activity. Such environments include neighborhood and community parks; safe and usable sidewalks; hiking and biking trails; swimming pools; community recreation centers; and stairways that offer a safe, convenient, and attractive alternative to the use of elevators and escalators (73,100). Although the systematic investigation of strategies for increasing the use of such environments remains in its infancy, low-cost efforts to increase stair use have shown promise. Two studies in the United States and Scotland have demonstrated the potential utility of placing a simple sign at the initial choice point for decisions about taking the stairs or an escalator in public places (e.g., train stations). In both studies, adding a sign resulted in significant increases in stair use by both men and women, which lasted for approximately 1 to 3 months beyond when the sign was removed (101,102). The effects of such point-of-choice information on the physical activity patterns of older adults merit further investigation.

Similarly, efforts are under way in several rural counties in Missouri to evaluate the addition of a new walking and biking path on the physical activity patterns of local residents, including older adults (R.C. Brownson, personal communication, 1998). Ready access to such settings, along with community policies and facilities development that encourage passive approaches to physical activity promotion (e.g., restricting downtown center to foot or bicycle traffic and making stairways more convenient and pleasant to use than elevators or escalators), will likely be necessary to reach national population targets (65). In addition, innovative uses of community settings such as shopping malls and schools as places to engage in safe and comfortable physical activities such as walking are becoming increasingly popular among seniors and other population segments (65).

Finally, although the home and local neighborhood constitute appealing physical activity venues for older adults and other subgroups (43,103), less systematic evaluation of large-scale interventions to promote regular physical activity in these locations has occurred (65,104). Possibilities for physical activity include neighborhood walking groups, which could accomplish neighborhood watch activities while providing a safe, convenient, and socially supportive method for promoting regular physical activity (65). The organization of residents living in urban public housing settings to engage in physical activity represents another possibility that has recently met with some success (104). The recent advent of assessment tools for describing environmental factors of potential significance for physical activity may provide the impetus for further investigation of environment determinants and intervention approaches (66).

In addition to the increasing investigation of physical activity-promoting environments and facilities, several mass media campaigns have been implemented to promote physical activity in communities or larger populations (73,105). The Australian national mass media campaigns to promote moderate-intensity physical activity such as walking, which took place in 1990 and 1991, have been particularly instructive (106,107). The campaigns used television advertisements, public service announcements, distribution of print materials, and other media events (e.g., incorporation of physical activity messages into episodes of popular television shows) to promote the physical activity message. Results from the 1990 campaign indicated that physical activity message recall increased from 46% before the campaign to 71% afterward (107). In addition, prevalence of walking for exercise increased significantly during the 1990 campaign for women and men in the older age groups (i.e., ages $\geq$50 y). Significant effects on walking were also noted in the least-educated group (107). No additional changes were noted for the 1991 campaign, although physical activity levels during the 1991 campaign remained above the levels observed at the beginning of the 1990 campaign (107). These results suggest that mass media efforts focused on more moderate and convenient forms of physical activity such as walking may be especially appropriate for older age groups.

Additional Issues

Assessment of Physical Activity in Older Populations

Significant advances in the fields of physical activity determinants and intervention remain predicated on the continued development of physical activity assessment instruments that are sensitive to the kinds of lighter-intensity activities engaged in and preferred by older populations (4). The development in recent years of several physical activity assessment tools targeted specifically to older adults is encouraging (80,108–110). However, evidence that such instruments are sensitive to the types of physical activity changes being targeted in physical activity intervention studies remains scarce.

Four recent physical activity intervention studies targeting different populations of seniors found the Community Healthy Activities Model Program for Seniors (CHAMPS) physical activity questionnaire for seniors, developed by Stewart and colleagues (80), to be sensitive to changes in the moderate-intensity forms of physical activity being promoted in those studies (80–82,111). Intervention length in these studies ranged from 6 months (80,111) to 1 year (81,82). In one of the latter studies (81), estimated energy expenditure measured by using the CHAMPS questionnaire was found to be sensitive to increases in physical activity levels in an endurance activity intervention program relative to a stretching and flexibility program, whereas the Physical Activity Scale for the Elderly (110) was not found to be sensitive to such increases. It is critical that a range of physical activity measures be included in future intervention studies targeting older adults so that we can continue to advance the knowledge base with respect to the most reliable and sensitive measures to use with this population.

Applications of a Clinical or Medical Versus Public Health Approach to Intervention

Many of the physical activity intervention efforts undertaken with older populations have applied a clinical or medical perspective in fashioning the physical activity program (112). In the typical medical model approach, the health professional usually engages in a waiting stance that involves having interested community members seek out services and initiate contact in determining whether the program being offered might meet their preferences and needs

(112). This approach usually results in participation by the segment of the population that is already motivated to exercise and is reasonably active. Alternatively, a public health approach usually uses a seeking stance to program development and delivery that entails actively initiating contact and collecting information across all segments of the target population. The goal of such an approach is to develop appropriate interventions tailored to the needs and preferences of different population groups that vary in motivational readiness to engage in regular physical activity (73,112).

At least six physical activity intervention studies focusing on older adults have used population-based recruitment methods to broaden the reach of the program into a more diverse portion of the older adult population being targeted (4). In one of these studies, a comparison was made of persons aged 50 to 65 years who were enrolled in the physical activity intervention through use of a random-digit-dial telephone survey (a seeking stance for participant enrollment) as opposed to more typical general media promotion (a waiting stance) (113). The two strategies attracted two different segments of the targeted age group living in the community under study. The participant group enrolled in the program via the random-digit-dial strategy had higher low-density lipoprotein cholesterol and systolic blood pressure levels and included a significantly greater percentage of smokers; the participant group enrolled via general media promotion was significantly more overweight, and the women were more likely to be separated or divorced (113). The two enrollee groups showed similar physical activity participation rates across the 1-year intervention period (113). These results underscore the potential utility of broadening enrollment strategies to reach those older adult subgroups (e.g., smokers) that usually are underrepresented in the physical activity intervention literature.

Fashioning the Optimal Physical Activity Regimen in Promoting Long-term Participation

With the recent expansion of the national physical activity recommendations to include a broader range of physical activities through which important health benefits can be achieved (114), attention has begun to be focused on understanding how physical activity type, intensity, frequency, duration, and format may influence subsequent physical activity participation. Although the number of studies aimed at understanding these issues for the adult population in general and older adults in particular are few, the available studies are instructive. For example, one investigation of 357 postmenopausal women and similar-aged men compared the 24-month participation rates for individuals randomly assigned to a higher-intensity (i.e., walk or jog) telephone-supervised home-based physical activity program with rates for individuals randomly assigned to a lower-intensity (i.e., brisk walking) program using the same home-based format (84). The two programs were matched for weekly energy expenditure; individuals assigned to the higher-intensity program were prescribed three sessions of physical activity per week lasting approximately 40 minutes per session, whereas those assigned to the lower-intensity program were prescribed five sessions of physical activity per week lasting approximately 30 minutes per session. During the first 12 months of the intervention, when individuals in both programs were receiving regular (i.e., monthly) staff-initiated telephone contact, physical activity participation rates were identical for the two programs and were high (i.e., approximately 75% of exercise sessions prescribed were completed) (55). However, during the second year of the intervention, when staff-initiated telephone contact and support were substantially reduced, individuals assigned to the higher-intensity program had significantly better exercise participation rates than did individuals assigned to the lower-intensity program (84). Anecdotal reports from participants assigned to the lower-intensity program suggested that the inconvenience of having to exercise more frequently, particularly when staff encouragement was reduced, overrode any adherence-related benefits of a lower-intensity program. However, most participants (67% of women and 87% of men) worked outside the home, which may have added to the inconvenience of a more frequent exercise regimen. It is unclear how such exercise parameters would influence the physical activity participation rates of retirees.

In addition, a recently completed study of older adults with knee osteoarthritis (15) found that individuals undertaking moderate-intensity exercise of longer duration (e.g., an average of approximately 38 minutes per session) lost the improvements in knee pain and disability accrued by individuals exercising for shorter durations. These results indicate that the potential health gains that often accompany increased exercise volume may at least in some groups of older adults be offset by changes in other factors (e.g., overuse problems) that can influence subsequent exercise adherence.

Summary and Future Directions

The current literature aimed at understanding physical activity determinants and interventions for older adults, although providing a promising beginning, contains gaps that need to be addressed systematically if our knowledge in this area is to be advanced to the point of reaping significant public health benefits. In addition to the issues already highlighted, a number of other areas deserve scientific attention, including understanding sedentary behavior, targeting subgroups of older adults, understanding the behavioral synergy between physical activity and other health behaviors, applying a developmental perspective, and facilitating environmental and policy level interventions for physical activity promotion.

Understanding Sedentary Behavior

The preponderance of the behavioral literature in the physical activity field has focused on physically active behaviors while excluding the domain of sedentary activities that usually compete for people's time and interest. Without a fuller understanding of the types of sedentary behaviors that may need to be displaced so that weekly physical activity goals can be achieved, physical activity interventions may fall short of their desired objectives. The several laboratory-based studies that have been undertaken in this area with children and young adults indicate that strategies aimed at modifying the convenience, availability, or reinforcing properties of engaging in sedentary activities can in-

fluence subsequent levels of physical activity (115–117). However, such studies of older adults have not been done, and the generalization of such strategies from the laboratory to the field remains to be explored. Of relevance to understanding the relationship between sedentary behaviors such as television viewing and physical activity levels in adults, a recent cross-sectional study of adult Pima Indians found that although television viewing and physical activity levels were negatively correlated in men and women aged 21 to 39 years, no significant relationships between these variables were found in older adults (40–59 y) (118). The authors speculated that the lack of a significant association in the latter group could stem from low reported levels of physical activity and television viewing in the older age group, but this observation merits further investigation.

Targeting Subgroups of Older Adults

As noted previously, few studies evaluating physical activity determinants or interventions for older adults have targeted specific subgroups of older adults for whom physical activity interventions may be particularly indicated (4,33). Such subgroups include older adults who are from different ethnic groups, have multiple chronic conditions, are frail, have low incomes or low levels of education, are depressed or isolated, live in rural areas, or represent the oldest-old adults (≥85 y). Although a growing number of national and regional surveys that include older adults contain African American, Hispanic, and, more recently, Native American subgroups (2,118,119), few contain adequate numbers of Asian respondents. The recently completed U.S. Women's Determinants Study failed to secure sufficient numbers of middle- and older-aged Asian women through the random-digit-dial telephone survey method used to allow for their inclusion in the study data set (48). It is critical that research efforts continue to target this growing and diverse segment of the U.S. population.

Understanding the Behavioral Synergy Between Physical Activity and Other Health Behaviors

A relatively large volume of evidence has documented the potential physiological synergy obtained when other health behaviors (e.g., dietary patterns and smoking) are changed simultaneously with physical activity (120–122). Few studies have evaluated the behavioral synergy that may occur when physical activity is targeted for intervention along with other health behaviors. At least two recent trials with young adults are compelling in this regard. The first, referred to as the Commit to Quit study (123), randomly assigned women smokers to receive a smoking cessation intervention alone or combined with a vigorous-intensity exercise intervention. The additional staff attention conferred by the exercise program was controlled for in the smoking-cessation-alone condition through the administration of extra staff contact. Women randomly assigned to the smoking-cessation-plus-exercise condition showed significantly better continuous smoking abstinence rates at the end of the 8-week treatment (19%) relative to the smoking-cessation-alone condition (10%), as well as better continuous abstinence rates at 20 weeks (16% vs 8%) and 60 weeks (12% vs 5%) postcessation. They also gained significantly less weight and had greater increases in their fitness levels (122).

Similarly, recent data from the 5107 employees participating in the Working Healthy Trial, undertaken in 26 manufacturing work sites, showed that increases in physical activity over the 2.5-year study period were associated with greater improvements in dietary patterns than was remaining sedentary (124). The reverse was not observed; that is, differential increases in physical activity were not observed in response to positive dietary changes (124). Few studies have evaluated systematically whether such behavioral synergy exists in older adults. In the Stanford-Sunnyvale Health Improvement Project data set referred to previously (73), no evidence was found showing either that changes in physical activity were associated with natural changes in dietary patterns or that physical activity changes sparked changes in participants' motivation to change other health behaviors, including diet. However, in that study, unlike the two positive studies cited above, only one health behavior (physical activity) was specifically targeted for change as part of the intervention. In light of the potentially substantial public health impact that synergy among such health behaviors would confer, systematic study of this issue among older adults is strongly indicated.

Applying a Developmental Perspective

Tendencies for becoming more or less active as one ages occur within a developmental context spanning an individual's life. Relatively little is known concerning how early and midlife experiences with physical activity shape physical activity patterns in older adulthood. At least one population-based study of 327 women aged 70 to 98 years living in Vancouver, British Columbia, found that self-efficacy for performing fitness-oriented exercise later in life was significantly associated with recollections of specific childhood physical activity competencies and movement capabilities occurring decades earlier (26). In light of the potentially powerful effects of earlier experiences on current and future physical activity behavior, an increased emphasis on understanding physical activity determinants and patterns across the life span is warranted.

A developmental or life-span perspective is also reflected in attempts to understand how commonly occurring developmental milestones or transitions can naturally affect physical activity patterns as people age (73). Potentially relevant transitions include changes in marital status (125,126), retirement (21), and becoming an informal caregiver for a sick or frail relative—an increasingly common role facing older women in particular (46,127). The few studies available that evaluate the effects of marital status on physical activity patterns suggest that the effects may be positive, negative, or neutral depending on the type of marital transition that occurred and the population under study (128). However, the specific effects of such transitions on the physical activity patterns and preferences of older adults in general and different subgroups of older adults in particular remain minimally explored.

A third avenue of research that reflects a developmental and life-span perspective focuses on intergenerational as-

pects of physical activity behavior. An intergenerational approach to the understanding of physical activity determinants and the development of potentially powerful interventions is indicated in light of the effects that members of one age group can exert on those from another age group (129). Although a substantial proportion of this literature has usually looked at intergenerational issues within the context of the parent-child relationship (130), the potential opportunities for children and grandchildren to influence the physical activity levels of older adults deserve increased attention. By identifying situations in which intergenerational contact naturally occurs, interventions may be developed that can take advantage of these potentially powerful relationships.

The investigation of the types of developmental and life-span approaches discussed previously could be enhanced greatly through increased interaction among scientists working at different points of the life-span continuum. Scientists in the field traditionally have focused on one portion of this continuum (e.g., youth, middle age, or old age), with a potential loss of intergenerational synergy and continuity the likely result.

Facilitating Environmental- and Policy-Level Interventions for Physical Activity Promotion

The consistent evidence indicating that physical activity levels tend to decrease with age, coupled with the aging of populations in the United States and elsewhere, underscores the importance of developing the types of large-scale environmental- and policy-level interventions, which can have a widespread effect on the population as a whole (65). As discussed, social environment–based interventions targeting health care providers as well as mass media–based approaches to physical activity promotion may be particularly influential for older adults. However, the systematic testing of such interventions remains in its infancy. Increasing our understanding of the role of environmental and policy factors in enabling and maintaining adequate physical activity levels in older adults as well as other segments of the population may arguably represent the most important challenge currently facing the field.

Acknowledgments

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