This study identified factors associated with exercise participation and adherence in a sample of 102 sedentary, functionally limited, community-dwelling adults aged 60 to 94 years who participated in a home-based resistance training program. Stepwise regression analyses revealed that baseline physical factors (i.e., higher levels of mobility, weaker muscle strength, and fewer numbers of new medical conditions) were associated with higher rates of participation in the home program. Positive attitudes and a sense of control toward exercise, lower levels of confusion and depressive moods, and the development of fewer new medical problems during the program were related to higher levels of adherence to the program. Findings revealed that although physical health variables were the primary indicators of an older person's overall participation in the program, it was the psychological factors that were most important to adherence to this home-based program.

Key Words: Community-dwelling older adults, Exercise programs, Adherence

Home-Based Resistance Training: Predictors of Participation and Adherence

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The physiologic benefits of physical activity by older adults are well-documented in the scientific literature (Blair et al., 1996; King, Oman, Brassington, Bliwise, & Haskell, 1997; Kushi et al., 1997; Rooks, Kiel, Parsons, & Hayes, 1997; U.S. Dept. of Health and Human Services [DHHS], 1996). The growing evidence of functional benefits of exercise in later life is especially important to prospects for good health and well-being among older adults (Ettinger et al., 1997; Fiatarone et al., 1994; Jette et al., 1996; Stewart, King, & Haskell, 1993). Yet, research reveals that 70% or more of older adults have no regular exercise routine (Clark, 1995; Kovar, Fitti, & Chyba, 1992). Finding strategies for increasing exercise levels in older persons remains an important societal goal.

Poor adherence to exercise programs has been identified as a major barrier to increasing physical activity levels among older adults, particularly among those who need it the most—sedentary adults and those who have some level of functional limitation. Dishman, in summarizing his review of the adherence literature, stated that among adults who start exercise programs, the dropout rate is 50% or greater within the first 6 to 12 months (Dishman, 1988). This dropout from exercise occurs despite the well-known fact that exercise-induced health benefits are maintained only by sustained adherence. This lack of long-term participation further contributes to the low prevalence of habitual physical activity seen among older adults in the United States (Public Health Service, 1990; DHHS, 1996).

Although group exercise training is still the predominant form of exercise in the United States, many Americans choose to exercise on their own, outside a formal class setting (Dishman, Sallis, & Orenstein, 1985; Jette et al., 1996; King, Haskell, Taylor, Kraemer, & DeBusk, 1991). Home exercise programs allow an individual to exercise privately, at his or her convenience, in the comfort of familiar surroundings and without having to travel, thus reducing some of the barriers to maintaining a more physically active lifestyle. This is particularly relevant for older and disabled adults for whom limited class times, facility accessibility, and transportation are key obstacles to exercise participation (Dishman & Sallis, 1994; King et al., 1994; Robison & Rogers, 1994).

Home exercise programs that are monitored by professionals have proven effective in maintaining participation rates greater than 70% in middle-aged adults over 6-month (Juneau et al., 1987) and 12-month periods (King et al., 1991; King et al., 1994). Few home-based exercise studies, however, have included subjects over the age of 65; of those that have, rarely are adherence rates reported beyond simple counts of ongoing participation in the study (Jette et al., 1996; McMurdo & Johnstone, 1995). There-
fore, relatively little is known about older adults’ adherence to specific home exercise protocols or the factors related to adherence.

Many factors have been identified that affect decisions regarding the adoption and maintenance of exercise behaviors in adults. The existing literature can be organized into three categories: psychological state, physical characteristics, and sociodemographic background of the individual (Dishman et al., 1985; Dishman & Sallis, 1994; King et al., 1994). It is important to note, however, that most of the existing literature comes from studies that focus on aerobic forms of exercise, exercise among young or middle-aged populations, specific patient populations, or from studies that examined spontaneous (i.e., recreational) forms of activity (Dishman & Sallis, 1994; Dishman et al., 1985; King et al., 1994), and thus may be limited in their applicability to the older population or to home-based exercise programs.

The role of psychological factors in exercise adherence has been investigated thoroughly. A person’s self-efficacy (i.e., a judgment about one’s capability to accomplish a certain level of performance; Bandura, 1997) has shown considerable promise in explaining exercise program participation among adults (Clark, 1996; Sallis et al., 1986; Sallis, Hovell, Hofstetter, & Barrington, 1992). However, self-efficacy has been less predictive of participation in recreational forms of exercise (Dishman et al., 1985; King et al., 1991; Sallis et al., 1986). Efficacy has been found to be related more strongly to initiating an exercise regimen than to sustaining one (Bandura, 1997). An individual’s attitudes toward exercise (Ebrahim & Rowland, 1996; Fitzgerald, Singleton, Neale, Prasad, & Hess, 1994; King et al., 1994; Robertson & Keller, 1992) and his or her level of perceived control over exercise-related outcomes has also been associated with level of physical activity in some studies (Lynch et al., 1992; Menec & Chipperfield, 1997; Wolinsky, Stump, & Clark, 1995), but not in others (Williams & Lord, 1995). The evidence regarding the presence of depressive and anxious moods is also mixed; these moods have been associated with poor adherence in cardiac patients (Giese & Schomer, 1986; Oldridge & Streiner, 1990) but with higher levels of adherence in adults with hypercholesterolemia (Lynch et al., 1992).

There is less research that has examined the association of physical characteristics with adherence in nonclinical samples of adults. As one might expect, reviews of the literature confirm that healthy adults are more physically active than those in poor health (Dishman et al., 1985; King et al., 1994) or those who perceive themselves to be in poor health (Dishman et al., 1985; Ebrahim & Rowland, 1996; Menec & Chipperfield, 1997; Sallis et al., 1986; Wolinsky et al., 1995). Little is known about the effect of specific medical conditions on participation rates in leisure-time exercise. In clinical samples, participants with symptoms are more likely to adhere to an exercise regimen than those with identified risk factors but no symptoms (Oldridge, 1982). The presence of functional limitations or poor physical functioning has been shown to predict lower levels of adherence among older adults (Wolinsky et al., 1995), while muscle weakness, slow reaction time, and psychoactive drug use have been related to lower levels of adherence among older women (Williams & Lord, 1995).

Physical activity levels have been widely reported to decline with age in both national and community studies of adults (DHHS, 1996), yet increased age does not appear to have an effect on maintaining participation in specific exercise programs (Dishman & Sallis, 1994; Dishman et al., 1985). Among older adults, activity levels do not vary widely between men and women, especially for activities of light to moderate intensity (King et al., 1991). One consistent finding across age groups is the positive association of higher education level with physical activity involvement (Dishman & Sallis, 1994; King et al., 1994).

The present study sought to address several identified limitations in the existing exercise literature. First, we sought to identify rates of participation and adherence to a home-based exercise training program that employed cognitive training and behavioral incentives along with traditional exercise instruction. Second, we sought to identify predictors of participation in and adherence to this home exercise program. We hypothesized that a profile of factors similar to those identified in the literature would be associated with overall participation and specific adherence to the program in this community-dwelling, older sample with functional disability. We hypothesized that, in general, physical characteristics that reflected good health and physiologic capability of the individual as well as positive psychological factors would be associated with higher levels of participation and adherence rates for this home-based program.

Methods

Subjects

The subjects (N = 102) for these analyses participated in an exercise study conducted by the Edward R. Roybal Center for Research in Applied Gerontology at Boston University. Subjects were recruited through mailings, referrals from community agencies and professionals, senior center and senior housing sites, and self-referrals. To qualify, subjects had to be 60 years of age or older and limited in at least one of nine functional activities listed in the SF-36 physical function scale (Ware & Sherbourne, 1992). Volunteers were excluded if they reported medical histories that contained current treatment for cancer, kidney disease requiring dialysis, a recent fracture, uncontrolled diabetes or seizures, regular use of a wheelchair, current rehabilitation care, current fainting or dizzy spells, sudden loss of coordination, or legal blindness, or their physicians identified contraindications for exercise. Each volunteer who met inclusion criteria received a home visit during which written informed consent, a final screening, and baseline assessment were obtained. All subjects received either an inexpensive videotape player or a comparable monetary amount for participating in the
Exercise Program

The Strong for Life program consisted of a 35-minute, videotaped program of 10 exercise routines performed using elastic bands of varying thickness, which provided individualized resistance to each movement (Jette et al., 1996). The exercise routines incorporated diagonal and rotational motions associated with functional activities, including:

- Hip extension in sitting; hip extension with abduction and internal rotation in sitting;
- Ankle plantarflexion in sitting;
- Bilateral shoulder extension and external rotation coupled with elbow flexion and supination in sitting;
- Bilateral ankle plantarflexion in standing with progression to unilateral standing;
- Hip extension, abduction, and internal rotation coupled with knee extension and ankle plantarflexion in standing;
- Hip extension, abduction, and internal rotation coupled with knee extension and ankle plantarflexion, and shoulder flexion, abduction, external rotation coupled with elbow extension and forearm supination and wrist extension in the contralateral upper extremity;
- Bilateral shoulder flexion, abduction, and external rotation coupled with wrist extension and forearm supination in sitting;
- Sit to half-standing transition and eccentric half-stand to sit transition; and
- Elbow extension coupled with shoulder flexion, abduction, and external rotation in sitting.

The program contained 5 minutes of warm-up, 25 minutes of strengthening, and 5 minutes of cool-down exercises done to music and performed by a trained exercise leader.

Subjects were instructed to increase resistance when they could perform 10 repetitions of a movement pattern without significant fatigue or loss of proper execution. Perceived exertion was assessed with the Borg Scale of Perceived Exertion that ranges from 6 (very, very light exertion) to 20 (very, very heavy exertion; Gambarelli, 1972). The goal for level of exercise exertion was a Borg score of 15. The overall adherence goal was to complete the program three times per week over the 26 weeks of the study while using an agreed upon level of resistance for most exercises. The subject was rated as having completed the session if he or she completed that session’s goal for more than half of the exercise routines.

Participants were taught the home exercise program during two home visits conducted by a physical therapist. On the first visit, the exercise techniques were taught and practiced as necessary. The subjects were given guidelines for how to progress resistance of the program and how to complete the bimonthly exercise calendars. Exercise calendars contained information on the frequency, band color used, and rating of perceived exertion for all exercise sessions during a 2-week period.

As part of the initial visit, the therapist used cognitive strategies to enhance each subject’s positive attitudes and beliefs related to exercise (Lachman et al., 1997). This aspect of the training was delivered through the viewing of a motivational videotape, a discussion of potential obstacles to long-term exercise participation, and a review of the benefits of exercise. During the second visit, 2 or 3 weeks after the first, the therapist reviewed the materials covered during the first session, reviewed exercises the participant had difficulty with, explained the criteria for progression of exercise resistance, and provided instruction on proper use of the exercise calendars.

Simple behavioral incentives (Lachman et al., 1997) were implemented to promote subject adherence to the intervention protocol. Subjects received a crisp, new dollar bill for returning each calendar; a sticker was sent if the subject achieved the exercise goal during a calendar period; and a colored magnet was sent when a subject progressed to the next level of resistance. Subject monitoring was accomplished by periodic telephone contact by the therapist. Participants were called bimonthly during the first 3 months and monthly for the final 3 months of the program. Additional calls were made if the subject was encountering difficulty. Participants were also instructed to identify obstacles detrimental to exercise program adherence and strategies to overcome the obstacles. They were encouraged to call the monitoring therapist if they needed assistance in resolving the obstacle.

Subjects who participated in the program achieved statistically significant strength, balance, functional ability, and disability benefits compared with controls. Physical disability differences ranging from 15–18% across study groups were observed while muscle strength and balance group differences of 6–20% were detected (Jette, Lachman, et al., in press).

Outcome Measures

Exercise Performance.—Several dimensions of adherence have been shown to be important in assessing subjects’ performance of an exercise program (Robison & Rogers, 1994). The most common dimension seen in the literature is the overall participation rate in an exercise program (Daltroy, Robb-Nicholson, Iversen, Wright, & Liang, 1995; Ettinger et al., 1997; King et al., 1991; Lee et al., 1996; Rooks et al., 1997; Williams & Lord, 1995). A second dimension of adherence incorporates some measure of the intensity of the exercises performed because a direct relationship exists between exercise intensity and physiological benefit. To achieve exercise-induced physical change, the exercise must be of a prescribed level of intensity and continually increased; this level is commonly reported as the percentage of time exercise was performed in the “training range” (Juneau et al., 1987; Lee et al., 1996) or as a percentage of maximal activity.
effort (Fiatarone et al., 1994). In most group exercise studies, the intensity of the program is controlled and therefore determined and monitored by the exercise instructor (Lee et al., 1996). In home exercise programs, the intensity of exercise is more under the control of the subject; thus adherence studies of home exercise need to consider intensity of the exercises performed as well as overall participation rates.

For this study, self-reported exercise performance data were recorded on calendars, a typical methodology used in exercise studies (Ettinger et al., 1997; Jette et al., 1996; King et al., 1997). Participants were instructed to record the date, color of elastic band used, and the level of perceived exertion for each exercise session. Each calendar covered a 2-week period and was returned to the therapist in the self-addressed, stamped envelope provided. Two outcomes were developed from calendar information:

- **Exercise participation rate** was calculated as the total number of exercise sessions performed divided by the total number of exercise sessions possible (3 times/week × 26 weeks = 78 sessions).

- **Exercise adherence** was defined as the number of calendar periods that the subject exercised at least half the number of desired sessions (a minimum of 3 of 6 sessions over the 2-week period) with the agreed upon level of resistance (color band) divided by the total number of calendar periods (14). Fourteen calendar periods were needed to cover participation over the 26-week intervention period due to the variation in the day of the week when each subject started the program.

**Predictor Variables**

All self-report, physical, and psychological measures were administered at baseline over the telephone by a trained interviewer. Muscle strength and physical functioning were assessed during a baseline home visit. Each subject reported new medical events on the exercise calendars.

**Sociodemographic Factors**

During the baseline telephone interview, subjects reported their date of birth, gender, and level of formal education, which were used as the sociodemographic factors in these analyses.

**Psychological Factors**

**Mood State.**—The Profile of Mood States Short Form (POMS S-F) was used to assess six different mood states (McNair, Lorr, & Droppleman, 1981). The POMS S-F contains 30 items rated on a 5-point scale, from “not at all” (1) to “extremely” (5). Mean scores were computed across items, with higher scores indicating greater endorsement of the designated mood. Coefficient alpha internal consistency reliability for the sample on each of the six mood subscales was: Tension-Anxiety (.83); Depression-Dejection (.84); Vigor (.86); Fatigue (.84); Anger (.86); and Confusion (.62).

**Exercise Attitudes.**—Four items were used to assess whether exercise was seen as desirable and beneficial for health. The scale was derived from work on attitudes toward mental exercise in the memory domain (Lachman, Bandura, Weaver, & Elliott, 1995). Responses were rated on a 5-point scale, from “strongly agree” (1) to “strongly disagree” (5). After conducting item analyses, one item was dropped because of the low item to total correlation (.09) with the resulting three-item scale achieving a coefficient alpha of .57. The items used were: “Doing an exercise routine is satisfying and rewarding to me”; “Doing an exercise routine is good for me”; and “Exercising regularly can be helpful to my health.” The mean score was computed across the three items. A higher score indicated a more positive attitude about the value of exercise.

**Exercise Control Beliefs.**—A 6-item scale was developed to assess beliefs about control over exercise behavior. These items were based on similar items used to assess control over memory change (Lachman et al., 1995). Items were rated on a 5-point scale, from “strongly agree” (1) to “strongly disagree” (5). The mean score across items was computed with a higher score indicating greater perceived control. The coefficient alpha for the 6-item scale was .59.

**Exercise Self-Efficacy.**—We modified Bandura's exercise self-efficacy scale (Bandura, 1997) for use with older adults (coefficient alpha = .88). The scale included nine items, which assessed how sure subjects were that they would do exercise under different conditions or constraints, including when they were tired. Based on pilot testing with older adults over the telephone, the response format was modified to a 4-point scale, ranging from “very sure” (1) to “not at all sure” (4). The mean score across the nine items was computed. A higher score indicated greater exercise-related self-efficacy.

**Physical Factors**

**Functional Mobility.**—A timed “Up and Go” test was used to assess functional mobility (Podsiadlo & Richardson, 1991). The subject, seated in a straight-back chair, was asked to stand up (with or without using his or her arms), walk at a normal pace for 10 feet, turn 180°, walk back to the chair, and sit down. Assistive devices were used if needed. Three trials were performed (one practice and two recorded) with the mean time to complete the task recorded as the test result.

**Muscle Strength.**—A calibrated, handheld dynamometer (Nicholas Dynamometer, Lafayette Instruments, Lafayette, IN) was used to assess isometric strength of the shoulder, elbow, hip, and knee. The right extremity was used for all measurements unless pain, a previous surgery, or an injury prohibited its use. Subjects were instructed to provide maximal effort for
were entered simultaneously, and the procedure was performed per subject for each motion. The final two trials were averaged and recorded as the test result (in kg). Testing was performed with the subject in the seated position with the testing-side shoulder at 0°, the hip flexed to 90°, and the knee flexed to 60°. All scores were normalized to an individual's height and weight (Buchner & deLateur, 1991). Details on these protocols are provided elsewhere (Jette, Assmann, et al., in press).

Medical History.—A health history was completed by telephone, repeated during a baseline home visit, and supplemented by a brief medical history form completed by each subject’s physician. The home medical history interview included a review of the subject’s telephone medical history, inspection of current medications, and a standardized review of specific medical conditions. All of the initial home visits were performed by the same physical therapist (the fifth author). Medical history information was coded using the ICD-9 coding system and was grouped by physiological system for analysis. Coding decisions were made jointly by two physical therapists to ensure consistency in coding format. Any history of a systemic disease process (i.e., cancer, coronary artery disease) was coded even if it was a long-standing diagnosis and the subject currently had no symptoms. Episodic musculoskeletal problems (i.e., old fractures, torn cartilage) were only included in the medical history if they presented an active problem for the subject. In addition, medications were reviewed and comorbidities coded if evident by medication use. All diseases were categorized into one of 12 physiological systems. Two variables were created from the medical history data: (a) the number of comorbidities present and (b) the number of physiological systems affected by disease.

New Medical Events.—Within each calendar period, subjects recorded whether there were any medical problems that prohibited them from exercising. These events were documented by the monitoring physical therapist, and a dichotomous variable was created for each calendar period, which was summed over the whole study period. The number of medical events ranged from 0–14.

Statistical Analysis

We examined the association of three sets of predictors—sociodemographic, psychological, and physical variables—with participation rate and adherence level, using stepwise regression. All predictor variables were assessed on a continuous scale, except gender, for which a dummy variable was created. Because both participation rate and level of adherence were approximately normally distributed, no scale transformations were required. Three sets of predictors were entered simultaneously, and the procedure was implemented using forward addition and backward elimination procedures to build the best predictor model. For potential outlier detection, an overall residual plot was examined and found to be distributed normally with a mean of 0 and a variance of 2. To test the homogenous variance assumption, each predictor was plotted against the residuals and an overall impression of a horizontal band of residuals was considered acceptable. Finally, a plot of predicted value of each outcome variable against the residuals was obtained, and no special pattern of model specification error was identified.

Results

Subjects

In this study, 102 subjects were randomized to participate in the home program; of these, 97 (95%) completed the 26-week study. Two subjects dropped out of the study because of muscle soreness after exercising; 1 dropped out because the program was too easy; 1 refused to continue but did not provide a reason; and 1 subject dropped out because of a medical problem unrelated to the program. Subjects who withdrew from the study did not differ significantly on background characteristics from those who continued. Baseline characteristics of the sample are provided in Table 1. The sample was predominantly female.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean or %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sociodemographic background</td>
<td>(N = 102)</td>
</tr>
<tr>
<td>Age (mean ± SD)</td>
<td>75.3 ± 7.4</td>
</tr>
<tr>
<td>Women (%)</td>
<td>73</td>
</tr>
<tr>
<td>BMI (mean kg/m²)</td>
<td>25.8</td>
</tr>
<tr>
<td>Some college or above (%)</td>
<td>61.0</td>
</tr>
<tr>
<td>Married (%)</td>
<td>39.0</td>
</tr>
<tr>
<td>Annual income (%)</td>
<td></td>
</tr>
<tr>
<td>≤$12,000</td>
<td>39.0</td>
</tr>
<tr>
<td>$12,001-$24,000</td>
<td>25.0</td>
</tr>
<tr>
<td>&gt;$24,000</td>
<td>24.0</td>
</tr>
<tr>
<td>Refused to answer</td>
<td>12.0</td>
</tr>
<tr>
<td>White (%)</td>
<td>95.0</td>
</tr>
<tr>
<td>Strength (kg, mean ± SD)</td>
<td></td>
</tr>
<tr>
<td>Shoulder abduction</td>
<td>9.6 ± 3.7</td>
</tr>
<tr>
<td>Shoulder flexion</td>
<td>9.6 ± 4.2</td>
</tr>
<tr>
<td>Elbow extension</td>
<td>8.7 ± 2.9</td>
</tr>
<tr>
<td>Knee extension</td>
<td>13.8 ± 5.0</td>
</tr>
<tr>
<td>Hip abduction</td>
<td>8.4 ± 2.5</td>
</tr>
<tr>
<td>Hip extension</td>
<td>10.8 ± 4.1</td>
</tr>
<tr>
<td>Balance and mobility (mean ± SD)</td>
<td></td>
</tr>
<tr>
<td>“Up and Go” test (sec)</td>
<td>13.4 ± 6.1</td>
</tr>
<tr>
<td>Tandem gait (sec)</td>
<td>3.5 ± 3.4</td>
</tr>
<tr>
<td>Psychologic factors (mean ± SD)</td>
<td></td>
</tr>
<tr>
<td>Exercise attitude</td>
<td>4.8 ± 0.30</td>
</tr>
<tr>
<td>Exercise control</td>
<td>4.6 ± 0.45</td>
</tr>
<tr>
<td>Exercise efficacy</td>
<td>3.2 ± 0.59</td>
</tr>
<tr>
<td>Anxiety</td>
<td>1.3 ± 0.62</td>
</tr>
<tr>
<td>Confusion</td>
<td>1.6 ± 0.42</td>
</tr>
<tr>
<td>Depression/dejection</td>
<td>1.4 ± 0.65</td>
</tr>
<tr>
<td>Fatigue</td>
<td>1.8 ± 0.68</td>
</tr>
<tr>
<td>Tension/anxiety</td>
<td>1.4 ± 0.65</td>
</tr>
<tr>
<td>Vigor</td>
<td>2.9 ± 0.80</td>
</tr>
<tr>
<td>Clinical variables (mean ± SD)</td>
<td></td>
</tr>
<tr>
<td>No. of diseases</td>
<td>2.7 ± 1.5</td>
</tr>
<tr>
<td>No. of body systems with disease</td>
<td>2.0 ± 1.0</td>
</tr>
</tbody>
</table>

Note: BMI, body mass index.
female (73%) and White (95%), had a mean age of 75 years and was well-educated. The sample represented a range of functional limitation: 56% reported some limitation in 3 or more functional areas, 25% in 2 areas, and 19% in 1 area. The sample had a mean SF-36 physical function score of 64.4 (where 0 = maximum disability and 100 = no disability).

**Participation and Adherence Rates**

On average, the 97 subjects who provided calendar data achieved a participation rate of 93% over the 26-week study period. Fifty-eight percent of the subjects had participation rates of 100% or greater, and 76% of the sample exercised 90% or more of the time (Figure 1). The adherence rate for this sample was also high with 78% of the subjects adhering to the recommended frequency and intensity level of the exercise program for 11 of the 14 calendar periods (Figure 2).

**Predictors of Participation Rate**

In multivariate analyses, a significant inverse relationship was identified for functional mobility, knee extension strength, and the development of a medical condition with exercise participation rate (see Table 2). In this sample of functionally limited older adults, those with higher functional mobility, weaker knee strength, and fewer new medical problems during the intervention had higher participation rates. None of the demographic factors (age, gender, education level), medical conditions at baseline, or psychological factors were significant predictors of participation rate.

**Predictors of Adherence**

In contrast to the results for exercise participation, exercise adherence was associated with several psychological variables, including attitudes toward exercise, exercise sense of control, confusion, and depressed mood (Table 3). Subjects with positive attitudes toward exercise as well as a strong sense of control over exercise, lower levels of confusion, and a higher degree of depressed mood were the most adherent to the home exercise program. Within the medical factors, the number of new medical events that developed during the intervention period ($p < .05$) was a significant predictor and the number of body systems with disease showed a marginally significant inverse association with adherence levels ($p = .07$). The demographic variables, perceived self-efficacy, and the other physical variables (i.e., functional mobility, muscle strength, and number of comorbidities) were not significant predictors of adherence.

**Discussion**

This study extends several important aspects of previous knowledge about predictors of home-based exercise by older adults. Contrary to our expectations, this study revealed that predictors of the frequency of exercise participation were not the same as those that predicted high levels of adherence (defined as a combination of frequency and intensity of the exercises performed). Our findings are consistent with Dishman's (1985) claim that a psychobiologic approach is superior to simply relying on the association of either psychological or biological variables with exercise behavior. In this self-selected sample of functionally dis-
abled, older adults, those subjects with higher functional mobility, weaker knee strength, and fewer new medical problems during the intervention participated more frequently in the home-based strength training program. None of the demographic factors (age, gender, education level), comorbidities, or psychological factors were significant predictors of participation. In contrast, subjects’ positive attitudes toward exercise and strong sense of control over exercise, lower levels of perceived confusion, and depressed moods were associated with higher adherence to their individual home exercise programs. This finding suggests that for home exercise programs designed for older persons, knowledge of physical health factors might be important in predicting frequency of exercise participation, but knowledge of participants’ psychological profiles would be important to identify people who would adhere to a specific home program or need particular assistance to improve adherence. This finding is important to the design of future home-based exercise interventions.

Although not associated with participation, positive attitudes toward and a sense of control over exercise were associated with adherence to the exercise regimen. Subjects who saw exercise as more desirable and beneficial for their health and felt they had greater control over their exercise behavior were more likely to meet their exercise goals. These findings support the claim that beliefs related to exercise are important motivational factors involved in maintaining an exercise program (Bandura, 1997). Those who believe that exercise is valuable and something that can be managed are more likely to invest the effort to accomplish established goals. However, in contrast to other work (Clark, 1996; Marcus, Rakowski, & Rossi, 1992; McAuley, 1993), we found no evidence that an older person’s self-efficacy toward exercise was related to either the frequency of participation in the

Table 2. Predictors of Participation Rates in the Strong for Life Program

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Beta Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical function</td>
<td>-0.25**</td>
</tr>
<tr>
<td>Knee strength</td>
<td>-0.18*</td>
</tr>
<tr>
<td>No. of new medical problems</td>
<td>-0.26***</td>
</tr>
</tbody>
</table>

Note: $R^2 = 0.15$.  
*p < .1; **p ≤ .05; ***p ≤ .01.

Table 3. Predictors of Exercise Adherence in the Strong for Life Program

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Beta Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude toward exercise</td>
<td>0.24**</td>
</tr>
<tr>
<td>Sense of control regarding exercise</td>
<td>0.24***</td>
</tr>
<tr>
<td>Confusion</td>
<td>-0.28***</td>
</tr>
<tr>
<td>Depression/dejection</td>
<td>0.27***</td>
</tr>
<tr>
<td>No. of disease categories</td>
<td>-0.17*</td>
</tr>
<tr>
<td>No. of new medical problems</td>
<td>-0.24*</td>
</tr>
</tbody>
</table>

Note: $R^2 = 0.22$.  
*p < .1; **p ≤ .05; ***p ≤ .01.
program or specific adherence to the program. Bandura (1997) has suggested that self-efficacy may be related to whether one begins an exercise program, but other factors (e.g., beliefs about control over one’s exercise behavior) may contribute more to whether one adheres to the program. Knowing that one has the ability to engage in exercise under varying conditions is not necessarily enough to sustain one’s participation and progress. One must also believe that the hard work associated with exercise will be beneficial and that one has some degree of control over the physical changes associated with age. Another potential explanation for the lack of association between self-efficacy and adherence is that efficacy may increase over time with success with an exercise program. Post-test levels of efficacy or changes in self-efficacy, therefore, may be a better predictor of adherence.

Our findings support the notion that interventions aimed at improving physiologic health and function through exercise should include a focus on psychological variables such as beliefs about control over one’s exercise behavior (Lachman et al., 1997) in order to maximize adherence, particularly when the exerciser has been involved in setting the goals, as was the case in the present study. Linking psychological factors to exercise adherence could also lead to creating profiles of older individuals who are unlikely to achieve the levels of program adherence necessary to produce health benefits; these profiles could, in turn, lead to the development of strategies and protocols to facilitate long-term adherence of older adults in exercise programs (Public Health Service, 1990). Furthermore, knowledge of psychologic factors could be helpful to investigators estimating attrition rates in prospective studies and could enable better sample size calculations when designing home exercise studies.

Results from this study revealed that those participants who had some mental confusion (as assessed by the POMS) were less likely to follow the exercise plan. This is likely because they were not certain what was expected of them. This finding suggests that home exercise programs may not be the ideal approach for older persons with some mental confusion. In future programs involving older persons with some confusion, it may be critical to develop strategies to assist participation. Alternatively, group exercise programs that provide closer professional supervision may be more appropriate for confused older persons.

The finding that a depressed mood was positively associated with adherence to Strong for Life was in opposition to the results of several studies (Dishman et al., 1985; Ward & Morgan, 1984), but was similar to a finding reported by Lynch and colleagues (1992) in an exercise intervention for adults with hypercholesterolemia. Several potential explanations might be considered for this result. For example, those subjects who were unhappy might have been more willing to exercise to please the monitoring therapist. Alternatively, those subjects with a depressed mood might have been more likely to set realistic goals for themselves, thereby leading to greater success in meeting goals (Abramson, Seligman, & Teasdale, 1978). Different methods of assessing depression across studies could also explain the findings. Or more depressed participants may have adhered more closely to the exercise program because they associated performance of the program with an improvement in their mood. This is an important topic for future investigation.

In contrast to Williams and Lord’s (1995) finding that stronger women achieved higher levels of participation in a group exercise program, we found that subjects who were weaker were more likely to participate in this home exercise program. This finding may reflect an advantage of an exercise program done in one’s home, eliminating the need to travel. A home approach also allows subjects to initiate the exercises at the appropriate level of intensity, thereby eliminating possible frustration from attempting exercises that are too difficult for a weak person to perform. As the person’s strength increases, a home program such as Strong for Life allows for gradual progression of resistance at an individualized pace. This not only minimizes boredom but continually provides a sufficient training stimulus for strength increases. This interpretation, however, is not consistent with our finding that degree of mobility limitation was inversely related to frequency of exercise. However, this association may possibly reflect disabled subjects’ increased difficulty in executing their exercise maneuvers or their need to follow a modified protocol because of specific mobility limitations.

Finally, as many others have also shown, poor health status impedes the frequency of exercise (Dishman et al., 1985; Ebrahim & Rowland, 1996; King et al., 1994; Menec & Chipperfield, 1997; Sallis et al., 1986; Wolinsky et al., 1995). However, contrary to our expectations, the number of preexisting medical conditions was not related to degree of exercise participation. This negative finding is important, because many clinicians who work with disabled older adults believe that the sheer number of an older person’s comorbidities does affect the person’s ability to participate in home exercise programs. Some clinicians may not even suggest a home exercise program or they may assume that a supervised setting is required. Our findings indicate that the number of baseline preexisting diseases may not be a barrier to home exercise for disabled older persons, although the development of new problems during the course of the exercise program and the presence of mobility limitations certainly were.

The finding of high levels of exercise participation and adherence in a home-based strength training program is encouraging for professionals interested in promoting physical activity among the sedentary, functionally disabled, older population. Overall, this sample, whose mean age was 75 years, achieved an average participation rate of 93% of the recommended exercise sessions over the 26-week intervention period. This high rate of participation is similar to participation rates reported by other home-based studies with middle-aged samples (Juneau et al., 1987; King et al., 1991; Mulder, 1981; Slujs, Kok, & van der Zee, 1993) and is higher than previous home exercise studies done with older persons (Daltroy et al., 1995; Jette et al., 1996; Radtke, 1989). The adherence rate for
this sample was also very high: 78% of the subjects achieved high frequency and adherence to the agreed upon intensity of the exercise program. The current findings demonstrate the willingness, as well as the ability, of sedentary, disabled older adults to maintain levels of recommended exercise intensity and frequency in home-based strength training programs. Further analyses are underway to examine the efficacy of the Strong for Life program in achieving positive changes in physiologic health and functioning in this sample.

The high rate of participation and adherence achieved in this study also suggests that our cognitive and behavioral strategies were effective in reinforcing the exercise program and motivating subjects throughout the 6-month intervention. In an earlier study, which used the same strength training program with non-disabled older adults but did not employ cognitive-behavioral techniques, an overall participation rate of 58% was achieved (Jette et al., 1996). The two initial exercise training home visits conducted by a physical therapist, the use of periodic telephone contact to monitor and discuss each subject’s progress with the program, and the provision of simple behavioral reinforcement throughout the study period were designed to enhance participation and adherence rates. Contact with the monitoring therapist averaged 7–8 telephone calls of 5–30 minutes over the intervention period, depending on the needs of the subject. The use of telephone monitoring and behavioral incentives employed in this study with older adults are consistent with approaches used by others (Juneau et al., 1987; King et al., 1991). Telephone contact is a time-efficient and effective method of monitoring involvement in a home-based exercise program. Although it was not specifically assessed, the use of a motivational videotape as part of the exercise training may have also contributed to the high participation rate seen in this study, possibly by providing a perception of social contact that may have complemented the periodic contact by the monitoring therapist. It should also be noted that this sample of volunteers was well-educated.

The extent to which these findings can be generalized to less educated older persons needs to be explored in future research. Ongoing analyses will determine the extent to which the findings seen over the initial 6-month period of the study were maintained during a subsequent 6-month period when the behavioral reinforcement and monitoring strategies were withdrawn.

Many older adults are restricted to their homes by choice or circumstance and do not have access to formal exercise facilities. For this population, home-based exercise is a viable and important option for adopting a more active lifestyle. The results of this study strongly support the attractiveness of home-based exercise by demonstrating that high levels of participation and adherence can be achieved. With the burgeoning interest in home exercise programs for the elderly population, there is an urgent need to identify factors that influence participation and adherence to maximize the impact and health benefits of such programs. It is encouraging that many of the attitudinal and control factors associated with exercise adherence in this study can be modified or enhanced through the use of cognitive and behavioral techniques (Lachman et al., 1997; Lachman, Weaver, Bandura, Elliot, & Lewko-wicz, 1992). To facilitate the adoption and maintenance of a lifestyle involving regular physical activity in the older population (Public Health Services, 1990; DHHS, 1996), more work is required to better understand the factors that promote and deter exercise participation.

References


Received July 22, 1997
Accepted April 16, 1998