Factors Predicting Adherence to 9 Months of Supervised Exercise in Healthy Older Women

Amanda J. Visek, Erin A. Olson, and Loretta DiPietro

Background: Little is known about factors affecting adherence to highly-structured and supervised exercise programs in older people. Methods: Healthy, inactive older (≥65 y) women (N = 30) were randomized into a 1) higher- (AT_H—80% VO_2peak); 2) moderate- (AT_M—65% VO_2peak) intensity aerobic; or 3) lower-intensity resistance (RT_L; 50% VO_2peak) group. All 3 groups exercised 4 days-week^1 for an average of 45 to 70 min-session^1 over 9 months. Adherence (%) was defined as the proportion of prescribed sessions (N = 144) in which subjects achieved their 1) prescribed heart rate (intensity adherence) and 2) their prescribed duration (duration adherence). Primary determinants of adherence included prescribed intensity (METs) and prescribed duration (min), as well as age, body composition, VO_2peak, and exercise self-efficacy score. Results: Intensity adherence was nearly 100% for all 3 groups, while duration adherence was 95%, 91%, and 85% in the RT_L, AT_H, and AT_M groups, respectively. Prescribed exercise duration was the strongest determinant of duration adherence (r = -0.72; P < .0001), independent of prescribed METs, age, VO_2peak, and body composition. Conclusions: Due to competing lifestyle demands, exercise intensity may be less of a factor in adherence among older women than is exercise duration.

Keywords: attendance; duration; intensity; physical activity
several influential variables—namely, age, body composition, peak aerobic capacity (VO₂peak), and exercise self-efficacy.

Methods

Participants

Older (≥65 y) women were recruited via advertisement from private older adult residential communities in Connecticut and from local community senior centers. Eligible study participants included those who reported no regular physical activity for the previous 6 months, were nonsmokers and not on hormone replacement therapy or glucose-lowering medication, and without class I obesity (ie, BMI <30 kg·m⁻²). Older volunteers were screened by their personal physician for cardiovascular disease, neuroendocrine disorders, and other uncontrolled chronic disease. Participants meeting the inclusion criteria completed all baseline assessments before being randomized into their training group (N = 30). The protocol was approved by the Human Investigations Committee of Yale University School of Medicine and all eligible study subjects gave written informed consent before their participation. It is important to note that study subjects were not paid for their participation in the exercise training portion of the study. Subjects were compensated monetarily only for clinical procedures at baseline and follow-up requiring overnight stays in the Hospital Research Unit (HRU) of the Yale Center for Clinical Investigations (YCCI).

Exercise Training Protocol

Subjects were randomized into either one of 3 arms: 1) a higher- (ATH: 80% VO₂peak); 2) moderate- (ATM: 65% VO₂peak) intensity aerobic; or 3) a lower-intensity resistance training (RTL: 50% VO₂peak) group. Exercise intensity was based on a heart rate necessary to achieve this relative intensity during the graded exercise challenge. Thus, the average (range) heart rate targets for the 3 groups were 123 bpm (107–134 bpm) for the ATH group; 104 bpm (97–110 bpm) for the ATM group; and 81 bpm (75–90) for the RTL group. All exercise was supervised by trained research assistants. Further, heart rate was monitored continuously during exercise (Polar Electro, Finland) and was recorded every 10 min during each session.

All 3 groups were identical with regard to exercise frequency (4 days·wk⁻¹) throughout the 9-month exercise intervention. Participants in the ATH and ATM groups exercised on treadmills, while those in the RTL group participated in a program of 15 min of lower-intensity treadmill walking and stretching, and 30 to 45 min of strengthening using Thera-bands, Thera-balls, and hand weights. After an initial 4 to 6 week lead-in period that allowed participants to gradually attain their given exercise duration and intensity, exercise volume was held constant for those women in both the ATH and the ATM groups. Therefore, participants randomized to the 2 aerobic training groups exercised for a duration necessary to expend 300 kcal per session (estimated from VO₂peak and body weight). If we assume a VO₂peak of ~1.40 L·min⁻¹ [20 ml·(kg·min)⁻¹] for a 68 kg older woman, this required about 55 and 65 min of exercise for ATH and ATM groups, respectively. Subjects in the RTL group exercised for 45 to 60 min per session.

Procedures to Reduce Barriers to Exercise

Lack of time, transportation, and social support are often cited as 3 key obstacles to exercise participation in older people. To minimize these and other perceived barriers, exercise training was provided on-site at the different residential communities and senior centers. Transportation to/from the training sites and to/from the University Hospital Research Unit (HRU) in New Haven were provided whenever necessary. Participants were also given a choice of a morning or afternoon exercise class to best accommodate their schedules, and they exercised in groups of 4 to 5 to enhance social support. In the event of a missed exercise session, participants were contacted immediately and their exercise session was rescheduled.

Adherence

Over the 9-month training period, all subjects were expected to complete a total of 144 exercise sessions. Thus, attendance was operationally defined as the number of actual sessions attended divided by the expected number and was expressed as a proportion (%). We also defined adherence more specifically as the proportion of the prescribed exercise sessions in which subjects met their prescribed intensity for at least 80% of the session (intensity adherence (%)) and the proportion of exercise sessions in which subjects met their prescribed exercise duration (duration adherence (%)).

Determinants of Adherence

Since exercise intensity varied among the 3 groups, prescribed intensity was considered a primary predictor variable and was characterized in metabolic equivalents (METs). Exercise duration also varied widely among the participants and the groups because it was calculated from individual VO₂peak and body weight based on the time necessary to achieve 300 kcal of energy expenditure in the AT groups and was set at 45 to 60 min for women in the RTL group. Therefore, prescribed minutes of exercise was also considered a primary predictor variable and was expressed in minutes.

We further considered several physiological variables as potential confounding variables, as they have demonstrated a strong association with both exercise prescription and exercise adherence in the literature—age, aerobic capacity (VO₂peak), body weight, lean mass, and body fat and the change in these physiological variables.
over 3, 6, and 9 months. Peak VO$_2$ [ml·(kg·min)$^{-1}$] was determined on a treadmill at baseline, 3, 6, and 9 months according to methods previously described by our Laboratory.$^{13}$ Height and weight were measured on a balance-beam scale and the body mass index (BMI; kg·m$^{-2}$) calculated as a measure of weight status. Overall body composition [whole body muscle (kg) and fat mass (kg, %)] scans were obtained using dual energy x-ray absorptiometry (DXA).

Finally, exercise self-efficacy was assessed immediately following randomization (to assess accurately the subject’s confidence in the task at hand) using the Stanford-Sunnyvale Health Improvement Project (SSHIP)–II Questionnaire.$^{18}$ The SSHIP questionnaire provides a confidence scale ranging from 0% (not at all confident) to 100% (totally confident) and asks subjects to rate their confidence in exercising under a number of different conditions (eg, when tired, during bad weather, when there are competing interests). The SSHIP also queries overall confidence in completing the prescribed number of exercise sessions over the 9-month training period. We used this latter overall score as the measure of exercise self-efficacy.

### Statistical Analysis

Univariate statistics (mean ± SE) first were generated on all study variables. Differences in the mean levels of the study variables among the 3 training groups were tested using analysis of variance (ANOVA), while simple correlations were tested using the Spearman Rank Order Correlation Coefficient. Significant findings from the simple analyses were then entered into multivariable linear regression models to determine the strongest independent predictors of exercise attendance and adherence. Statistical significance was set at an alpha level of 0.01 to correct for the multiple comparisons.

We note that both baseline and 9-month follow-up assessments were completed on 26 of the 30 older women, resulting in 87% retention. The full sample of older women (N = 30) was used in the denominator of all calculated measures of adherence, however, to provide the most conservative estimates.$^{11,19}$ Among the 3 groups, retention was 100% in the AT$_{LM}$, 82% in the AT$_{M}$, and 82% in the RT$_{L}$. Older women who completed the 9-months of training were similar to those who did not with regard to age, VO$_2$peak, and BMI.

### Results

Baseline characteristics of the study participants are presented in Table 1 according to their assigned exercise group. Although women assigned to the AT$_{H}$ group appeared slightly younger and more aerobically fit than women in the RT$_{L}$ group, these differences were not statistically significant. Level of lean mass and body fat were also similar among the groups. As expected, the exercise self-efficacy score was highest in the RT$_{L}$ group (96%) and lowest in those women assigned to higher-intensity exercise (88%). Table 2 contains information on the prescribed exercise frequency (days·wk$^{-1}$), intensity (METs), and the prescribed minutes of exercise according to group assignment. Although the mean values for prescribed minutes of exercise appear similar for women in the AT$_{M}$ and AT$_{H}$ groups, exercise times ranged from 45 to 100 min in the AT$_{M}$ group and from about 44 to 86 min in the AT$_{H}$ group, depending on the body weight and the VO$_2$peak of the individual study participant.

### Table 1 Subject Characteristics of the Study Population by Group Assignment

<table>
<thead>
<tr>
<th></th>
<th>RT$_{L}$ (n = 11)</th>
<th>AT$_{M}$ (n = 11)</th>
<th>AT$_{H}$ (n = 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>75 ± 2</td>
<td>73 ± 1</td>
<td>71 ± 1</td>
</tr>
<tr>
<td>BMI (kg·m$^{-2}$)</td>
<td>27.7 ± 1.8</td>
<td>29.0 ± 1.7</td>
<td>25.8 ± 1.0</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>38.4 ± 2.3</td>
<td>37.8 ± 2.0</td>
<td>37.4 ± 1.7</td>
</tr>
<tr>
<td>Lean mass (kg)</td>
<td>38.7 ± 2.0</td>
<td>38.0 ± 1.7</td>
<td>40.0 ± 2.6</td>
</tr>
<tr>
<td>Peak VO$_2$ (ml·(kg·min)$^{-1}$)</td>
<td>18.3 ± 1.6</td>
<td>20.7 ± 1.3</td>
<td>21.4 ± 1.3</td>
</tr>
<tr>
<td>Self-efficacy score</td>
<td>96.4 ± 2.3</td>
<td>92.1 ± 2.4</td>
<td>87.5 ± 5.6</td>
</tr>
</tbody>
</table>

*Note.* Values are mean ± SE.

### Table 2 Exercise Prescription by Group Assignment

<table>
<thead>
<tr>
<th></th>
<th>RT$_{L}$ (n = 11)</th>
<th>AT$_{M}$ (n = 11)</th>
<th>AT$_{H}$ (n = 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (d·wk$^{-1}$)</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Intensity (METs)</td>
<td>2.61 ± 0.23</td>
<td>3.85 ± 0.24</td>
<td>4.89 ± 0.29</td>
</tr>
<tr>
<td>Duration (min)$^a$</td>
<td>51.0 ± 3.2</td>
<td>68.2 ± 5.3</td>
<td>63.4 ± 5.4</td>
</tr>
</tbody>
</table>

*Subjects in the AT$_{M}$ and AT$_{H}$ groups exercised for a duration necessary to expend 300 kcal per session. Values are mean ± SE.*
Factors Predicting Attendance

Women in the AT_H group attended the greatest number of sessions (94%), whereas women assigned to RT_L had the lowest attendance (65%; \(P < .01\)) (see Table 3). In the simple analysis, we observed no correlation between age and attendance \((r = -0.09; P < .63)\). Body mass index was significantly and inversely correlated with attendance \((r = -0.48; P < .01)\), while peak VO_2 demonstrated a marginally significant positive association \((r = .49; P < .03)\). Contrary to our study hypothesis, we observed a positive (rather than an inverse) correlation between the prescribed intensity of training (METs) and attendance \((r = .48; P < .02)\); however, prescribed minutes of exercise had little effect on this same adherence measure \((r = .14; P < .46)\) (see Figure 1). For the multivariable analysis, group assignment, BMI, VO_2peak, and age next were entered into a regression model to determine the independent effects of each of these variables on attendance over 9 months of training. The overall model was statistically significant \((F = 5.76; P < .002)\) and explained 51% of the variance in the percentage of sessions attended. Group assignment maintained marginal statistical significance \((P < .03)\) in the presence of the other variables; however, BMI remained an even stronger independent and negative predictor of attendance \((P < .01)\).

Predictors of Duration Adherence

Adherence to the prescribed exercise duration tended to be greatest in the RT_L (94%), compared with the AT_H (91%) and AT_M (85%) groups, although these differences were not statistically significant (see Table 3) Neither age \((r = -0.04; P < .82)\) nor BMI \((r = -0.34; P < .08)\) were correlated with adherence to the prescribed exercise duration, although percent body fat was a significant inverse correlate \((r = -0.58; P < .002)\) of this adherence measure. As expected, VO_2peak also demonstrated a strong positive association with duration adherence \((r = .60; P < .01)\) in the simple analysis. In contrast to our hypothesis, however, prescribed intensity of exercise (METs) was a significant, but positive, correlate of this same measure \((r = .53; P < .01)\), presumably because the higher the prescribed intensity, the shorter the duration of the session. Even though the prescribed minutes of exercise was not associated with attendance, it was a strong, inverse correlate of adherence to that duration of exercise \((r = -0.72; P < .0001)\) (see Figure 1). In the

| Table 3 Attendance and Adherence Data by Group Assignment |
|-----------------------------|-----------------|-----------------|-----------------|
|                             | RT_L (n=11)     | AT_M (n=11)     | AT_H (n=8)      |
| Attendance (%)*             | 65              | 90              | 94              |
| Adherence*—prescribed time (%) | 95              | 85              | 91              |
| Adherence*—prescribed HR (%)           | 97              | 100             | 100             |

* Percentage of total classes (n = 144) attended.

**Percentage of classes in which subjects adhered to the prescribed duration (min) and intensity of exercise (HR).

Figure 1 — The association of prescribed exercise time with exercise attendance and with exercise adherence (N = 30).
multivariable modeling, duration adherence then was regressed on the study variables prescribed minutes of exercise, BMI, VO2peak, percent body fat and age. The overall model was statistically significant \( (F = 10.25; P < .003) \) and explained a large proportion of the variance in adherence to the prescribed exercise duration \( (R^2 = .72) \). Moreover, prescribed exercise time remained an independent negative predictor of duration adherence in the presence of the other influential covariates. Indeed, as described in Table 4, for every added minute of prescribed exercise time, adherence to that time decreased by nearly one-half of a percent \( (\beta = –0.47; 95\% \text{ CI: } –0.73 \text{ to } –0.20) \). Age emerged marginally as an independent predictor of duration adherence in the presence of the other variables. For each year of older age, duration adherence decreased by nearly 2% \( (\beta = –1.78; 95\% \text{ CI: } –3.11 \text{ to } –0.44) \). The further addition of prescribed intensity (METs) to the model did little to alter the parameter estimates, and we observed no statistical interaction between prescribed time and age.

As shown in Table 3, intensity adherence was nearly 100% for all 3 groups; however, none of the study variables demonstrated a significant association with adherence to the prescribed intensity, presumably due to this lack of variability among the women. Exercise self-efficacy did not correlate significantly with any of the outcome measures of adherence either. Similarly, we observed no change in VO2peak or in body composition at 3, 6, or 9 months, which we have previously reported, and therefore, a positive or negative training effect was not a factor in any type of adherence.

### Discussion

Findings from 2 meta-analyses of randomized controlled exercise trials in older populations\(^{11,12}\) suggest that characteristics of the exercise training program and of the exercise itself relate distinctly to measures of adherence and of completion (ie, retention). Indeed, these comprehensive analyses reported that group-based exercise and resistance training predicted higher attendance, whereas facility-based programs predicted better retention compared with home-based programs.

We were interested specifically in how characteristics of the exercise itself (eg, type, prescribed duration and intensity) predicted adherence. Similar to the findings of Martin & Sinden\(^{11}\) and of Hong et al,\(^{12}\) we observed distinct relations between several of these study factors and the different measures of adherence. For example, attendance over 9 months was significantly lower in the resistance training group than in either of the 2 aerobic training groups, which was contrary to our study hypothesis, as well as to findings from other studies of older people (see\(^{11,12}\) for reviews). More notably, prescribed exercise time did not predict attendance or intensity adherence, but was a strong independent predictor of duration adherence. In fact, women assigned to the ATM group had the longest prescribed exercise times (range = 45–100 min) and although their attendance was similar to the ATM group (90% vs. 94%), they demonstrated the lowest level of duration adherence (85%) overall. This suggests that a prescribed exercise duration beyond 60 min per session may not be practical for older women due to physical or emotional fatigue or perhaps due to competing life-style demands.

It is not surprising that prescribed exercise time negatively impacts adherence; however, it does refute our hypothesis that the prescribed intensity of exercise would be the stronger predictor of adherence over 9 months in older women. Interestingly, we observed a positive (rather than the predicted inverse) correlation between the prescribed METs and both attendance and duration adherence in the simple analysis, and this is more than likely because a higher prescribed intensity resulted in shorter exercise duration. Prescribed intensity, however, failed to retain an independent relation with any measure of adherence in the multivariable modeling. Other studies of older people also report a null association between exercise intensity and adherence.\(^{11,12}\)

We were also interested in how various participant characteristics, such as age, BMI, VO2peak affected adherence. Body mass index was an independent predictor of attendance, while age demonstrated a marginal

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**Table 4** Multiple Linear Regression Estimates Describing the Independent Relation Between Prescribed Exercise Time and Adherence

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter estimate</th>
<th>95% Confidence Interval</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prescribed time (min)</td>
<td>–0.47</td>
<td>–0.73 to –0.20</td>
<td>0.004</td>
</tr>
<tr>
<td>VO2peak (ml·(kg·min)(^{-1}))</td>
<td>1.05</td>
<td>–0.36 to 2.46</td>
<td>0.16</td>
</tr>
<tr>
<td>BMI (kg·m(^{-2}))</td>
<td>–0.41</td>
<td>–1.51 to 0.69</td>
<td>0.47</td>
</tr>
<tr>
<td>Age (y)</td>
<td>–1.78</td>
<td>–3.11 to –0.44</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Note. Overall model: \( F = 10.25; P < .0003; R^2 = .72 \). The regression estimate describes the change in adherence to the prescribed exercise duration (%) per unit change in the study variable.
independent relation to duration adherence. Other studies of older people report equivocal findings with regard to the influence of these subject characteristics and others on program adherence.\textsuperscript{11,16,21} Recently, Flegel et al\textsuperscript{11} reported that self-rated depression, fatigue, and physical components of health-related quality of life were significant correlates of adherence (ie, attendance) to a 6-month exercise intervention in people 65 to 85 years old, whereas age was not. Exercise self-efficacy score did not predict any of the 3 adherence measures in our study, which contradicts findings from several other studies of older people.\textsuperscript{6,12–14} We assessed exercise self-efficacy after randomization, but before the start of exercise training, and therefore, subjects may not have assessed their ability accurately due to a lack of familiarity with their specific exercise regimen. Other studies have measured exercise self-efficacy after a 2-week lead-in period, resulting in more realistic and accurate assessments.\textsuperscript{22} Also, since neither body composition nor VO\textsubscript{2}peak changed measurably over the course of the training study, negative outcome expectations and decreased motivation could have influenced the relations of interest\textsuperscript{25}—especially among women in the RTL group, among whom attendance was significantly lower compared with the AT groups. Unfortunately, we collected no longitudinal data on these important psychosocial variables and therefore cannot assess their contributions to the exercise adherence outcomes. Other unmeasured factors that may have influenced adherence to the 9 months of structured exercise in older people include enjoyment, significant life events (serious illness, death of a spouse), or interpersonal relations with the research personnel.

Nonetheless, a major strength of this study included the control for several program characteristics and environmental barriers known to influence physical activity participation. We provided an exercise training program that was conducted within on-site facilities and was group-based. These design features have demonstrated a relation to exercise adherence and completion among older people participating in studies of long duration.\textsuperscript{12,25} Moreover, the group setting is a key factor in maximizing exercise attendance and adherence to a difficult exercise prescription due to greater social support,\textsuperscript{27} motivation,\textsuperscript{28} peer support\textsuperscript{29} and group cohesion.\textsuperscript{30} Exercise frequency and study length also were not factors in predicting adherence in our study as they are in other studies (see\textsuperscript{12} for review), as these factors were held constant among the 3 training groups.

Exercise training studies remain necessary as we continue to modify practice guidelines to include greater specificity of exercise prescription within various age or risk groups. Our findings suggest that group-based exercise and exercise offered via facility-based programs remain important program characteristics in maximizing attendance and adherence to highly-structured training studies. Contrary to our initial premise, exercise intensity may be less of a factor in adherence among older people than is exercise duration. This may be an indication that due to competing demands of their lifestyles, at least older women may be willing to work harder during exercise training if such greater intensity results in a shorter exercise duration. This information is important in balancing the scientific requirements of a given exercise intervention with what participants are willing to accept.

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**References**