ORIGINAL INVESTIGATION

Exercise and Changes in Health Status in Patients With Ankylosing Spondylitis

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Background: Although exercise is a commonly recommended treatment for ankylosing spondylitis (AS), little is known about the effectiveness of unsupervised recreational and back exercises. We examined the effects of recreational exercise and back exercises on patient-reported pain severity, stiffness severity, and functional disability in a prospective longitudinal study of 220 patients with AS.

Methods: Participants provided information on exercise habits and health status every 6 months using mailed questionnaires (median follow-up, 4.5 years). Pain severity and stiffness severity were measured using visual analog scales, and functional disability was measured using the Health Assessment Questionnaire (HAQ) Disability Index.

Results: Among all patients, there were no associations between either the number of exercise minutes per week or the number of days of back exercise per week and short-term (6-month) changes in pain, stiffness, or HAQ Disability Index. However, among those who had AS for 15 years or less, pain scores were 0.18 points lower (on a scale of 0-3; $P=.04$), and stiffness scores were 6.4 points lower (on a scale of 0-100; $P=.005$) during periods with more than 200 minutes per week of exercise compared with periods with 0 to 30 minutes of exercise per week. Among those who had AS for more than 15 years, pain scores were 0.11 points lower (on a scale of 0-3; $P=.03$), and HAQ Disability Indexes were 0.08 points lower (on a scale of 0-3; $P<.001$) during periods with 5 to 7 days per week of back exercise compared with periods when back exercises were not performed. Less intense levels of exercise were not associated with improvements in health status.

Conclusions: Unsupervised recreational exercise improves pain and stiffness, and back exercise improves pain and function in patients with AS, but these effects differ with the duration of AS. Health status is improved when patients perform recreational exercise at least 30 minutes per day and back exercises at least 5 days per week.

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ANKYLOSING spondylitis (AS) is an inflammatory arthritis mainly of joints of the axial skeleton and has a prevalence of about 0.1%.[1] In the early 1900s, immobilization of patients in plaster jackets was used as a treatment for AS in the belief that resting the inflamed joints of the spine and pelvis would be beneficial.[2,3] This treatment was abandoned in the 1940s when it was observed that military recruits who had had their plaster casts removed and who exercised had less severe symptoms and improved mobility.[4] Since then, exercise has been considered an essential component of the treatment of AS. Patients with AS are frequently encouraged to exercise and lead active lives, because this may help them reduce pain, reduce the need for analgesic medications, maintain good posture, and improve function. Several studies[5-16] have reported beneficial effects of exercise on symptom severity or spinal mobility in patients with AS. However, most studies examined the effect of supervised therapeutic physical therapy rather than unsupervised exercise. The benefits of supervised physical therapy may not be sustained after therapy is discontinued,[11] raising questions about the effectiveness of unsupervised exercise in AS.

Because access to physical therapy may be limited by time or financial constraints and because many clinicians emphasize regular recreational exercise and back stretching exercise for patients to perform at home in an unsupervised setting, it is important to assess the effectiveness of such exercise in the treatment of AS. We assessed the effect of unsupervised recreational exercise and back exercises on patient-reported pain, stiffness, and functional disability in a prospective longitudinal observational study of 220 patients with AS.

PARTICIPANTS AND METHODS

STUDY PARTICIPANTS

Patients in this study were participants in the Longitudinal Study of Outcomes in Ankylosing Spondylitis, a prospective longitudinal study of health status, treatments, and outcomes in patients with AS.[17] Patients were recruited from 1992 to 1997 from the rheumatology clinics at Stanford University Medical Center, Stanford, Calif, and the Veterans Affairs Palo Alto Medical Center, Palo Alto, Calif, from local rheumatologists and the community by advertisement. To be eligible for the study, participants had to have a diagnosis of AS by the modified New York criteria,[18] be 18 years or older, and be able to read English. Radiographs of the sacroiliac joints were not obtained for this study, but prior radiographs or radiograph reports documenting sacroiliac joint abnormalities were required. Patients with a history of inflammatory bowel disease were excluded. A total of 241 patients were enrolled. Study participation included a physical examination at study entry and completion of mailed questionnaires at entry and every 6 months thereafter.

In this study, we included 220 patients who had completed at least 2 consecutive study questionnaires. The 21 participants excluded from this study did not differ in demographic or clinical characteristics from the 220 patients included in the study, except they reported more severe stiffness (visual analogue scale score, 59.2 vs 47.2; $P=.03$) and fewer exercise minutes per week (35 vs 90 minutes; $P=.05$) at study entry.

STUDY VARIABLES

Questionnaires at entry and follow-up included questions on health status, including functional disability, pain severity, and stiffness severity, exercise habits, and medication use. Functional disability was measured using the Health Assessment Questionnaire (HAQ) Disability Index, a 20-item self-report instrument that asks respondents to rate the degree of difficulty they have performing tasks in 8 areas (dressing, arising, eating, walking, hygiene, reaching, gripping, and errands and chores).[19] Responses to each question can range from 0 (no difficulty) to 3 (unable to do), and the scores of each functional area are averaged to compute the Disability Index (possible range, 0-3). Pain severity was measured using the pain score of the HAQ, a 15-cm visual analog scale with a range of 0 (no pain) to 3.0 (severe pain). Stiffness severity was also measured using a 15-cm visual analog scale, with a range of 0 (no stiffness) to 100 (severe stiffness).

On each questionnaire, participants were asked to report their exercise habits, including the number of days per week that they exercised and the duration of each exercise session. From this information, we computed the number of exercise minutes per week. They were also asked about the specific type of exercise performed (aerobic exercises, jogging, brisk walking, swimming, weight lifting, bicycling, team sports, and other) and how many days per week they performed back stretching or strengthening exercises.

FOLLOW-UP

Patients were followed up from study entry to death, withdrawal from the study, or the end of data collection for this analysis (March 31, 1999). Follow-up was also truncated at the last reported value if data were missing for the exercise variables, pain, stiffness, or the HAQ Disability Index on 2 consecutive questionnaires. The total number of patient-years of follow-up was 751.5 years.

No data were missing for the HAQ Disability Index or the number of days per week of back exercises. Sporadically missing values for measures of pain severity, stiffness severity, and exercise minutes per week were imputed using the average of the 2 flanking values. Values were imputed for missing values of pain severity on 23 questionnaires (1.3%), for stiffness severity on 7

RESULTS

Most of the 220 participants were middle-aged, male, white, and well educated (**Table 1**). The mean duration of AS at study entry was 19.9 years. The median duration of recreational exercise per week was 85 minutes, and the median number of days per week that back exercises were performed was 3. Fifty-eight percent of patients had previously received physical therapy, and 77% had been instructed in back stretching and strengthening exercises in the past. Most patients used nonsteroidal anti-inflammatory medications.

At study entry, 173 patients reported doing some exercise, and 47 reported not exercising. Among those who exercised, most performed more than 1 type of exercise, and 20.8% reported doing 4 or more types of exercise (**Table 2**). The most common exercise combinations were back exercises and brisk walking (27.7%), back exercises and other exercises (26%), back exercises and weight lifting (19.7%), and back exercises and swimming (16.2%).

The median follow-up was 4.5 years (range, 0.5-5.5 years). Many patients reported changes in their weekly exercise duration during the study: 82% changed by more than 60 minutes per week from their baseline level, and 51% changed by more than 120 minutes per week. Thirty-nine (83%) of the 47 patients who were not exercising at study entry began exercising during the study, and 9 patients never exercised. There was also little consistency in the types of exercise performed over time: 84% dropped an exercise activity, and 89% added a new activity. Patients' ratings of the intensity with which they exercised were available for 740 questionnaires (43%). Patients reported their exercise to be of low intensity on 14.7% of questionnaires, moderate intensity on 50% of questionnaires, and strenuous on 35.3% of questionnaires. Changes in health status were also common over time. Pain severity scores changed by more than 1.0 point (on a scale of 0-3) from study entry in 40% of patients, stiffness severity scores changed by more than 25 points (on a scale of 0-100) from study entry in 58%,

questionnaires (0.4%), and for exercise minutes per week on 37 questionnaires (2.1%).

STATISTICAL ANALYSIS

Two analyses were performed: one to examine the relation between exercise minutes per week or number of days per week of back exercise and changes in pain severity, stiffness severity, and the HAQ Disability Index for 6-month periods and the other to examine differences in the rate of progression of functional disability between patients who reported consistently high and those who reported consistently low levels of exercise over time.

To determine the association between exercise intensity and short-term changes in measures of health status, we used pooled time series regression analysis.[20,21] This technique is a modification of classical linear regression that accommodates multiple time-ordered observations on multiple subjects in a single regression model. Random effects models were specified. The dependent variable in these models was the measure of health status (pain severity, stiffness severity, or HAQ Disability Index) recorded on each questionnaire. The independent variables of interest were minutes per week of exercise and number of days per week of back exercise. To allow for nonlinear associations, minutes per week of exercise was categorized into quartiles (≤30, 31-90, 91-200, and >200 minutes per week). The number of days per week of back exercise was categorized as 0, 1 to 4, or 5 to 7. The lowest category of each exercise measure (≤30 minutes per week of exercise and 0 days per week of back exercise) was used as the reference category. Changes in pain, stiffness, and HAQ Disability Indexes during 6-month periods of more regular exercise were measured relative to these low-intensity periods. Unadjusted models included only exercise minutes per week and number of days per week of back exercises as the independent variables. Adjusted models included patient age, sex, race (white vs nonwhite), education level, duration of AS, and indicator variables for the use of analgesics, nonsteroidal anti-inflammatory drugs, disease-modifying medications (sulfasalazine or methotrexate), or prednisone during the same time interval as additional independent variables. Because the associations between exercise and changes in health status were thought potentially to differ between those with early AS and those with more long-standing AS, we repeated these analyses in 2 subgroups of patients, those who had AS for 15 years or less (n=100) and those who had AS for more than 15 years at study entry (n=120).

Because functional disability may cumulate over time, we performed a second analysis that compared the rate of change of HAQ Disability Indexes among patients with different exercise habits. We first computed the rate of change (slope) of the HAQ Disability Index over time for each patient using classical linear regression. We then categorized each patient into 1 of 3 groups based on the consistency of his or her exercise habit over time. Patients were categorized as consistently high exercisers if they reported exercising 150 minutes per week or more on at least 80% of their questionnaires. Patients were categorized as consistently low exercisers if they reported exercising 60 minutes per week or less on at least 80% of their questionnaires. All others were considered intermediate exercisers. Mean rates of change in the HAQ Disability Index were compared among these 3 groups by analysis of variance. We then repeated this analysis using the consistency with which patients reported doing back exercises over time as the independent variable. Consistent back exercisers were considered those who reported doing back exercises on 5 to 7 days per week on at least 80% of their questionnaires, nonback exercisers were those who reported not doing back exercises on at least 80% of their questionnaires, and all others were considered intermediate back exercisers.

Limdep programs (Econometric Software Inc, Bellport, NY) were used to perform the pooled time series regression analyses. All other analyses were performed using SAS programs (SAS Institute, Cary, NC). All hypotheses were 2-tailed, and *P* values less than .05 were considered statistically significant.

and HAQ Disability Indexes changed by more than 0.5 points from study entry (on a scale of 0-3) in 46%.

ASSOCIATIONS WITH SHORT-TERM CHANGES IN HEALTH STATUS

Neither exercise duration nor the frequency of back exercises was associated with short-term (6-month) changes in pain, stiffness, or HAQ Disability Indexes for the patient group as a whole (**Table 3**). For example, compared with the reference period of 30 minutes per week of exercise or less and no back exercises, in which the average unadjusted pain score was 1.22 (on a scale of 0-3), the average pain score was 0.05 points lower in periods in which more than 200 minutes per week of exercise were performed. Adjustment for potential confounders did not alter these results. In an exception, pain scores improved significantly in periods when back exercises were performed 1 to 4 days per week (change in pain score of –0.08; $P<.05$), but a similar improvement in pain was not seen in periods when back exercises were performed 5 to 7 days per week. There were no significant changes in either stiffness severity or HAQ Disability Indexes with longer durations of exercise or more frequent back exercises in the group as a whole.

To assess whether exercise might have a greater effect in those with early AS vs more long-standing AS, we repeated these analyses in subgroups stratified by the duration of AS (≤15 years and >15 years). Among those who had AS for 15 years or less, pain severity and stiffness severity scores improved significantly during periods when exercise was performed for more than 200 minutes per week compared with periods when exercise was performed for 30 minutes per week or less (**Figure**). For example, pain severity scores improved by 0.18 points (on a scale of 0-3; $P=.04$) and stiffness severity scores improved by 6.4 points (on a scale of 0-100; $P=.005$) in these periods compared with periods of exercise of 30 minutes per week or less. Durations of recreational exercise less than 200 minutes per week were not associated with significant improvements in pain or stiffness nor was the frequency of back exercises. Neither exer-

Table 1. Characteristics of the 220 Patients at Study Entry*

Characteristic	Mean ± SD or No. (%)
Age, y	47.5 ± 13.7
Male	150 (68.2)
White	190 (86.4)
Education level, y	15.5 ± 2.7
Employed	131 (59.5)
Duration of AS, y	19.9 ± 13.9
HLA-B27*	117 (90)†
Peripheral arthritis	46 (20.9)
Comorbid conditions, No.	
0	58 (26.4)
1	71 (32.3)
2	49 (22.3)
≥3	42 (19.0)
Pain severity score	1.18 ± 0.8
Stiffness severity score	47.2 ± 24.4
HAQ Disability Index	0.54 ± 0.59
Prior physical therapy	127 (57.7)
Current physical therapy	26 (11.8)
Ever instructed in back exercises	169 (76.8)
Days per week of back exercise	
0	66 (30.0)
1-4	89 (40.5)
5-7	65 (29.5)
No medications	24 (10.9)
NSAID use	175 (79.5)
Analgesic use	61 (27.7)
DMARD use	34 (15.5)
Prednisone use	19 (8.6)

**AS indicates ankylosing spondylitis; HAQ, Health Assessment Questionaire; NSAID, nonsteroidal anti-inflammatory drug; and DMARD, disease-modifying antirheumatic drug.*

†Of 130 patients tested.

Table 2. Types of Exercise Performed at Study Entry

Exercise	No. (%)
Back exercises	120 (69.4)
Aerobics	27 (15.6)
Brisk walking	74 (42.8)
Jogging or running	18 (10.4)
Biking	40 (23.1)
Swimming	38 (22.0)
Water exercises	18 (10.4)
Weight lifting	38 (22.0)
Team sports	7 (4.0)
Other	68 (39.3)
No. of different types of exercise	
1	34 (19.7)
2	58 (33.5)
3	47 (27.2)
≥4	36 (20.8)

cise duration nor the frequency of back exercises was associated with significant changes in the HAQ Disability Index in this subgroup of patients.

Among patients who had AS for more than 15 years, the duration of recreational exercise was not associated with significant improvements in pain severity, stiffness severity, or HAQ Disability Indexes. However, the frequency of back exercises was significantly associated with improvements in pain severity and HAQ Disability Indexes in this subgroup (Figure). Compared with periods in which back exercises were not performed, pain scores improved by 0.11 points (on a scale of 0-3; $P=.03$) in those periods when back exercises were performed 5 to 7 days per week. The HAQ Disability Indexes improved by 0.045 points (on a scale of 0-3; $P<.001$) in periods when back exercises were performed 1 to 4 days per week and improved by 0.08 points ($P<.001$) in periods when back exercises were performed 5 to 7 days per week compared with periods when back exercises were not performed.

ASSOCIATIONS WITH THE RATE OF PROGRESSION OF FUNCTIONAL DISABILITY

Fifty patients reported consistently low durations of recreational exercise during follow-up, 44 patients reported consistently high durations of exercise, and 126 patients had intermediate levels of exercise (**Table 4**). The average slopes of HAQ Disability Indexes over time were lowest in the low-exercise group, and on average these patients had HAQ Disability Indexes that improved over time (slope of –0.023). This trend was most evident among patients who had AS for more than 15 years. Among those who had AS for 15 years or less, patients in the consistently high-exercise group had slopes that were lower than those in either the consistently low- or intermediate-exercise groups, but this difference was not statistically significant.

Fifty-five patients reported consistently low frequencies of back exercise, 27 reported consistently high frequencies, and 138 patients had intermediate frequencies (Table 4). Patients who reported a consistently high frequency of back exercise had HAQ Disability Indexes that improved over time (average slope, –0.02), although rates of change in the HAQ Disability Index were not significantly lower among these patients than among those who performed back exercises rarely or at an intermediate frequency. There was a stronger trend toward improvement in the slope of HAQ Disability Indexes when back exercises were performed consistently and at high frequency than when they were performed less regularly ($P=.09$) among those who had AS for more than 15 years than among those with earlier AS.

COMMENT

In this prospective longitudinal study, we found that unsupervised recreational exercise and back exercises were effective in improving pain severity, stiffness severity, and functional disability in patients with AS. However, benefits were seen only in periods with more than 200 minutes per week of exercise or periods in which back exercises were performed at least 5 days per week. The effects of exercise also differed with the duration of AS. Among patients who had AS for 15 years or less, more frequent recreational exercise was associated with reduced severity of pain and stiffness but no change in functional disability. The frequency of back exercises did not significantly affect pain, stiffness, or functional disability in this subgroup. In contrast, among patients who had AS for more than 15 years, more frequent back exercise was as-

Table 3. Effect of Recreational Exercise and Back Exercise on Pain, Stiffness, and Health Assessment Questionaire (HAQ) Disability Index Among All Patients*

	Pain		Stiffness		HAQ Disability Index	
	Unadjusted	Adjusted†	Unadjusted	Adjusted†	Unadjusted	Adjusted†
Reference period‡	1.22	1.64	48.3	51.0	0.65	1.32
Change from reference period						
Exercise 31-90 min/wk	0.006	0.13	0.27	0.41	0.009	−0.01
Exercise 91-200 min/wk	−0.007	0.008	−0.88	−0.51	−0.011	−0.006
Exercise >200 min/wk	−0.05	−0.035	−1.71	−1.51	−0.034	−0.032
Back exercises 1-4 d/wk	−0.08§	−0.078§	−0.69	−0.54	−0.027	−0.024
Back exercises 5-7 d/wk	−0.04	−0.035	0.66	0.81	−0.018	−0.014

**The reference period value is the group value for each measure during periods of recreational exercise of less than 30 minutes per week and of back exercises 0 days per week. Subsequent rows present the changes in each measure associated with increasing levels of exercise.*

†Adjusted for patient age, sex, race, education level, duration of ankylosing spondylitis, and the use of analgesics, nonsteroidal anti-inflammatory drugs, disease-modifying antirheumatic drugs, and prednisone.

‡Possible range for pain score was 0 to 3, possible range for stiffness score was 0 to 100, and possible score for HAQ Disability Index was 0 to 3.

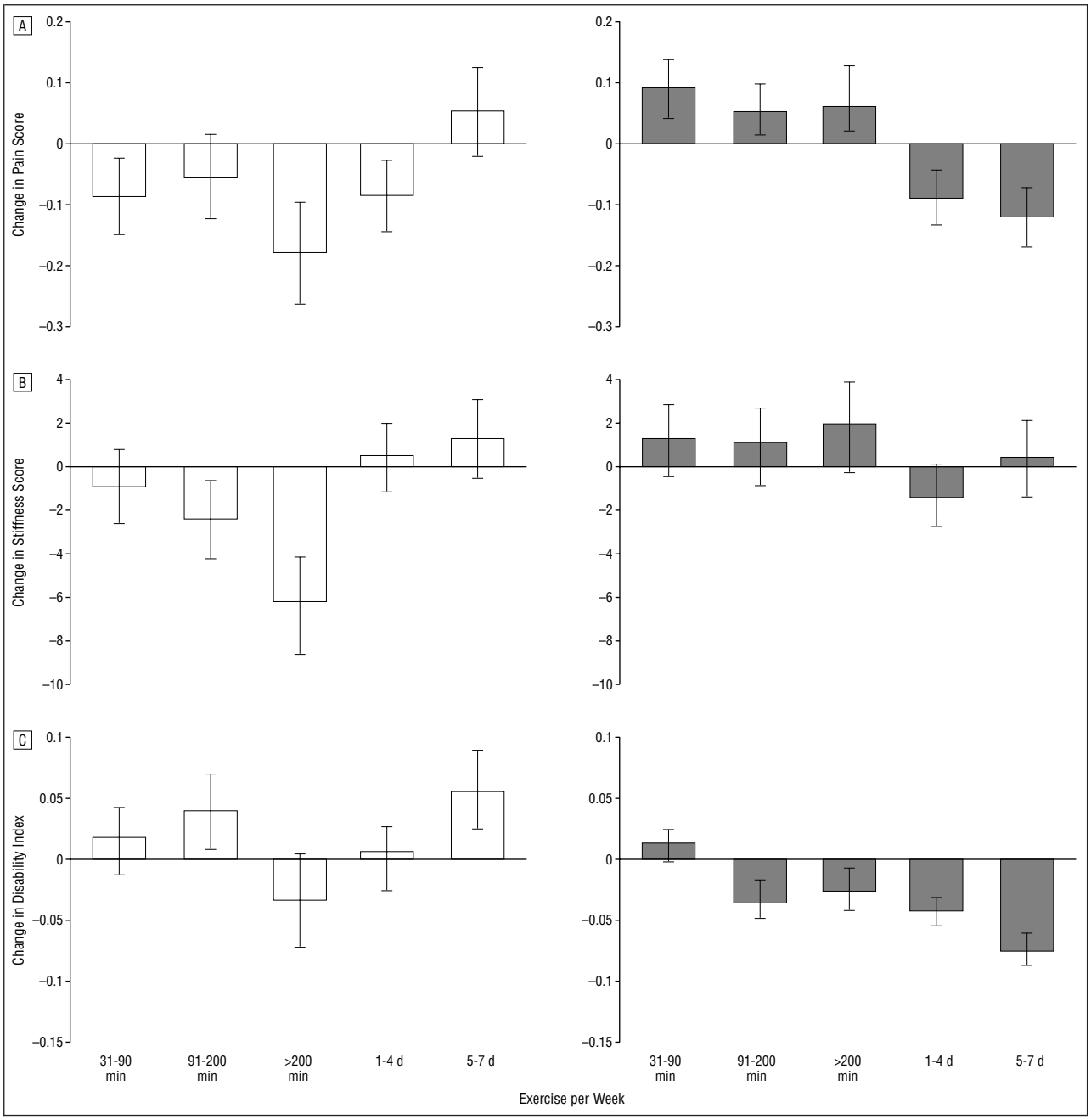
§P<.05.

sociated with graded improvements in both pain and functional ability. The consistency with which back exercises were performed was also associated with a trend toward lower rates of progression of functional disability among patients with more long-standing AS.

Although it has been recognized for several decades that exercise plays an important role in the treatment of AS, the effectiveness of unsupervised exercise has not been extensively studied. Most studies[6,7,9-15] of exercise in AS have assessed the efficacy of supervised physical therapy. Intensive physical therapy has been reported to improve neck and lumbar range of motion.[9,10,13,14] Improvements in symptoms or measures of health status have been less consistently demonstrated.[10,13] Among patients who received individualized physical therapy and who exercised for a median of 3.3 hours per week (198 minutes per week), Hidding et al[10] reported a 17.5% improvement in pain scores, a 5.4% improvement in stiffness scores, and a 5.4% worsening in HAQ Disability Indexes from baseline after 9 months, whereas patients who received both individual and group physical therapy had improvements of 5.9% in pain scores and 9.1% in HAQ Disability Indexes and a worsening of 3.1% in stiffness scores. Kraag et al[13] reported a 16.1% improvement in pain scores from baseline during 4 months among patients who received home physical therapy. Both studies primarily included patients with early AS. These improvements were comparable to the magnitude of the short-term improvements seen in our study: among those with early AS, pain severity and stiffness severity improved by 10% and 11.4%, respectively, in periods with more than 200 minutes per week of recreational exercise compared with periods with 30 minutes per week of exercise or less; and among those with more long-standing AS, pain severity and HAQ Disability Indexes improved by 6.7% and 6%, respectively, during periods when back exercises were performed 5 to 7 days per week compared with periods when back exercises were not performed. Importantly, these changes represent improvements over and above those provided by concurrent treatment with medications and are likely clinically meaningful improvements.

We also found that the benefits of exercise were modified by the duration of AS. Among patients who had AS for 15 years or less, recreational exercise reduced the severity of pain and stiffness, whereas among patients who had AS for more than 15 years, consistent back exercise improved pain and function. It is unclear why different exercise measures demonstrated different benefits in patients with early or more long-standing AS. It is possible that, in patients with early AS, pain and stiffness may be due more to inflammation than mechanical factors and therefore improve more readily with exercise. Because less spinal fusion may be present, patients with early AS may also be able to exercise more vigorously and may derive more analgesic benefit through the systemic effects of exercise. Exercise elevates blood levels of catecholamines, β-endorphin, and cortisol, substances that have analgesic and anti-inflammatory effects, and causes redistribution of lymphocyte subsets.[22] Intense bicycling can lead to brief (less than 1 hour) improvements in neck and lumbar spine mobility in patients with early AS, suggesting a systemically mediated mechanism.[23] The absence of an association between the duration of recreational exercise and health status among patients who had AS for more than 15 years was not because patients in this group rarely exercised. In fact, the average exercise minutes per week at study entry was higher among these patients than among patients who had AS for 15 years or less (157 vs 105 minutes per week; $P=.02$). Rather, the frequency of back exercise appeared to be more important in improving pain and function among these patients, whose symptoms may be due to both mechanical and inflammatory processes.

Patients who reported performing back exercises consistently throughout the study tended to have stable or improving scores on the HAQ Disability Index, whereas patients who performed back exercises less regularly had slow worsening of their Disability Indexes over time. These differences in rates of progression of functional disability were more pronounced among patients who had AS for more than 15 years and approached statistical significance. These findings suggest that back exercises, rather than recreational exercise in general, may have more specific advantages in maintaining function in patients with AS.



Changes in pain severity (A), stiffness severity (B), and Health Assessment Questionnaire Disability Indexes (C) with longer durations of recreational exercise and more frequent back exercises among patients who had ankylosing spondylitis for 15 years or less (left column, open bars) and those who had ankylosing spondylitis for more than 15 years at study entry (right column, shaded bars). The changes are referent to periods of recreational exercise of 30 minutes per week or less and no back exercises, values of which have been set to 0. Error bars represent 1 SE. Values are adjusted for patient age, sex, race, education level, duration of ankylosing spondylitis, and the use of analgesics, nonsteroidal anti-inflammatory drugs, disease-modifying antirheumatic medications, and prednisone.

Our study has several strengths, including a large number of patients and prospective follow-up for a median of 4.5 years. Patients with varying durations of AS were studied, which permitted the detection of differing effects among patients with early and more long-standing AS. We also used the longitudinal data to examine associations between the consistency of exercise habits and the rate of progression of functional disability. Moreover, the study provided a naturalistic observation of what patients actually do and an indication of the benefits of unsupervised exercise, a treatment more routinely recommended than supervised physical therapy. Unfortunately, we could not examine the effects of particular types of exercise, because patients frequently changed the types of exercise they performed. We did not independently validate patients' reports of their exercise habits. However, any misclassification would likely attenuate the magnitude of the associations. Because physical examinations were performed only at study entry, we could not examine the effects of exercise on spinal mobility. We also did not examine the effects of exercise on other aspects of health, such as cardiovascular

Table 4. Associations of the Consistency of Recreational Exercises and Back Exercises on the Rate of Progression (Slope) of Functional Disability Measured by the Health Assessment Questionnaire Disability Index

	All Patients		Ankylosing Spondylitis ≤15 y		Ankylosing Spondylitis >15 y	
Consistency	n	Mean Slope	n	Mean Slope	n	Mean Slope
Recreational exercise consistency*						
Consistently low	50	−0.023†	25	−0.014	25	−0.032
Intermediate	126	0.036	57	0.045	69	0.028
Consistently high	44	0.006	18	−0.023	26	0.025
Back exercise consistency*						
Consistently low	55	0.018	24	0.012	31	0.023
Intermediate	138	0.092	69	0.023	69	0.023
Consistently high	27	−0.02	7	−0.007	20	−0.025‡

**Recreational exercise consistency was defined as consistently low for patients who reported 60 minutes per week or less of exercise on 80% or more of questionnaires, consistently high for patients who reported 150 minutes per week or more of exercise on 80% or more of questionnaires, and intermediate for all others. Back exercise consistency was defined as consistently low for patients who reported doing no back exercises on 80% or more of questionnaires, consistently high for patients who reported doing back exercises 5 to 7 days per week on 80% or more of questionnaires, and intermediate for all others.*

*†Significantly lower (*P = *.05) than the intermediate group, by Scheffé multiple comparisons, adjusted for patient age, sex, race, education level, and duration of ankylosing spondylitis at study entry.*

‡Global P = *.09, adjusted for patient age, race, sex, education level, and duration of ankylosing spondylitis at study entry.*

fitness, lung function, weight control, and osteoporosis, all of which may benefit from exercise.

In summary, unsupervised recreational exercise and back exercises were effective in improving the health status of patients with AS, but the specific beneficial effects varied with the duration of AS. Recreational exercise of at least 200 minutes per week (about 30 minutes per day) was associated with improvements in pain and stiffness in patients with early AS, but lower exercise durations were not. The frequency of back exercises was associated with graded improvements in pain and functional disability in patients with more long-standing AS, with the greatest benefit among those who performed back exercises at least 5 days per week. Although a therapeutic exercise prescription remains an important educational and treatment practice, the benefits associated with unsupervised exercise were comparable in magnitude to those reported in short-term studies of supervised physical therapy. Consistent back exercise for years may help stabilize or decrease the rate of progression of functional disability in AS. Therefore, physicians should vigorously recommend that patients with AS exercise at least 30 minutes per day and perform back exercises at least 5 days per week as an important part of their treatment.

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