Longterm Effect on Leisure Time Physical Activity Level in Individuals with Axial Spondyloarthritis: Secondary Analysis of a Randomized Controlled Trial

Silje Halvorsen Sveaas, Hanne Dagfinrud, Melissa Woll Johansen, Elisabeth Pedersen, Ole-Martin Wold, and Annelie Bilberg

ABSTRACT. ***Objective.*** To explore the longterm effect of a 3-month exercise program on leisure time physical activity level in individuals with axial spondyloarthritis (axSpA).

Methods. A secondary analysis was performed on data from 100 individuals with axSpA who were included in a randomized controlled trial. The exercise group (EG) participated in a 3-month exercise program while the control group (CG) received no intervention. Physical activity during leisure time was measured with a questionnaire (physically active: ≥ 1 h/week with moderate/vigorous intensity physical activity). Disease activity was measured with the Ankylosing Spondylitis Disease Activity Scale (ASDAS; higher score = worst). Statistical analyses were performed on an intention-to-treat basis using chi-square tests, logistic regression, and mixed models.

Results. At the 12-month followup, significantly more individuals in the EG than in the CG were physically active [29 (67%) vs 13 (30%), $p < 0.001$] and exercised 2–3 times/week [25 (58%) vs 15 (34%), $p = 0.02$], and fewer exercised at light intensity [3 (8%) vs 14 (44%), $p = 0.002$]. “Participation in the EG” (OR 6.7, 95% CI 2.4–18.6, $p < 0.001$) and “being physically active at baseline” (OR 4.7, 95% CI 1.4–15.8, $p = 0.01$) were the factors most associated with being physically active. There were no differences between the groups in ASDAS ($p = 0.79$).

Conclusion. A 3-month exercise program had a beneficial longterm effect on leisure time physical activity in individuals with axSpA, thus indicating a more beneficial health profile. Still, few individuals continued the intensive program, and there was no difference between the groups in disease activity after 12 months. (ClinicalTrials.gov: NCT02356874) (J Rheumatol First Release June 15 2020; doi:10.3899/jrheum.190317)

Key Indexing Terms:
SPONDYLOARTHRITIS EXERCISE PHYSICAL ACTIVITY

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Axial spondyloarthritis (axSpA) is a chronic inflammatory rheumatic disease that mainly affects the axial skeleton[1]. The disease is characterized by inflammatory back pain, and may also lead to reduced spinal mobility, arthritis, enthesitis, stiffness, and fatigue[1], as well as an increased risk of cardiovascular (CV) diseases[2].

Physical activity is recommended as an important part of the management of axSpA[3], but there is concern that exercise at a vigorous intensity might exacerbate axSpA disease activity, and patients have generally been advised to engage in light-intensity exercises[4,5]. However, in recently published recommendations, individuals with inflammatory arthritis are advised to adhere to the general physical activity recommendations[6]. These recommendations state that adults should perform moderate intensity aerobic activity for a minimum of 30 min on 5 days per week or vigorous intensity aerobic activity for a minimum of 20 min on 3 days per week (or a combination), and engage in strength exercises 2–3 days per week. Hence, these recommendations represent a shift toward a more active approach with cardiorespiratory and strength exercises.

Exercise reduces the disease burden in individuals with axSpA because it has beneficial effects on disease activity, physical function, stiffness[7,8,9], and CV health[10]. Despite this, individuals with axSpA tend to be less physically active than recommended[11,12,13], and they report that they engage less in activities of moderate and vigorous intensity[14,15]. The most frequent exercise modes are pool exercises, stretching, and walking[13,16,17], and a previous cross-sectional study reported that fewer than one-third of individuals with axSpA engage in regular aerobic activities[13]. Hence, it is important to investigate how physical activity can be implemented into daily life for this group. Staying physically active over time is important to secure health benefits[18], but few studies have investigated the longterm effect of exercise programs on physical activity level in axSpA. The aim of this study was therefore to examine longterm physical activity levels after a 3-month exercise program in individuals with axSpA.

MATERIALS AND METHODS

Design. This is a secondary analysis of a multicenter randomized controlled trial comparing the effects of 12 weeks of supervised exercise with usual care. The trial was conducted at outclinic rheumatology departments in Norway [Diakonhjemmet Hospital (DH), Martina Hansen Hospital (MHH), and the University Hospital of North Norway (UNN)] and in Sweden [Sahlgrenska University Hospital (SUH)]. The study was approved by the Regional Committee for Medical and Health Research Ethics (REK South East 2015/86) in Norway and the Regional Ethical Review Board Gothenburg in Sweden (032-16). All procedures followed the Declaration of Helsinki, and all participants gave written and oral informed consent before entering. The study protocol is registered at ClinicalTrials.gov (NCT02356874).

Participants. Participants were recruited from outpatient rheumatology departments as well as through various social media channels. The inclusion criteria were fulfillment of the Assessment of Spondyloarthritis international Society criteria for axSpA[19], age 18–70 years, no change in tumor necrosis factor inhibitor use during the last 3 months, and moderate to high disease activity [Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) ≥ 3.5]. In addition, participants should not have participated in regular exercises (> 1 h per week) during the last 6 months with the aim of increasing cardiorespiratory fitness or muscular strength[20]. Even though they could have been physically active in activities such as pool exercises, walking, and stretching, the program should have the potential to further increase their cardiorespiratory fitness and muscular strength. Exclusion criteria were established or symptoms of coronary heart disease, other comorbidity involving reduced exercise capacity, inability to participate in weekly exercise sessions, and pregnancy.

Exercise group (EG): exercise program. The EG had access to supervised sessions during a 3-month period. A physiotherapist with experience in the field of rheumatology and trained in the exercise protocol supervised the sessions twice a week. The program followed the American College of Sports Medicine (ACSM) recommendations for cardiorespiratory and strength exercises (Sveaas, *et al*, 2019 for details[21]). Some pain was tolerated during the exercises (≤ 5 on a scale 0–10), but the exercises were adapted if the pain got worse the day after.

The cardiorespiratory exercise was performed 3 times per week for ≥ 40 min. Two times per week the EG performed intervals on a treadmill or a cycle ergometer at vigorous intensity level [10 min warmup, thereafter 4 min at 90–95% of maximal heart rate (HR) followed by 3 min of active resting at 70% of maximal HR repeated 4 times][22]. Maximal HR was determined at baseline and monitored by a pulse-watch. Once a week, participants in the EG performed ≥ 40 min on a moderate intensity level (> 70% of maximal HR) on their own.

The strength exercises were performed twice a week with 8–10 repetitions maximum in 2–3 sets. The exercises were individually adapted and focused on major muscle groups (squat, leg press, deadlifts, rows to chest, bench press, shoulder press, pulldowns, and sit-ups).

Behavior change techniques. Several behavior change techniques[23] were used in the delivery of the intervention. The most important was the use of supervision that gave the participants a detailed plan, individual feedback, and information. Two of the hospitals organized the exercise program as group sessions (UNN and SUH), while the physiotherapists were available for the participants during a fixed timepoint at the 2 others (DH and MHH). Equal for all the participants in the EG was that they had committed to exercise, the intensity was monitored during the sessions, and adherence was recorded by the physiotherapist as well as self-reported in an exercise diary. Participants in both the EG and the control group (CG) tested their physical fitness before and after the intervention period.

After the 3-month period, the exercise intervention ended, and participants were not given any instructions or reminders regarding physical activity.

Program for CG. Participants in the CG received no intervention and were asked to continue their usual physical activity habits during the intervention period. All included participants received standard outpatient care from their respective hospitals, but before inclusion in the study it was specified that no change in medication before the 3-month assessment was desirable. After the 3-month assessment, participants in the CG were not given any instruction in physical activity.

Assessments. All participants underwent a clinical examination and filled out questionnaires at baseline and 3 months after inclusion. After 12 months, a questionnaire was sent by postal mail to all participants together with a prepaid envelope. Along with the questionnaire, participants were requested to visit the local study center to give blood samples to be analyzed for C-reactive protein (CRP) and erythrocyte sedimentation rate. Up to 2 reminders were given by phone calls or text messages.

Variables such as age, educational level, working status, disease characteristics, and medication were obtained from the questionnaires. Cardiorespiratory fitness was tested using a maximal walking test on treadmill for estimation of peak oxygen uptake (VO_2peak) at baseline. Spinal mobility was assessed by the Bath Ankylosing Spondylitis Metrology Index (0–10, 10 = worst)[24].

Physical activity level. To assess physical activity we used the questions from the Nord-Trøndelag Health Study (HUNT1)[25] and the International Physical Activity Questionnaire Short Form (IPAQ-SF)[26]. The HUNT1 questions are considered valid to assess leisure time physical activity because higher values of the summary index correlate positively with higher values of VO_2max and also with accelerometer data. Further, HUNT1 questions are reported to have high test-retest reliability with correlation coefficients from 0.76 to 0.87. Participants were asked, "how often do you exercise? (never, less than once a week, once a week, 2–3 times a week and almost every day)," with the text, "give an average, exercise means going for walks, skiing, swimming and training/sports". If they exercised ≥ 1 week, they were asked about the intensity [no sweating/not out of breath (light), sweating/out of breath (moderate), or almost exhausted (vigorous)] and average duration (< 15 min, 16–30 min, > 30 min–1 h, or > 1 h). A product of frequency, intensity, and duration gave a summary index[25]. To categorize individuals into physical activity levels (physically active or inactive), total minutes per week were calculated by multiplying frequency and duration (frequency: never = 0, less than once a week = 0, once a week = 1, 2–3 times per week = 2.5, almost every day = 7; duration: < 15 min = 0, 16–30 min = 23 min, > 30 min–1 h = 45 min, > 1 h = 60 min)[27]. Thereafter, total minutes per week and intensity were used to categorize individuals as either physically inactive (0–420 min with light physical activity or 0–59 min with moderate/vigorous physical activity per week) and physically active (defined as ≥ 60 min per week with moderate/vigorous physical activity)[27].

IPAQ-SF is reported to have acceptable criterion validity when compared with an activity tracker and to have good test-retest reliability with a correlation coefficient of 0.80[26]. IPAQ-SF consists of 6 questions about physical activity during the last 7 days. Based on the data, metabolic equivalent (MET) scores were calculated, and 1 MET represents the body's resting energy expenditure (www.ipaq.ki.se). All the calculations and data cleaning were performed according to the official scoring protocol, but missing values were coded as no activity on the respective activity level. The MET scores were calculated by multiplying the number of minutes per day by the number of days per week by the activity MET (vigorous intensity = 8 MET, moderate intensity = 4 MET, and walking = 3.3 MET). Total physical activity level was calculated by summarizing the MET scores from the 3 activity levels.

Participants were also asked to list the exercise modes they had been active in during the last year. If they reported at the 12-month followup that they exercised ≥ 1/week, the listed exercise modes were categorized into relevant categories for analytical purposes.

Disease activity and physical function. Disease activity was measured with the Ankylosing Spondylitis Disease Activity Score (ASDAS)[28] and the BASDAI[29]. ASDAS is a composite score of CRP and self-reported variables: (1) neck/back/hip pain, (2) peripheral joint pain, (3) duration of morning stiffness, and (4) global assessment. All self-reported variables are reported on an 11-point numeric rating scale (NRS). ASDAS gives a continuous variable (inactive disease < 1.3, low disease activity 1.3 to < 2.1, high disease activity 2.1–3.5, and very high disease activity > 3.5). The BASDAI is a self-reported index of 5 symptoms (fatigue, neck-back-hip pain, peripheral joint pain, tenderness, and degree/length of morning stiffness)[29]. Physical function was assessed with the Bath Ankylosing Spondylitis Functional Index (BASFI), which is a disease-specific index[30]. Each question in BASDAI and BASFI was answered on an 11-point NRS, and a sum score from 0 to 10 (10 = worst) was calculated.

Statistical analyses. Data are presented as mean (SD), median (min–max), and number (%) as appropriate. All statistical analyses were performed on an intention-to-treat basis. For comparisons between groups, the chi-square test was used to analyze differences in categorical data and independent sample t test or Mann-Whitney U test was used to analyze differences in continuous variables as appropriate.

To examine factors associated with being physically active at the 12-month followup, physically active participants were compared with physically inactive participants according to background variables and variables thought to be associated with physical activity level. Thereafter, a multivariate logistic regression analysis was performed to calculate the odds for being physically active at the 12-month followup. Candidate variables for the multivariable logistic regression analysis were sex, age, and variables with p values < 0.1 in simple analyses.

A linear mixed model was used to assess differences between the groups in disease activity and physical function at 12-month followup, with adjustments for baseline values and study center and the interaction between treatment and time.

The linear mixed model analyses were performed in Stata (StataCorp.), and all other statistical analyses were performed in SPSS (IBM Corp.). The level of statistical significance was set at $p < 0.05$.

RESULTS

Participants. Flow of participants is shown in Figure 1. A total of 97 (97%) and 88 (88%) of 100 participants completed the assessment at 3 and 12 months, respectively. Background variables for the EG and CG are shown in Table 1.

Adherence and adverse events. A total of 38 (76%) participants in the EG followed ≥ 80% of the prescribed exercise protocol (≥ 29 of 36 sessions registered by the physiotherapist or in the exercise diaries), while 4 (8%) participants did not attend more than a few sessions. Two participants reported persistent pain during the exercise period but completed the prescribed exercise protocol. In addition, 1 participant experienced chest pain and nausea during the exercises and completed the intervention at moderate intensity after advice from a cardiologist.

Longterm effect on physical activity level. The EG had a significantly higher exercise summary index at the 12-month followup (p = 0.01; Table 2). Further, significantly more individuals in the EG were physically active (≥ 1 h per week with moderate/vigorous physical activity) compared to the CG ($p < 0.001$; Figure 2). At the 12-month followup, only 17 of 43 (40%) individuals in the EG performed both cardiorespiratory and strength exercises.

A total of 28 of 88 (32%) participants had missing items on the IPAQ. Although not significant, there was a tendency toward more MET at a vigorous intensity level and less walking in the EG compared to the CG. Further, more individuals in the CG were physically active on a moderate level than in the EG (p = 0.02).

Factors associated with being physically active at the 12-month followup. The adjusted logistic regression analysis (Table 3) showed that having received the exercise intervention ($p < 0.001$) and being physically active at baseline (p = 0.01) were the only factors that were significantly associated with being physically active at the 12-month followup. The OR for being physically active was 6.0 times higher in the EG than in the CG.

In the EG, physical activity level at 12-month followup was not associated with adherence to the exercise program (no. sessions) or study center.

Longterm effect on disease activity and physical function. The significant beneficial effect of the intervention seen at 3 months' followup (Sveaas, *et al*, 2019[21]), was no longer present at 12 months' followup; no statistical differences were seen between the groups in disease activity (ASDAS, p = 0.79; BASDAI, p = 0.37) or physical function (BASFI; p = 0.82l; Figure 3).

DISCUSSION

The results indicate that participation in an exercise program increases the chance of staying physically active at a health-enhancing level over time in individuals with axSpA. At the 12-month followup, almost 70% of the individuals in the EG were physically active during leisure time (≥ 1 h per week with moderate/vigorous intensity activity) compared to 30% in the CG. Hence, individuals in the EG were 6 times more likely to be physically active at the 12-month followup than those who did not receive the intervention. Still, few individuals continued with the exercise program, and the beneficial effect on disease activity and physical function found immediately after the exercise program had declined at the 12-month followup.

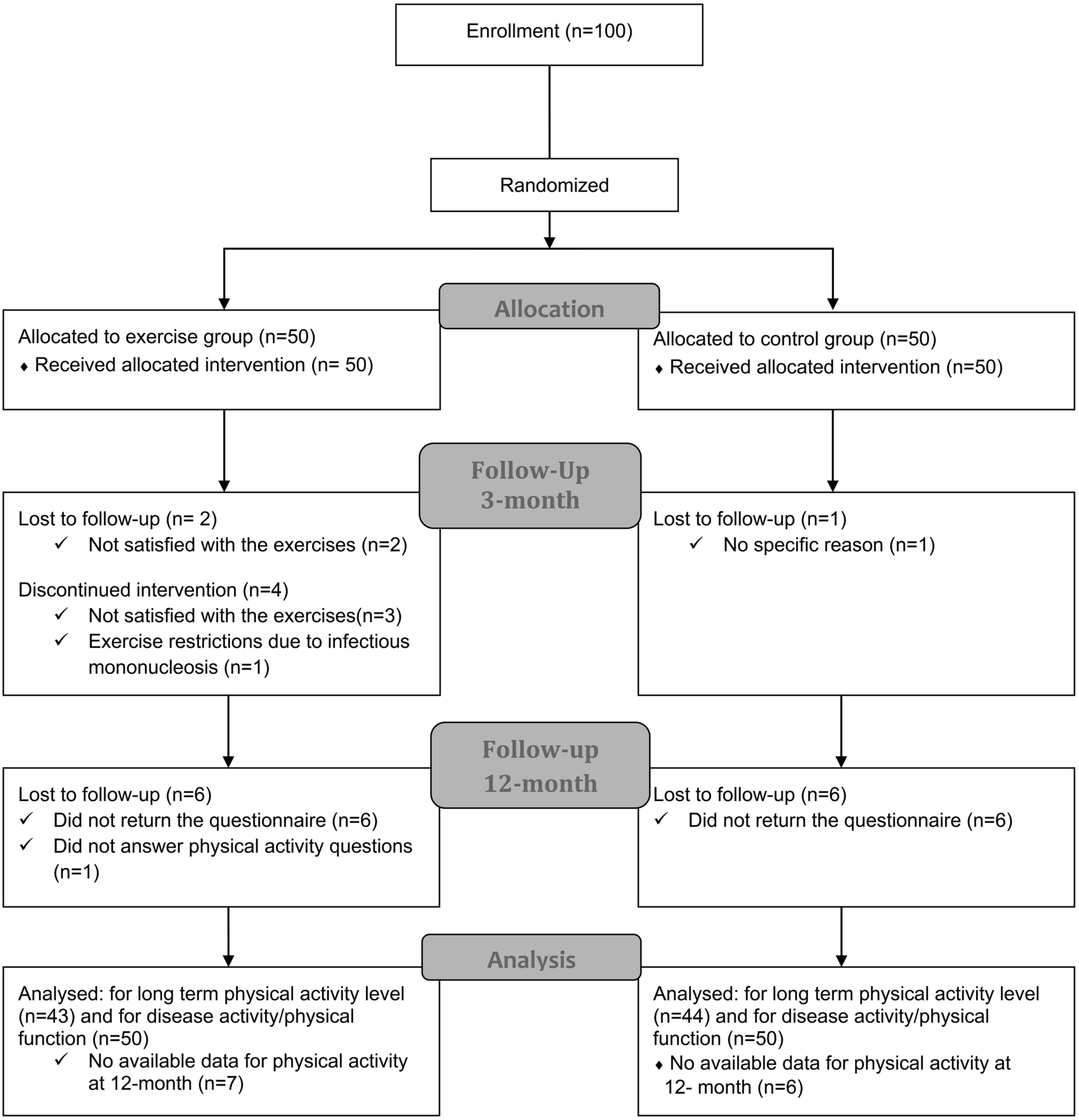


Figure 1. Flow of participants throughout the randomized controlled trial.

Physical activity and exercise are recognized as important in the management of axSpA[3]. However, previous research has shown that individuals with axSpA are less physically active than recommended[11,12,13,31]. The longterm improved physical activity level shown in our study is therefore important, because there are indisputable health effects of even a small enhancement in leisure time physical activity[18].

To the best of our knowledge, this is the first study to demonstrate a prolonged beneficial effect on physical activity level after an exercise program in individuals with axSpA. There are few comparable studies, and previous research is conflicting. Three studies, one in individuals with axSpA[10], one in individuals with osteoarthritis[32], and one in individuals with fibromyalgia[33] concluded with no effect of an exercise program on longterm activity, while a study of elderly individuals with rheumatoid arthritis (RA)[34]

Table 1. Baseline characteristics of all participants, the exercise group, and the control group.

Characteristics	All, n = 100	Exercise Group, n = 50	Control Group, n = 50
Age, yrs, mean (min–max)	46.2 (23–69)	45.1 (23–68)	47.2 (24–69)
Sex, male, n (%)	47 (47)	25 (50)	22 (44)
Radiographic axSpA, n (%)	70 (70)	38 (76)	32 (64)
Married/cohabitant, n (%)	76 (76)	39 (78)	37 (74)
In work, n (%)	81 (81)	42 (78)	39 (78)
Current smoking, n (%)	12 (12)	5 (10)	7 (14)
Height, cm, mean (SD)	172 (11)	172 (11)	172 (11)
Weight, kg, mean (SD)	82.9 (17.9)	81.5 (19.4)	83.1 (19.5)
Medication			
NSAID, n (%)	71 (71)	38 (76)	33 (66)
TNFi, n (%)	44 (44)	23 (46)	21 (42)
Disease characteristics			
Disease activity (ASDAS-CRP), mean (SD)*	2.6 (0.7)	2.6 (0.8)	2.7 (0.6)
Disease activity (BASDAI), mean (SD)	5.1 (1.6)	4.9 (1.6)	5.3 (1.5)
CRP, mg/l, median (min–max)	2 (2–28)	2 (2–28)	2 (2–13)
ESR, mm/h, median (min–max)	8 (1–67)	8 (2–67)	8 (1–28)
Physical function (BASFI), median (min–max)	3.2 (0.2–9.1)	2.6 (0.2–6.7)	3.0 (0.4–9.1)
Spinal flexibility (BASMI), mean (SD)	2.8 (1.3)	2.9 (1.3)	2.6 (1.3)
Cardiorespiratory fitness (VO_2peak), mean (SD)	35.7 (36.3)	36.0 (5.9)	35.4 (6.9)

*ASDAS-CRP: C-reactive protein–based Ankylosing Spondylitis Disease Activity Score (inactive disease < 1.3, low disease activity 1.3 to < 2.1, high disease activity 2.1–3.5, and very high disease activity > 3.5). axSpA: axial spondyloarthritis; BASDAI: Bath Ankylosing Disease Activity Index; BASFI: Bath Ankylosing Spondylitis Functional Index; BASMI: Bath Ankylosing Spondylitis Metrology Index (All BAS instruments: 0–10, 10 = worst); ESR: erythrocyte sedimentation rate; NSAID: nonsteroidal antiinflammatory drugs; TNFi: tumor necrosis factor inhibitor; VO_2peak: peak oxygen uptake.

Table 2. Comparison of physical activity level at 12-month followup between the exercise and the control groups.

Activity Level	Exercise Group, n = 44	Control Group, n = 44	p
Exercise summary index* (0–15, 15 = high), median (min–max)	3.8 (0–15)	2.3 (0–15)	0.01
Exercise frequency			
Never (0)	3 (7)	2 (5)	0.63
< 1 time per week (0.5)	2 (5)	10 (23)	0.02
1 time per week (1)	7 (16)	8 (18)	0.81
2–3 times per week (2.5)	25 (58)	15 (34)	0.02
Almost every day (5)	6 (14)	9 (21)	0.42
Exercise intensity†	n = 36	n = 31	
Not out of breath or sweating (1)	2 (6)	13 (42)	0.001
Out of breath and sweating (2)	25 (69)	15 (48)	
Almost exhausted (3)	9 (25)	3 (10)	
Exercise duration†	n = 38	n = 31	
< 15 min (0.10)	0 (0)	0 (0)	
16–30 min (0.38)	1 (3)	6 (19)	0.07
30–60 min (0.75)	27 (71)	19 (61)	
> 1 h (1.0)	10 (26)	6 (19)	
Exercise mode	n = 43	n = 44	
Cardiorespiratory	26 (60)	6 (14)	< 0.001
Muscular strength	21 (49)	5 (11)	< 0.001
Cardiorespiratory and muscular strength	17 (39)	3 (7)	< 0.001
Walking	18 (42)	23 (52)	0.30
Pool exercises	8 (19)	14 (32)	0.14
Physical activity level (MET)	n = 44	n = 44	
Total MET, median (min–max)	1886 (0–17,892)	1386 (0–9600)	0.83
MET vigorous	720 (0–10,080)	0 (0–7200)	0.15
MET moderate	120 (0–5040)	160 (0–5040)	0.95
MET walking	363 (0–4158)	495 (0–4158)	0.21

Values are n (%) unless otherwise specified. * Calculated based on exercise frequency, duration, and intensity with the scores for each response given in the parentheses. † Only participants exercising ≥ 1 per week were asked about intensity/duration of exercise. MET: metabolic equivalent.

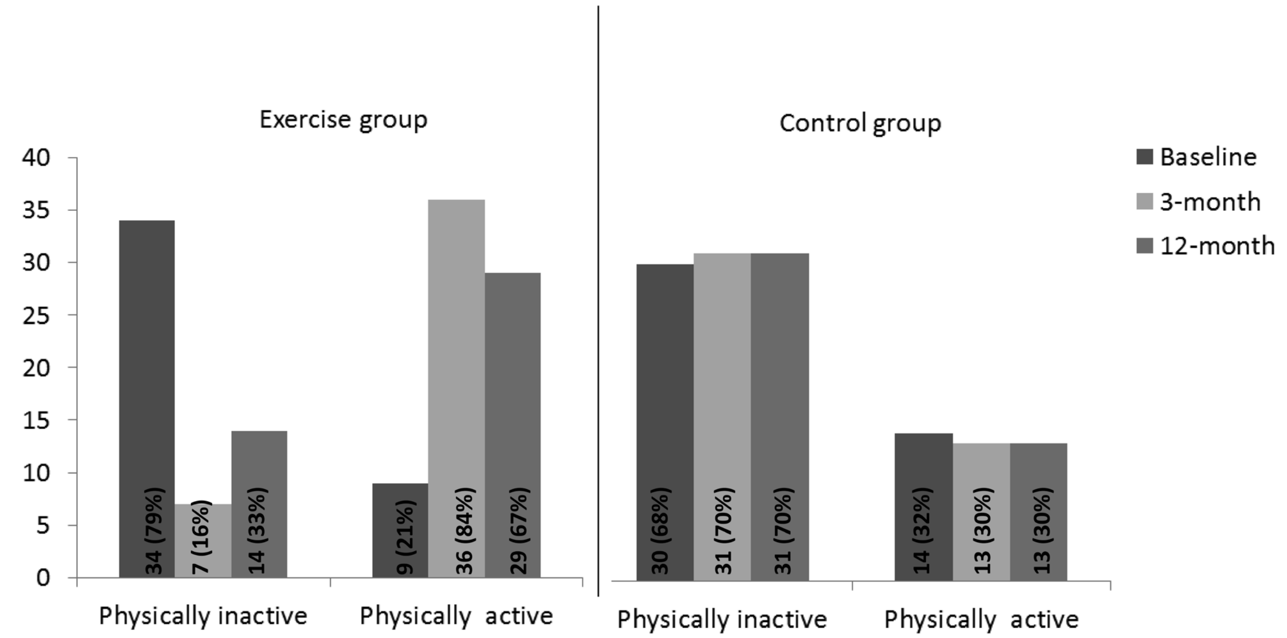


Figure 2. The longterm effect of the supervised exercise program on physical activity level. Bar graphs represent the frequency of physically inactive and physically active participants at baseline, 3-month, and 12-month followup in the exercise group (n = 43) and the control group (n = 44). Physically active: ≥ 60 min with moderate to vigorous activity. Physically inactive: 0–420 min per week with light activity or 0–59 min with moderate to vigorous activity.

Table 3. Factors associated with being physically active at 12-month followup. A total of 42 of 87 (48%) participants were physically active.

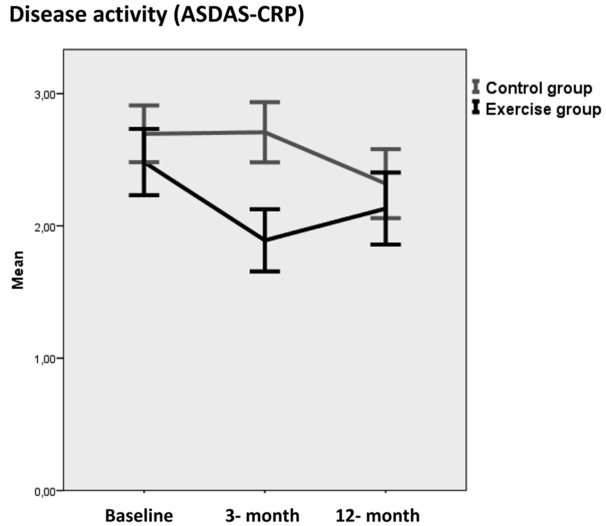
Variables	Crude Estimates, OR (95% CI)	p	Adjusted Estimates[3], OR (95% CI)	p
Age				
Continuous	1.00 (0.96–1.04)	0.88	0.99 (0.95–1.04)	0.79
Sex				
Male	Ref		Ref	
Women	1.38 (0.59–3.20)	0.46	1.51 (0.57–4.02)	0.41
Physical activity at baseline*				
Inactive at baseline	Ref		Ref	
Physically active at baseline	2.57 (0.95–6.92)	0.062	4.73 (1.42–15.75)	0.01
Intervention				
Control group	Ref		Ref	
Exercise group	4.94 (1.99–12.26)	0.001	6.72 (2.42–18.63)	< 0.001

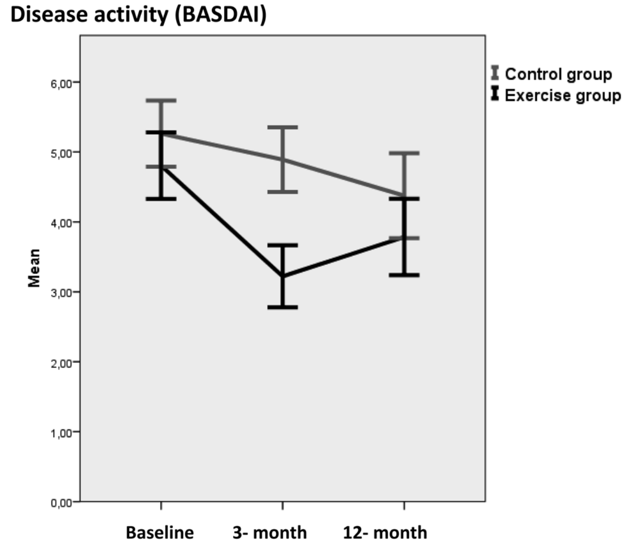
* Physically active was defined as ≥ 1 h per week with moderate/vigorous physical activity at baseline, and physically inactive was defined as 0–420 min with light activity and < 60 min with moderate/vigorous activity.

found a positive longterm effect on physical activity. The conflicting results might be explained by several reasons. First, the timepoint for measurement differed between the studies; one of the studies that found no effect on longterm activity[10] measured physical activity right after completion of the intervention. However, it has been reported that exercise adherence seems to diminish over time[35], hence it is not likely that the physical activity level had been higher at a later timepoint.

Second, the difference in results might be explained by differences in exercise modes and intensities. It is well known that intensity is crucial for achieving the effect of exercise[18] and that perceived benefits of exercise are important for adherence[36]. The study in RA[34] and our study[37] included cardiorespiratory interval exercises (with an intensity of 70–89% and 90–95% of maximal HR, respectively), and both studies demonstrated large effects on general health immediately after the exercise intervention. The experience of immediate benefits may have contributed to the prolonged effect on physical activity level observed in both the RA study[34] and the present study.

Motivational and educational interventions have shown beneficial effects on physical activity level in individuals with rheumatic diseases[38,39,40]. Even if these interventions are different from our exercise program, they are similar regarding inclusion of well-known facilitators for physical





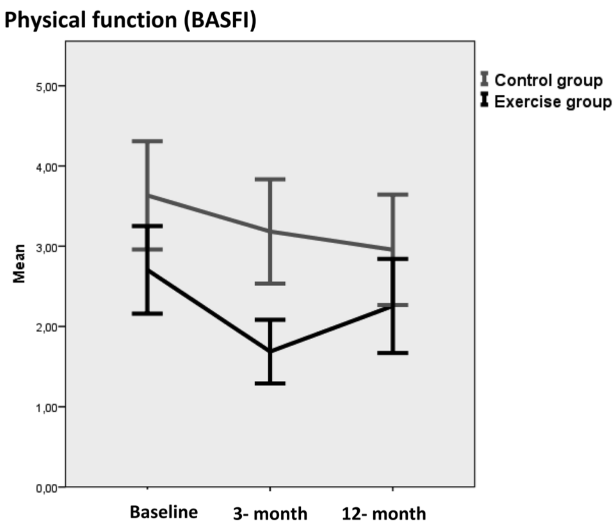


Figure 3. The longterm effect of the 3-month supervised exercise program on disease activity and physical function. ASDAS-CRP: C-reactive protein–based Ankylosing Spondylitis Disease Activity Score (inactive disease < 1.3, low disease activity 1.3 to < 2.1, high disease activity 2.1–3.5, and very high disease activity > 3.5); BASDAI: Bath Ankylosing Spondylitis Disease Activity Index (0–10, 10 = worst); BASFI: Bath Ankylosing Spondylitis Functional Index (0–10, 10 = worst).

activity, such as health professionals providing information[41,42], a focus on motivation for exercise[36,43,44], and use of reminders[45]. These factors may be of importance for improving physical activity level in individuals with axSpA.

In line with this, a recent systematic review concluded that education and supervision are important factors for adherence to exercise in individuals with axSpA[35]. Obviously, motivational or educational interventions are more cost-effective than supervised exercise programs, but it should be noticed that the magnitude of the clinical effect was poor in one of the educational studies[40]. Brophy, *et al*[44] stated that adding motivational strategies to the delivery of exercise programs was most effective in increasing physical activity, hence a combination of motivational and practical programs is probably important to increase physical activity level in patients with axSpA.

We found that physical activity status at baseline and participation in the supervised exercise program were the factors that were the most strongly associated with physical activity status at 12 months' followup. Previous research has shown that lower disease activity[31,44,46], better physical function, and quality of life is associated with being physically active in people with axSpA[31]. However, none of these factors were associated with physical activity level at the 12-month followup in our present study, and the difference in results may be explained by unequal study designs[31,44,46] and larger study populations in previous studies[31,44]. Our result is in line with the result of a systematic review stating that among several factors, low levels of physical activity at baseline were associated with poor adherence to physiotherapy treatment[47]. Exercise experience is known to be essential for achieving exercise self-efficacy[45]. In our study, the participants in the EG got practical training in exercise, which may perhaps compensate for lack of previous exercise experience.

The diminished effects on disease activity and physical function at 12 months' followup are in accordance with findings in previous studies[32,33,34,48]. Despite the beneficial effect on physical activity level, few participants continued with the exercise program. Our result is in line with earlier research reporting that it is more difficult for people to adhere to exercises at vigorous intensity, and that exercise-induced adaptations are reversed over time without adherence to the program[18]. Hence, the clinical implication is that vigorous-intensity exercise should be recommended as important in the treatment of individuals with axSpA owing to the beneficial effects on disease activity. However, as the effect slowly declines, future studies should investigate whether intermittent booster exercise sessions may increase participation in vigorous exercises.

Strengths of our present study are the study design, the relatively large sample size, the low dropout rate, and the longterm followup period. Further, the exercise program was based on the ACSM recommendations. The generalization of the study is probably high, because the study was carried out in outpatient clinics at 4 different hospitals and several physiotherapists supervised the exercise program. We have previously shown that the exercise program was safe and well tolerated in a group of individuals with high disease activity[37]. Self-reporting of physical activity level may be considered as a limitation, because participants may have under- or overreported their physical activity[49]. Further, participants were not blinded for group assignment, a factor that is reported to exaggerate subjective outcomes[50]. Nevertheless, it is a strength that physical activity was measured with standardized, frequently used questionnaires[27]. And, as the numbers of inactive individuals in the CG were unchanged during the study period, we argue that this strengthens the validity of the physical activity questions. Likewise, a limitation is how the exercise mode questions were formulated. Although only responses from individuals exercising ≥ 1/week were included, individuals in the EG might have included activities from the intervention period.

A supervised exercise program seems to increase the chance of staying physically active over time, thereby maintaining a beneficial health profile. Still, few individuals continued the exercise program, and the beneficial effect on disease activity and physical function at the end of the exercise program had declined at 12 months' followup.

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