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Research

Behaviour change intervention increases physical activity, spinal mobility and quality of life in adults with ankylosing spondylitis: a randomised trial

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KEY WORDS

Ankylosing spondylitis
Physical fitness
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ABSTRACT

Questions: Does a 3-month behaviour change intervention targeting physical activity (PA) increase habitual physical activity in adults with ankylosing spondylitis (AS)? Does the intervention improve health-related physical fitness, AS-related features, and attitude to exercise? Are any gains maintained over a 3-month follow-up? **Design:** Parallel-group, randomised, controlled trial with concealed allocation, assessor blinding and intention-to-treat analysis. **Participants:** Forty adults with a diagnosis of AS, on stable medication, and without PA-limiting comorbidities. **Intervention:** Over a 3-month period, the experimental group engaged in individually-tailored, semi-structured consultations aiming to motivate and support individuals in participating in PA. The control group continued with usual care. **Outcome measures:** The primary outcome was PA measured by accelerometry over 1 week. Secondary outcomes included clinical questionnaires and measures of health-related physical fitness. Measures were taken at baseline, post-intervention, and after a 3-month follow-up period. **Results:** Baseline characteristics were similar across groups, except age and body composition. There were statistically significant, moderate-to-large time-by-group effects in health-enhancing PA (mixed-design ANOVA for overall effect $F(2, 76) = 14.826$, $p < 0.001$), spinal mobility ($F(2, 76) = 5.691$, $p < 0.005$) and quality of life ($\chi^2(2) = 8.400$, $p < 0.015$) favouring the intervention group; post-intervention improvements were sustained 3 months later. No significant effects were seen in other physical fitness outcomes or on clinical questionnaires. No adverse effects were reported during the study. **Conclusion:** Health-enhancing PA, spinal mobility and quality of life were significantly improved after the intervention, and improvements were maintained at 3-month follow-up. **Trial registration:** NCT02374502. **[O'Dwyer T, Monaghan A, Moran J, O'Shea F, Wilson F (2016) Behaviour change intervention increases physical activity, spinal mobility and quality of life in adults with ankylosing spondylitis: a randomised trial. *Journal of Physiotherapy* 63: 30–39]**

Introduction

Ankylosing spondylitis (AS) is a chronic inflammatory rheumatic disease that primarily affects the axial skeleton. Clinically, it is characterised by inflammatory back pain and stiffness, with decreased spinal mobility, fatigue and limitations in physical function.[1] Accompanying extra-articular features may include uveitis, osteoporosis, inflammatory bowel disease, psoriasis, and cardiac, pulmonary and kidney involvement.[2] AS is associated with reductions in physical fitness, work productivity and health-related quality of life.[3–5]

Physical activity (PA), including therapeutic exercise, is a key component in the management of AS.[6,7] Exercise-based interventions have been shown to be effective in improving physical function, mobility, disease activity and quality of life outcomes.[8,9] In addition to these AS-specific benefits, PA has been shown to reduce the risk of cardiovascular disease, obesity, some cancers, type 2 diabetes and osteoporosis in the general population.[10] It also improves musculoskeletal health and reduces symptoms of depression. Despite these benefits, individuals with AS tend to have poor compliance with exercise programs;[11,12] the majority of adults with AS do not participate in regular exercise and may engage in less health-related PA than the general population.[5,12,13] Furthermore, exercise prescriptions have traditionally focused on flexibility and mobility.[8,9] Without also including aerobic and resistance components, exercise programs may not elicit the potential health benefits of PA. [10]

The promotion of PA to individuals with chronic conditions, such as AS, is a key challenge faced by healthcare professionals and policy makers.[7,14–16] International guidelines recommend that adults obtain at least 150 minutes of moderate-intensity aerobic PA per week, in bouts of activity lasting at least 10 minutes (PA_{BOUTS}).[6,15] Alternatively, weekly PA recommendations may be met by performing 75 minutes of vigorous-intensity PA, or by combining moderate-intensity and vigorous-intensity PA (MVPA). In addition, strengthening exercises are recommended for all adults, while balance and coordination exercises are recommended for adults aged > 65 years. Awareness of these guidelines among individuals with rheumatic conditions is low, and the

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efficacy of population-based approaches to PA promotion in reaching individuals with AS is questionable.[17]

'Brief intervention' is a term used to mean verbal advice, discussion, negotiation or encouragement, involving the provision of formal help and follow-up; this can vary from basic advice to a more extended, individually focused discussion.[16] National guidelines recommend brief interventions as effective methods with which to bring about health behaviour changes, including increasing PA.[16,18] In sedentary adults, brief interventions have shown positive short-term and long-term benefits on self-reported PA.[19,20] Although trials have delivered education and exercise-based interventions in AS cohorts,[8,9] it is believed that no study, to date, has explored strategies to increase habitual PA among individuals with AS. Thus, the Increasing Physical Activity in Ankylosing Spondylitis (INPACT-AS) trial was devised.

Therefore, the research questions for this parallel-group, randomised, controlled trial with concealed allocation, assessor blinding and intention-to-treat analysis were:

1. Does a 3-month behaviour change intervention targeting PA increase habitual PA in adults with AS?
2. Does the intervention improve health-related physical fitness, AS-related features, and attitude to exercise?
3. Are any gains maintained over a 3-month follow-up period?

Method

Design

This study was an assessor-blinded, parallel-group, randomised, controlled trial conducted between March 2015 and October 2015. Adults with a diagnosis of AS were randomly allocated either to individually tailored, semi-structured consultations to encourage PA (experimental group) or to usual care (control group), for a 3 month period. Eligible participants were randomised using a computer-generated list of random numbers that had been prepared using a blocked randomisation model by a researcher with no involvement in the trial. The allocation sequence was concealed in sequentially numbered, opaque, sealed envelopes. Following completion of baseline assessments, the lead researcher opened the appropriate envelope and assigned participants to their group. Outcomes were assessed at the end of the 3-month intervention period and 3 months later.

Participants, therapists and centres

Participants were recruited through the rheumatology outpatient clinics of St. James's Hospital, Dublin, and through patient support groups. Adults between 18 and 64 years of age who had been diagnosed by a rheumatologist with AS were eligible for inclusion in the study if they were on stable pharmacological management and proficient in English. The exclusion criteria were: a concomitant cardiac, respiratory or neurological condition; a comorbidity that restricts PA; an acute lower limb injury; uncontrolled epilepsy; a cognitive impairment; pregnancy; inability to ambulate without a mobility aid; or a change in medication during the 6 weeks preceding trial commencement. Written, informed consent was obtained from each participant prior to involvement in the study.

Intervention

Participants in the experimental group engaged in a number of individually tailored consultations with a physiotherapist. The aim of these sessions was to motivate and support individuals to participate in PA, taking into account their needs, ambitions, preferences and available resources. This intervention incorporated the 'spirit' of motivational interviewing, and emphasised partnership and cooperation between the physiotherapist and the participant.[21] Table 1 lists the specific behaviour change techniques used during the trial;[22] not all techniques were used for all participants.

Initial consultations (lasting approximately 30 minutes) were semi-structured, although three common areas were addressed with each participant. The first area was education: participants were provided with an AS information booklet (www.ankylosing-spondylitis.ie/pdf/SUAS_info_booklet.pdf) and participants were made aware of PA guidelines. The second area was resources: participants were provided with information about community-based programs, hospital-based classes and online resources. The third area was goal setting: individual PA goals were established, and individualised action plans were devised. Potential barriers to goal attainment were identified and strategies to overcome these were discussed.

Follow-up sessions were arranged to review PA behaviour, monitor progress, review goals and provide support and encouragement. The frequency of follow-up sessions and the mode of follow-up (in person or telephone) were at the discretion of the participant. Weekly reminders of personal PA goals were sent to participants by mobile text message or email. If applicable, participants were granted access to a commercial platform[a] to view individually tailored exercise programs.

Participants in the control group were informed of their group allocation by phone, and advised to continue with their habitual PA and medical management. They were only contacted by a member of the research team to schedule appointments for reassessment. No restrictions were imposed on beginning new PA routines, and appointments with healthcare professionals continued as normal.

Outcomes

Assessments were performed at baseline (Month 0), at the conclusion of the intervention period (Month 3), and following a 3-month follow-up period (Month 6). All physical fitness testing took place in the same exercise laboratory; equipment was calibrated prior to each session. Two physiotherapists trained in administering

Table 1
Behaviour change techniques used during the initial consultations and follow-up sessions (BCTTv1 labelling).[22]

Domain	Technique
Goals and planning	Goal setting (behaviour and outcome), problem solving, action planning, review of behaviour and outcome goal(s), 'discrepancy between current behaviour and goals
Feedback and monitoring	Self-monitoring of behaviour and outcomes
Social support	Social support (unspecified and practical)
Shaping knowledge	Instruction on how to perform the behaviour, re-attribution
Natural consequences	Information about health and emotional consequences, monitoring of emotional consequences, anticipated regret
Comparison of behaviour	Social comparison
Repetition and substitution	Behaviour substitution, habit formation, habit reversal, generalisation of target behaviour, graded tasks
Comparisons of outcomes	Pros and cons, comparative imagining of future outcomes
Reward and threat	Social reward
Antecedents	Body changes
Identity	Incompatible beliefs
Self-belief	Verbal persuasion about capability, focus on past success

the test protocol conducted outcome assessments. The assessors were blinded to participant group allocation, and participants were instructed not to divulge their group allocation. Participants were asked to refrain from smoking, eating or drinking for 4 hours, or engaging in strenuous exercise for 24 hours, prior to assessment sessions.

Sociodemographic characteristics were ascertained at baseline. Participants were also asked about symptom duration, time since diagnosis and current medication usage.

Primary outcome: physical activity

Free-living habitual PA was measured using ActiGraph GT3X accelerometers[b]. The validity and reliability of GT3X accelerometers have previously been established.[23–25] Participants wore the small tri-axial accelerometer on their hip during waking hours over a 7-day period. The monitor was only removed for showering and swimming, and non-wear time was documented in a daily log. The collected data was post-processed in the relevant software[c]. Wear time validity was determined according to the algorithm described by Choi et al;[26] wear time $\geq$ 10 hours per day and $\geq$ 4 days (including $\geq$ 1 weekend day) were also specified as criteria for valid wear time. Output in 'counts' was converted to time spent at different PA intensities according to established cutpoints.[27,28]

Secondary outcomes: physical fitness and anthropometry

A comprehensive battery of measures was used to assess components of health-related physical fitness. Anthropometric measures included: barefoot standing height[d], mass[e], and waist and hip circumferences.[29] Body fat percentage was estimated by whole-body bio-impedance analysis[e].[30] Spinal mobility was assessed by the Bath Ankylosing Spondylitis Metrology Index. (BASMI).[31,32] Thoracic mobility is underrepresented in the BASMI, so chest expansion was additionally measured circumferentially at the fourth intercostal level.[33] To assess cardiorespiratory fitness, participants undertook a multistage, submaximal exercise test on a treadmill.[34] After a 5-minute walking familiarisation period, participants began an incremental test following the modified Bruce protocol.[35] Breath-by-breath gas analysis and heart rate were recorded throughout[f]. The American College of Sports Medicine's metabolic equation was used to estimate VO_{2max}.[36] Finally, a push-up test and a curl-up test were completed according to the standardised American College of Sports Medicine procedures to measure muscular endurance;[36] the maximum number of consecutive repetitions performed without rest was recorded.

Secondary outcomes: clinical questionnaires

A number of commonly used questionnaires endorsed by the Assessment of SpondyloArthritis International Society were self-administered; these have established reliability and validity.[33,37] The Bath Ankylosing Spondylitis Global score (BAS-G) measured global well-being over the previous week and previous 6 months.[38] Disease activity was measured on the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI).[37,39] The Bath Ankylosing Spondylitis Functional Index (BASFI) assessed activities of daily living and functional ability.[40]

Additional questionnaires, not part of the Assessment of SpondyloArthritis International Society core set, were also administered. The Ankylosing Spondylitis Quality of Life Questionnaire (ASQoL) was used to measure the impact of AS on health-related quality of life.[41] Each participant's rating of their ability to manage their condition was measured using the AS version of the Arthritis Self-efficacy Scale (ASES-AS);[42] a higher mean score on the eight-item scale indicated higher self-efficacy. Each participant's perception of exercise was assessed using a modified version of the Exercise Benefits and Barriers Scale (EBBS).[43] The modified EBBS included 29 'benefit' items and 13 'barrier' items, with possible total scores ranging from 42 to 168; higher scores indicated a more positive perception of exercise.

Data analysis

Statistical analyses were performed with commercial software[g]. As this study was exploratory in design, no formal sample size consideration was performed. Data were analysed using an intention-to-treat analysis. Missing data were imputed with the last-observation-carried-forward approach. For all analyses, $p < 0.05$ (two-tailed) was taken as statistically significant. Normality of distributions was assessed using the Shapiro-Wilk normality test, in addition to visual evaluation of histograms and normal Q-Q plots of residuals. Descriptive statistics were used to report participant characteristics at baseline.

The main statistical analyses were performed using mixed-design repeated measures analysis of variance (ANOVA). A series of 3 x 2 ANOVAs (time: baseline versus post-intervention versus follow-up; group: intervention versus control) with repeated measures on the first factor and Bonferroni correction for multiple comparisons were run to assess the effects of the intervention on each of the outcome variables separately. One-way repeated measures ANOVAs were run to compare within-group main effects at each time point. Effect sizes were classified as small, medium or large (partial $\eta^2 < 0.01, < 0.06, < 0.14$, respectively).[44] If the assumptions of ANOVA were violated, data were transformed (square root or log10 transformations). If data transformation did not address the violations of assumptions for ANOVAs, data were analysed using related-samples Friedman's Two-way Analysis of Variance by Ranks test; separate Wilcoxon Signed-rank tests were used to identify within-group differences, and Mann-Whitney U tests were used to assess between-group differences at each time point.

Results

Compliance with the study protocol

Subsequent to protocol registration, costs associated with collection and processing of venous blood samples became prohibitively expensive. Consequently, inflammatory blood markers (C-reactive protein and erythrocyte sedimentation rate) were unavailable for the planned calculation of Ankylosing Spondylitis Disease Activity Scores.

Three participants were unable to attend the exercise laboratory for their post-intervention reassessment because of work commitments. One non-attendee from each group completed the self-report questionnaires and wore the PA monitor for 1 week, returning these by post. Five participants (three from the intervention group and two from the control group) were unable to attend the exercise laboratory for their follow-up assessment (work commitments n = 2, emigrated n = 1, did not attend n = 1, not contactable n = 1). Two of these non-attendees (one from each group) completed the self-report questionnaires and wore the PA monitor for 1 week, and returned them by post. Analysis of which data were missing showed that the curl-up and push-up tests had the largest numbers of missing values across the three test sessions; participants were unwilling, or felt unable, to attempt these tests. In light of the high number of missing cases, a complete case analysis was deemed appropriate for these strength outcomes.

Flow of participants, therapists and centres through the study

Recruitment for the trial concluded in April 2015. The participant flow through the study is summarised in Figure 1. A total of 44 potential volunteers were screened for inclusion in the study. Forty participants meeting the eligibility criteria were randomised to the intervention group (n = 20) and the control group (n = 20).

Baseline characteristics

The two groups of participants were similar with respect to baseline sociodemographic characteristics, symptom duration,

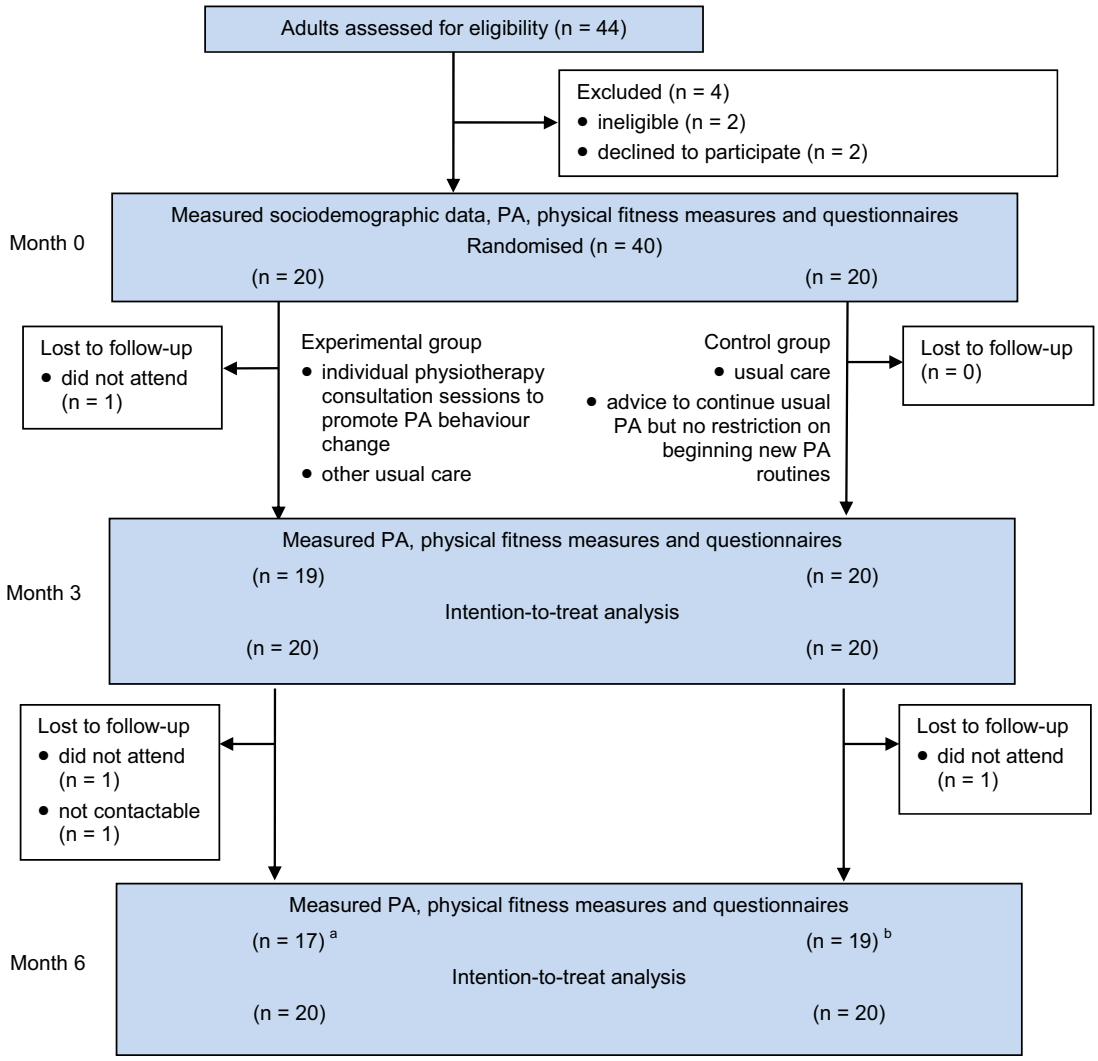

Figure 1. Design and flow of participants through the trial.
[a] Complete case analysis for muscular strength (n = 9 to 14).
[b] Complete case analysis for muscular strength (n = 7 to 13).

time since diagnosis, condition-related features (Table 2), PA measures (see Table 3 on the eAddenda) and physical fitness measures (see Table 4 on the eAddenda).

Engagement with intervention protocol

During the 3-month intervention, participants in the intervention group consulted with a physiotherapist a median of five times (IQR 4 to 5, range 2 to 6). Initial consultations were all in person. The median number of follow-up consultations was 4 (IQR 3 to 4), and 62% of these follow-up sessions were by phone (median 2, IQR 1 to 3). No adverse effects were reported as a consequence of the intervention.

Primary outcome: physical activity

There were large, statistically significant time-by-group effects for MVPA and PA_{BOUTS} (Table 5). In the intervention group, there were statistically significant differences in MVPA and PA_{BOUTS} between baseline and post-intervention ($p = 0.027$ and $p = 0.011$, respectively), and between baseline and follow-up ($p = 0.029$ and $p = 0.009$); this indicated a sustained increase in these variables over the follow-up period. In the control group, significant decreases in MVPA and PA_{BOUTS} were observed between the baseline and 3-month follow-up ($p = 0.026$ and $p = 0.013$, respectively). The between-group comparisons for the changes in these outcomes were statistically significant, indicating an effect of the intervention (see the last three columns of Table 5). No significant differences in time spent sedentary or engaging in light PA were observed across time points, indicating that the intervention had no significant effect on sedentary behaviour. At the end of the follow-up phase there were significantly more participants in the intervention group meeting the PA guidelines than in the control group (intervention group = 14, control group = 3; Pearson Chi-squared (1) = 12.379, $p < 0.001$). The experimental intervention significantly increased the likelihood of meeting the PA guidelines (RR 4.7, 95% CI 1.6 to 13.8).

Secondary outcome variables

Physical fitness

There was a moderate-to-large statistically significant time-by-group interaction effect for the BASMI (Table 6). In the intervention group, there was a significant decrease in BASMI score between baseline and post-intervention ($p < 0.0005$), and baseline and follow-up ($p < 0.0005$). In the control group, there were no significant differences in BASMI scores. In both groups, significant differences in the push-up test across the three time points were observed. In the control group, there was also a statistically significant difference in cardiorespiratory test duration. Post-hoc analyses did not show significant differences in these outcomes when Bonferroni corrections were applied. There were no significant time-by-group interaction effects for other physical fitness outcomes.

Table 2
Baseline characteristics of participants.

Characteristic	Total (n = 40)	Exp (n = 20)	Con (n = 20)
Age *(yr)*, mean (SD)	42 (9)	39 (8)	45 (10)
Gender, n males (%)	26 (65)	13 (65)	13 (65)
Caucasian, n (%)	40 (100)	20 (100)	20 (100)
Employed full time, n (%)	34 (85)	17 (85)	17 (85)
Tertiary educated, n (%)	30 (75)	17 (85)	13 (65)
Married, n (%)	23 (58)	10 (50)	13 (65)
Dependents *(n)*, median (IQR)	1 (0 to 2)	1 (0 to 2)	1 (0 to 2)
Smoker, n (%)	3 (8)	2 (10)	1 (5)
Residence, n (%)			
urban	37 (93)	18 (90)	19 (95)
rural	3 (8)	2 (10)	1 (5)
Symptom duration *(yr)*, mean (SD)	21 (12)	18 (10)	24 (14)
Time since diagnosis *(yr)*, median (IQR)	9 (5 to 20)	8 (5 to 13)	10 (5 to 22
Medications *(n)*, median (IQR)	1 (0 to 2)	1 (0 to 1)	1 (0 to 2)
Medications, n (%)			
none	10 (25)	5 (25)	5 (25)
anti-TNFα	22 (55)	11 (55)	11 (55)
NSAIDs	12 (30)	6 (30)	6 (30)
DMARD	2 (5)	0 (0)	2 (10)
analgesia	2 (5)	0 (0)	2 (10)
other	7 (18)	4 (20)	3 (15)
Back pain, total *(0 to 10)*, median (IQR)	3.0 (1.0 to 4.0)	3.0 (2.0 to 4.0)	2.5 (0 to 4.0)
Back pain, night *(0 to 10)*, median (IQR)	2.0 (0.3 to 4.0)	2.0 (1.0 to 3.9)	2.0 (0 to 4.8)
Global disease activity *(0 to 10)*, median (IQR)	3.0 (2.0 to 4.0)	3.0 (2.0 to 4.0)	2.0 (1.3 to 3.0)
Bath AS-Global (BAS-G) score *(0 to 10)*, mean (SD)	3.0 (2.0)	3.0 (1.8)	3.1 (2.2)
Bath AS Disease Activity Index (BASDAI) *(0 to 10)*, mean (SD)	3.2 (1.7)	3.4 (1.6)	3.0 (1.8)
Bath AS Functional Index (BASFI) *(0 to 10)*, median (IQR)	1.8 (0.5 to 3.5)	1.4 (0.5 to 3.3)	2.3 (0.7 to 4.0)
AS Quality of Life (ASQoL) questionnaire *(0 to 18)*, mean (SD)	4.8 (3.2)	5.1 (3.6)	4.5 (2.9)
AS version of the Arthritis Self-efficacy Scale (ASES-AS) *(0 to 10)*, mean (SD)	6.7 (1.7)	6.5 (1.6)	6.9 (1.8)

ASES-AS = Arthritis Self-efficacy Scale-Ankylosing Spondylitis version, ASQoL = Ankylosing Spondylitis Quality of Life questionnaire, BASDAI = Bath Ankylosing Spondylitis Disease Activity Index, BASFI = Bath Ankylosing Spondylitis Functional Index, BAS-G = Bath Ankylosing Spondylitis Patient Global score, Con = control group, DMARD = disease-modifying antirheumatic drugs, Exp = experimental group, NSAIDs = non-steroidal anti-inflammatories, TNFα = tumour necrosis factor alpha.
Some percentages do not sum to 100 due to the effects of rounding or because some patients were on multiple medications.

Clinical questionnaires

In the intervention group, there was a statistically significant difference in the ASQoL score over time (Table 7). Post hoc analyses, with Bonferroni corrections applied, showed a statistically significant decrease in the ASQoL score from baseline to post-intervention ($p = 0.007$), and from baseline to follow-up ($p = 0.008$). This indicated that the intervention improved AS-related quality of life. In the control group, there was also a statistically significant difference in the ASQoL, but post hoc analyses did not show significant differences in ASQoL score between time points when the Bonferroni correction was applied. There were no statistically significant time-by-group interaction effects for the other questionnaire outcomes.

Discussion

This randomised, controlled trial was the first to implement a behaviour change intervention targeting PA in an AS cohort. The results of this study demonstrated that an individually tailored brief intervention that targets PA increases habitual health-enhancing PA, and that this is sustained over a 3-month period. Brief intervention – as a strategy to increase PA – was well tolerated by individuals with AS who were able to moderate their chosen activities to match their personal abilities. After the intervention, 70% of the intervention group were adhering to the aerobic PA guidelines. This was significantly higher than the adherence rates in the control group, and higher than previously reported rates in AS cohorts[45] and the general Irish population.[46] Results from this study suggest that for every two people with AS who received the intervention, one of them will meet the PA guidelines who otherwise would not have met them (95% CI 1 to 4).

Secondary aims of the trial were to explore the effects of a PA behaviour change intervention on health-related physical fitness and on condition-related clinical outcomes. Importantly for individuals with AS, the brief intervention in this trial generated a moderate improvement in spinal mobility scores. This was achieved without implementing a specific flexibility program. Rather, participants selected exercises and activities that would help achieve their individual PA goals, which tended to be focused on functional tasks, aerobic exercise, or sporting activities. Other components of physical fitness (body composition, cardiorespiratory capacity and muscular fitness) did not significantly improve over the course of the study. The intervention targeted PA, and the dosage of exercise may not have been sufficient to generate physiological changes in these domains. The intervention showed benefits beyond PA and spinal mobility improvements; quality of life significantly improved from baseline to the end of the intervention, and this improvement was sustained at the 3-month follow-up.

Despite the numerous benefits of PA, compliance with exercise programs and participation in PA among individuals with AS are low.[11,45] Individuals with AS have proposed individually tailored interventions, collaboratively developed with healthcare professionals, as an effective strategy to PA and exercise prescription.[47] By incorporating this approach to PA promotion, this study was the first to demonstrate a significant, sustained positive effect on PA in adults with AS. Given the treatment effects of increased PA_{BOUTS}, improved spinal mobility and enhanced quality of life, against a background of stable self-reported disease activity, brief intervention as an approach to the management of people with AS appears to be safe, practical and beneficial. The adaptable nature of the intervention and the flexible approach to follow-up sessions facilitated engagement with the intervention. Similarly, such a self-directed approach has been successfully used to promote PA in the general population[19] and among people with rheumatoid arthritis.[48] Brief interventions require fewer resources than more intensive interventions such as exercise classes, and can be readily replicated in primary care or hospital settings. Brief interventions targeting PA behaviour are an alternate treatment option for clinicians working with individuals with AS.

Further clarification as to which behaviour change techniques generate the greatest effects and which, if any, are redundant, is

Table 5
Mean (SD) of groups, mean (SD) difference within groups, and overall effect size on physical activity outcomes.

Outcome	Groups						Difference within groups				Difference between groups		
	Month 0		Month 3		Month 6		Month 3 minus month 0		Month 6 minus month 0		Overall effect [a]		
	Exp (n = 20)	Con (n = 20)	Exp (n = 20)	Con (n = 20)	Exp (n = 20)	Con (n = 20)	Exp	Con	Exp	Con	F [b]	p-value [c]	Effect size [d]
Sedentary activity *(minutes/week)*	3800 (629)	3564 (790)	3600 (535)	3546 (760)	3755 (543)	3575 (722)	−140 (515)	−18 (547)	−46 (627)	−11 (489)	0.266	0.767	0.007
Sedentary time *(% of total wear time)*	65 (10)	60 (12)	64 (11)	62 (11)	63 (10)	63 (10)	−1 (7)	1 (8)	−1 (6)	3 (7)	2.405	0.097	0.060
Light physical activity *(minutes/week)*	1799 (495)	2022 (642)	1755 (606)	1894 (599)	1885 (610)	1818 (594)	−44 (360)	−128 (422)	87 (374)	−203 (514)	2.473	0.091	0.061
Moderate/vigorous physical activity *(minutes/week)* [e]	238 (72 to 382)	302 (196 to 479)	309 (171 to 448)	298 (185 to 429)	296 (177 to 446)	197 (160 to 288)	67 (11 to 137)	14 (-53 to 51)	58 (-4 to 146)	−65 (-155 to 17)	9.776	< 0.001	0.205
Moderate/vigorous physical activity in bouts ≥ 10 minutes *(minutes/week)* [e]	124 (4 to 230)	173 (46 to 234)	192 (119 to 308)	142 (50 to 193)	198 (144 to 315)	69 (40 to 114)	72 (8 to 155)	-6 (-64 to 10)	53 (1 to 162)	−72 (-139 to 1)	14.826	< 0.001	0.281
Total wear time *(minutes/week)*	5868 (435)	5920 (499)	5705 (509)	5758 (523)	5974 (636)	5642 (656)	−164 (465)	−162 (505)	105 (742)	−278 (661)	2.647	0.082	0.065

Con = control group, Exp = experimental group.
[a] 3 x 2 analysis of variance.
[b] Mixed-design analysis of variance F-ratio, representing interaction effect of time by group on dependent variable.
[c] Significant p-value < 0.05.
[d] Partial η^2: small > 0.01, medium > 0.06, large > 0.14.
[e] Data presented are median (IQR), median change (IQR) and overall effect.

Table 6
Mean (SD) of groups, mean (SD) difference within groups, and overall effect size on physical fitness and anthropometry outcomes.

Outcome	Groups						Difference within groups				Difference between groups		
	Month 0		Month 3		Month 6		Month 3 minus month 0		Month 6 minus month 0		Overall effect [a]		
	Exp (n = 20)	Con (n = 20)	Exp (n = 20)	Con (n = 20)	Exp (n = 20)	Con (n = 20)	Exp	Con	Exp	Con	F [b]	p-value [c]	Effect size [d]
Cardiorespiratory ftness													
VO_{2max} *(ml/min/kg)*	42.5 (9.1)	38.9 (8.5)	42.3 (10.0)	38.9 (10.4)	42.0 (9.6)	37.8 (8.6)	−0.1 (4.6)	0.0 (6.3)	−0.5 (4.9)	−1.1 (6.9)	0.095	0.910	0.002
Test duration *(s)* [e]	857 (756 to 934)	781 (662 to 872)	919 (747 to 947)	815 (725 to 905)	920 (756 to 948)	789 (742 to 917)	0 (-16 to 69)	56 (3 to 125)	21 (-12 to 73)	26 (-1 to 111)	1.701 [f]	0.427	N/A
											8.44 [g]	0.015	N/A
Body composition													
Mass *(kg)*	74.2 (12.5)	76.7 (11.6)	73.6 (11.8)	76.4 (11.5)	74.1 (11.8)	76.3 (11.8)	−0.6 (2.9)	−0.4 (1.6)	−0.1 (2.6)	−0.5 (2.6)	0.332	0.656	0.009
Body mass index *(kg/m)*	23.9 (3.8)	26.9 (3.6)	23.7 (3.5)	26.7 (3.7)	24.0 (3.5)	26.7 (3.9)	−0.2 (0.9)	−0.1 (0.5)	0.0 (0.8)	−0.2 (0.9)	0.674	0.486	0.017
Waist circumference *(cm)*	84.7 (8.3)	90.9 (10.1)	84.4 (8.4)	91.4 (11.6)	84.2 (9.1)	91.1 (12.0)	−0.3 (6.1)	0.5 (6.0)	−0.5 (4,8)	0.2 (6.3)	0.122	0.867	0.003
Hip circumference *(cm)*	99.9 (6.6)	103.3 (6.5)	99.1 (6.2)	101.1 (5.7)	98.8 (6.5)	100.9 (6.7)	−0.8 (1.9)	−2.2 (2.4)	−1.1 (1.9)	−2.4 (3.2)	2.237	0.114	0.056
Body fat *(%)*	21.9 (7.7)	26.9 (7.4)	21.5 (8.5)	26.4 (7.1)	22.1 (7.9)	26.9 (6.9)	−0.4 (2.4)	−0.4 (1.4)	0.1 (1,5)	0.0 (1.9)	0.016	0.984	<0.001
Muscular fitness													
Push-up Test *(n)* [e]	18 (11 to 28)	14 (8 to 24)	29 (19 to 31)	20 (10 to 27)	21 (20 to 30)	19 (12 to 30)	8 (5 to 14)	4 (1 to 10)	7 (1 to 12)	3 (3 to 11)	18.111[f]	<0.001	N/A
											7.680[g]	0.021	N/A
Curl-up Test *(0 to 25), (n)* [e]	20 (12 to 25)	20 (9 to 24)	23 (20 to 25)	21 (20 to 25)	22 (19 to 25)	20 (17 to 25)	2 (−2 to 8)	2 (−4 to 12)	5 (−2 to 6)	2 (−7 to 6)	1.152[f]	0.562	N/A
											1.04 [g]	0.595	N/A
Flexibility													
Chest expansion *(cm)*	4.8 (1.2)	4.2 (2.2)	5.5 (2.2)	4.7 (2.1)	6.0 (2.0)	5.3 (1.8)	0.6 (2.1)	0.5 (1.7)	1.1 (1.9)	1.1 (2.4)	0.029	0.971	<0.001
BASMI total score *(0 to 10)*	2.3 (1.1)	2.9 (1.3)	1.8 (1.0)	2.7 (1.4)	1.7 (1.0)	2.8 (1.4)	−0.5 (0.4)	−0.2 (0.4)	−0.6 (0.5)	−0.1 (0.5)	5.691	0.005	0.130

BASMI = Bath Ankylosing Spondylitis Metrology Index of spinal mobility, Con = control group, Exp = experimental group.
[a] 3 x 2 analysis of variance.
[b] Mixed-design analysis of variance *F*-ratio, representing interaction effect of time by group on dependent variable.
[c] Significant p-value < 0.05.
[d] Partial η^2: small > 0.01, medium > 0.06, large > 0.14.
[e] Data presented are median (IQR), median change (IQR) and overall effect.
[f] Data remained non-parametric after transformation so Friedmans' two-way analysis of variance by ranks is reported for the intervention group.
[g] Data remained non-parametric after transformation so Friedmans' two-way analysis of variance by ranks is reported for the control group.

Table 7
Mean (SD) of groups, mean (SD) difference within groups, and overall effect size on condition-related outcomes and attitudes to exercise.

Outcome	Groups						Difference within groups				Difference between groups		
	Month 0		Month 3		Month 6		Month 3 minus month 0		Month 6 minus month 0		Overall effect [a]		
	Exp (n = 20)	Con (n = 20)	Exp (n = 20)	Con (n = 20)	Exp (n = 20)	Con (n = 20)	Exp	Con	Exp	Con	*F* [b]	*p*-value [c]	Effect size [d]
Bath AS – Global (BAS-G) score *(0 to 10)*	3.0 (1.8)	3.1 (2.2)	3.1 (2.2)	2.9 (1.7)	2.9 (1.9)	3.0 (1.8)	0.1 (1.3)	−0.2 (1.6)	−0.1 (1.6)	−0.0 (1.1)	0.315	0.730	0.008
Bath AS Disease Activity Index (BASDAI) *(0 to 10)* [e]	3.2 (2.5 to 4.9)	2.8 (2.2 to 3.9)	2.7 (1.3 to 5.0)	2.4 (1.2 to 3.3)	2.2 (1.6 to 5.0)	2.5 (1.8 to 4.2)	−0.1 (−1.1 to 0.5)	−0.3 (−1.4 to 0.6)	−0.8 (−1.3 to 0.2)	−0.1 (−0.6 to 0.3)	3.534 [f]	0.171	N/A
											0.50 [g]	0.779	N/A
Bath AS Functional Index (BASFI) *(0 to 10)* [e]	1.4 (0.5 to 3.3)	2.3 (0.7 to 4.0)	1.0 (0.5 to 2.7)	1.9 (0.6 to 3.7)	0.6 (0.3 to 2.5)	2.4 (0.7 to 4.0)	0 (−0.5 to 0.5)	−0.2 (−0.8 to 0.2)	−0.1 (−0.1 to 0.5)	0 (−0.6 to 0.6)	3.545 [f]	0.170	N/A
											1.34 [g]	0.511	N/A
AS Quality of Life (ASQoL) questionnaire *(0 to 18)* [e]	5.0 (2.5 to 6.0)	4.5 (2.3 to 7.0)	2.0 (0.3 to 5.8)	3.0 (2.0 to 4.8)	2.5 (0.0 to 5.8)	4.0 (1.0 to 6.0)	−1.5 (−3.8 to 0)	−1.0 (−3.0 to 0)	−2.0 (−4.0 to 0)	−0.5 (−1.9 to 0)	8.400 [f]	0.015	N/A
											6.43 [g]	0.040	N/A
AS version of the Arthritis Self-efficacy Scale (ASES-AS) *(0 to 10)*	6.5 (1.6)	6.9 (1.8)	7.0 (1.2)	7.5 (1.8)	7.2 (1.7)	7.0 (2.0)	0.5 (2.0)	0.6 (1.1)	0.7 (2.2)	0.1 (1.4)	0.927	0.400	0.024
Exercise Benefits and Barriers Scale (EBBS)													
Total *(42 to 168)*	135.3 (16.3)	137.6 (14.3)	141.9 (10.0)	142.7 (15.0)	141.5 (13.5)	142.8 (15.4)	6.7 (13.1)	5.1 (7.8)	6.2 (12.7)	5.2 (8.1)	0.136	0.873	0.004
Benefits *(29 to 116)*	94.5 (11.8)	97.0 (10.8)	98.6 (8.2)	100.2 (11.0)	98.0 (10.5)	100.4 (11.1)	4.1 (9.5)	3.1 (6.6)	3.6 (9.4)	3.3 (6.2)	0.098	0.906	0.003
Barriers *(13 to 52)*	25.7 (6.3)	23.7 (4.9)	22.7 (3.8)	21.7 (5.3)	22.6 (5.2)	21.8 (5.3)	−2.6 (4.9)	−2.0 (2.5)	−2.7 (4.5)	−1.9 (2.6)	0.288	0.734	0.008

AS = ankylosing spondylitis, Con = control group, Exp = experimental group.
[a] 3 x 2 analysis of variance.
[b] Mixed-design analysis of variance *F*-ratio, representing interaction effect of time by group on dependent variable.
[c] Significant *p*-value < 0.05.
[d] Partial η^2: small > 0.01, medium > 0.06, large > 0.14.
[e] Data presented are median (IQR), median change (IQR) and overall effect.
[f] Data remained non-parametric after transformation so Friedmans' two-way analysis of variance by ranks is reported for the intervention group.
[g] Data remained non-parametric after transformation so Friedmans' two-way analysis of variance by ranks is reported for the control group.

needed. Future studies should also investigate the relative effects of different frequencies and durations of consultations, establish the optimal make up of follow-up sessions, and examine the effect of combining brief intervention for increasing PA with structured exercise classes. The feasibility and efficacy of a fully remote intervention (without face-to-face consultations) should be explored. Future studies should investigate the optimal timing for starting the intervention, and identify sub-groups that may be most amenable (or resistant) to this form of intervention. The efficacy of the intervention among individuals who are ambivalent or resistant to PA behaviour change remains to be ascertained. A full cost-benefit analysis of the intervention was not conducted, although community-based brief interventions to promote PA in the general population are cost-effective.[49]

Because of the exploratory nature of this study, an a priori sample size calculation was not performed. Consequently, this study may have been underpowered, and a larger study is recommended to replicate the findings. Nevertheless, the trial demonstrated that the benefits accrued over the course of the intervention were sustained for 3 months; the longer-term effects of the intervention remain unknown. The cohort of participants recruited to this trial had relatively low BASFI scores; results may not be generalisable to individuals with more severe forms of AS, whose functional limitation may limit their ability to be physically active. In dealing with missing data, the imputation methods that were used may have introduced bias into the results by failing to account for the uncertainty due to the missing data. Another limitation was the lack of blinding of participants and therapists. However, a strength of this study was that over its 6-month duration there were just three dropouts. Missing data were deemed to be missing completely at random, and so unlikely to bias the data set.

In conclusion, this was the first study to implement a brief intervention targeting PA behaviour in a cohort of individuals with AS. The intervention led to significant increases in health-enhancing PA, improved spinal mobility and increased quality of life, compared to controls. These improvements were sustained for 3 months.

What is already known on this topic: Among people with ankylosing spondylitis, exercise improves physical function, mobility, disease activity and quality of life. The majority of people with ankylosing spondylitis do not participate in regular exercise.

What this study adds: A brief intervention of counselling and goal setting to increase physical activity can be used repeatedly over 3 months to significantly improve physical activity, spinal mobility and quality of life in people with ankylosing spondylitis. These benefits appear to be maintained 3 months later.

Footnotes: [a]Salaso©, Salaso Healthcare Solutions, Limerick, Ireland, [b]GT3X accelerometers, ActiGraph, Pensacola, USA, [c]ActiLife software V.6, ActiGraph, Pensacola, USA, [d]Leicester portable height measure, Invincta Plasics, Leicester, UK, [e]MC-180 MA, Tanita Corp, Tokyo, Japan, [f]Quark, Cosmed, Rome, Italy, [g]SPSS for Windows V.22, IBM, Armonk, NY, USA

eAddenda: Tables 3 and 4 can be found online at doi:10.1016/j.jphys.2016.11.009

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