Title: **The longitudinal effects of a physical activity programme on the physical fitness and disability of back pain patients: a service evaluation**

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Title: The longitudinal effects of a physical activity programme on the physical fitness and disability of back pain patients: a service evaluation

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ABSTRACT

OBJECTIVE: To evaluate the longitudinal effect of a group physical activity service to help patients self-manage un-resolving back pain.

BACKGROUND: Back pain is one of the most common and costly conditions. Large scale trials have demonstrated a role for less traditional treatment including exercise, yet the long term effects of patient centred, group physical activity programmes remains unclear.

METHODS: One hundred and eighty one un-resolving back pain patients (aged 53 ±17 years) completed a 6x2h physical activity programme. All activities were relevant to activities of daily living and incorporated activities to develop aerobic fitness, flexibility, core activation, and muscular strength & endurance. Dietary advice, home diaries and pedometers were provided. **RESULTS**: Measures of back pain, aerobic fitness, muscular endurance and body composition showed significant ($p < 0.05$) pre-post intervention improvements. Disability rating decreased by 19% alongside improvements in aerobic fitness (15%), back extension (36%) back flexion (16%) and grip strength (5%). Six month follow up identified ($p < 0.05$) reductions in body fat (6.5%) whilst aerobic fitness, disability rating and muscular strength & endurance remained stable. **CONCLUSION:** Group physical activity programmes could contribute to the self-management of back pain, enabling sustained improvements in fitness, physical activity and body fatness.

KEYWORDS

Physical Activity, Back Pain, Disability, Self-Management, Group Exercise, Fitness

The longitudinal effects of a lifestyle physical activity programme on the physical fitness and disability of back pain patients: a service evaluation

Introduction

Back pain is a major health condition in Western countries and is associated with high levels of medical expenditure [1,2], work absence [3–5] and is the most common musculoskeletal condition [6–8]. Between 60-80% of adults will experience back pain [9–11], and 16% of adults in the United Kingdom (UK) consult their general practitioner every year [12]. The most appropriate intervention to support patients with back pain remains unknown [13] which can result in patients depending on pain medication, experience psychological deterioration and have low levels of physical inactivity through fear avoidance [14]. Preventing patients entering the 'revolving door' of health professionals requires new approaches to back pain treatment and studies have shown major advantages of group exercise therapy [15], that is more cost effective than individual treatment [16]. Nevertheless, few papers report on how these findings translate to actual service provision [39].

Long periods of inactivity is detrimental to recovery and medical guidelines recommend that patients should remain as active as possible [17,18]. Different types of exercise have been explored including low-moderate intensity aerobic exercise [19,20], high intensity aerobic exercise [21,22], core stabilisation and muscular strength exercises [23–27] and flexibility programmes [28–31].

It is increasingly apparent that multi-modal physical activity to increase aerobic fitness and muscular strength that relates to activities of daily living (ADL), can improve back pain. To date, the majority of research into exercise therapy has centred on delivering monodisciplinary interventions that have focused on improving specific outcomes such as strength of the lumbar stabilising muscles [32], functional range of motion of the lumbar spine [33] or aerobic fitness

[22,34] yet the most effective form of exercise remains unknown [33]. As 85% of back pain cases are non-specific [35] with multidimensional causes of pain, varying greatly between patients[36], a holistic approach to exercise therapy warrants further consideration.

Previous studies into back pain have focused on specific outcomes, [22,34,37], yet few appear to have assessed the effectiveness of group based exercise that incorporate a range of physical activity modalities, including dietary advice in combination with behaviour change strategies to promote self-management and patient empowerment [38]. At present, there is a paucity of research that explores the effectiveness of holistically orientated, multidisciplinary exercise therapy services for the treatment of back pain. This paper documents the findings of a local community back pain service designed to adopt a holistic approach to the management of non-specific back pain. The specific aims are to:

i. To investigate the effectiveness of a group lifestyle physical activity service on; physical activity, fitness and disability of back pain patients.
ii. To examine the longevity of the service six-months after completion.

METHOD

Participants

Patients were medically screened and referred from their GP to the sub-acute back pain service delivered by local Osteopaths in conjunction with cognitive behavioural therapy and exercise. These data are a random sample of one hundred and eighty-one participants (aged 53 ±17 years) that were deemed eligible to attend the physical activity programme as recommended by the Osteopath. Inclusion criteria were patients identified with non-specific or un-resolving back pain with no contraindications to-light to-moderate physical activity and a willingness to try exercise. Given the community and holistic focus of the service, no other exclusion criteria were imposed. As this programme was part of a new

community back pain service for the locality and not funded research, a pre-post-post design was adopted to help evaluate the effectiveness of the service, given that a control group was not possible. To evaluate the exercise component of the service, local ethical clearance was granted and patients had the right to withdraw from the programme at any time, without penalty.

Programme content

Patients completed a six session, multi-component, group (n=10) physical activity programme lasting two hours per week. Each session provided the patients with a different practical and educational focus including activities designed to develop safe and effective aerobic fitness, flexibility, core activation, stability, and muscular strength and endurance. All activities were designed to be relevant to activities of daily living and functional movement. Dietary advice, home diaries and pedometers were also provided to record and analyse lifestyle activities completed at home. Patients were provided with an information booklet to support activities completed during the sessions and extend patient knowledge of exercise, nutrition and principles of training. Patients were encouraged to set and review their own goals each week to promote self-management and patient empowerment. Physical activity opportunities were provided across formal (gym, swimming, outdoor activities, orienteering, sports) and informal environments (walking, lifting, cleaning, sitting, driving, home) so patients could maintain a physically active lifestyle after the programme had finished. Patients were able to attend and share the sessions with their carers, children or spouse to promote a physically activity culture within both the family and social environments. Comprehensive details on the programme content and design are included in table 1 and have been published elsewhere [39]

	Table 1: Summary of programme content								
	Theme	**Activity 1**	**Activity 2**	**Activity 3**	**Activity 4**	**Activity 5**	**Activity 6**	**Activity 7**	**Activity 8**
Week One	**Introduction & Baseline**	Introduction to the programme; Administration	Core activation & posture; chair based warm-up /mobility	Chester step test or alternative & education	Body composition assessment & education	Core flexion extension endurance & education	Flexibility and cool down & education	Individualized exercise therapy and rehabilitation Personalised goal setting	Social drinks tea/coffee
Week Two	**Motion patterns and core activation**	Small group discussion of daily diary, pedometers.	Chair based warm-up; sit to stands; calf raises; balance work; glut activation	Back saving motion patterns; hip hinge in context of daily tasks; explore neutral spine	Outside walk focusing on technique, pace, core activation and posture	Introduction to Nordic Walking focusing on co-ordination	Core strengthening; introduction to bird-dog, back saver sit up and side-plank	Individualized exercise therapy and rehabilitation Personalised goal setting	Social drinks tea/coffee
Week Three	**Aerobic Fitness**	Small group discussion of daily diary, pedometers. Larger group sharing as appropriate	Relaxation techniques: Lifestyle integration of learnt skills	Induction to fitness gym and aerobic equipment & education	Explore aerobic equipment; 5-8 minutes on up to 4 different ergometers	Progressions of bird-dog, back saver sit up and side-plank; glut max and med strengthening	Flexibility of major muscle groups; Review of achievements since starting the programme	Individualized exercise therapy and rehabilitation Personalised goal setting	Social drinks tea/coffee
Week Four	**Muscular Strength and Endurance**	Small group discussion of daily diary, pedometers. Larger group sharing as appropriate. Larger group sharing as appropriate	Introduction to resistance bands for home use	Nutrition and healthy food discussion. Food diary task	Aerobic warm up – patient led based on learnt exercise principles & increased self-efficacy	Introduction to resistance equipment in the fitness gym & education	Patient led core and flexibility exercises. Trouble shooting and adaptations	Individualized exercise therapy and rehabilitation Personalised goal setting	Social drinks tea/coffee
Week Five	**Free flow: Water, land & Exergaming**	Small group discussion of daily diary, pedometers. Larger group sharing as appropriate	Analysis of food diaries and group comments / observations	Aqua aerobics or land based options: Exercise gaming; aerobic exercise; Pilates; Nordic walking; Resistance exercise; fitness suite; flexibility; Floor based exercises (bird-dog, back saver sit up and side-plank; glut max and med strengthening)			Discussion around exit programme options. Barriers to exercise	Individualized exercise therapy and rehabilitation Personalised goal setting.	Social drinks tea/coffee
Week Six	**Summary & retest**	Small group discussion of daily diary, pedometers. Larger group sharing as appropriate	Retest baselines measures Chester step test; Body composition assessment; Core flexion extension; Questionnaires;			Individualized exercise therapy and rehabilitation		Café Group discussion Programme reflections Finish	

Measures

All measurement activities were also used as an educational opportunity for the patients to learn about their physical capability and better understand their back pain. Anthropometric measures of body mass (Weight Counting Scale, Seca Limited, UK), stature (Leicester Height Measure, Seca Limited, UK), body fat mass and lean muscle mass (Tanita MC-180) were obtained. Aerobic capacity was measured using the Chester Step Test protocol (Assist Creative Resources, UK) during which heart rate (HR) and ratings of perceived exertion (RPE) were recoded for each stage. The test was completed when either the patient reached 80% of HRmax or reaching an RPE >13. Muscular strength was measured using a hand grip dynamometer – grip A (Takei Physical Fitness Test, Japan). Back flexion and extension muscular endurance was measured with patients instructed to hold a specified position for as long as possible without pain, or until the test was terminated at 120s. Pedometers were used to assess physical activity and disability was measured using the Modified Oswestry Low Back Pain Disability Questionnaire (MODQ). All measures were taken on the first session and then repeated six weeks later. After the programme had completed, participants were later invited for a follow-up assessment at six-months.

Treatment of Data

Data were inputted and stored in a Microsoft Office Excel 2007 Spreadsheet (Microsoft Corporation, USA). Statistical software package SPSS (version 22.0, SPSS, Chicago, Illinois) was used for all statistical analyses. Parametric pre-post-post results were statistically compared using one-way repeated measures analyses of variance (ANOVA) with Bonferroni adjustment. Where differences were indicated, post hoc pairwise comparisons were used to compare means. Associations between data sets were examined using Pearson Product Moment Correlations. Probability values of <0.05 were considered significant and all tests were two sided. All results are expressed as means (SD) unless otherwise stated.

RESULTS

Repeated measures ANOVA indicated that measures of body mass, body fat percentage (%), lean mass and BMI were not significantly ($p>0.05$) different between pre-post programme measurement occasions. At 6-month follow-up, small (-3.8%) but significant ($p<0.05$) reduction in participants body fat % were identified.

Table 2: Body composition

Measure	Pre-Programme [(a)] (n-181)	Post-Programme [(b)] (n = 177)	6 month [(c)] (n=53)	% Change (Pre - 6 month)
Total Mass (kg)	84.2 (21.5)	83.4 (22.0)	83.6 (19.9)	-0.7
Body Fat Percentage (%)	34.2 (8.3)	33.8 (8.7) [c]	32.9 (8.7) [b]	-3.8
Lean Mass (kg)	54.3 (12.7)	54.3 (11.7)	54.8 (11.1)	+0.9
BMI	30.5 (7.0)	30.3 (7.0) [a]	30.4 (6.9)	-0.7

[a,b,c] Denotes statistical significance $p<0.05$

Repeated measures ANOVA revealed significant ($p<0.05$) improvements in aerobic fitness (15%) between pre-post programme measurement occasions (27, (15.3) $mL \cdot kg^{-1} \cdot min^{-1}$ to 31.1, (14.2) $mL \cdot kg^{-1} \cdot min^{-1}$) which were maintained at six month follow-up (32.6 (12.5) $mL \cdot kg^{-1} \cdot min^{-1}$). Measures of muscular strength (grip strength) and muscular endurance (back flexion and extension) revealed a similar pattern with significant ($p<0.05$) improvements in pre-post programme measures that were maintained but not improved ($p>0.05$) at six-month follow up, compared to post-programme values (table 3).

Table 3: Performance measures of physical fitness and disability

Measure	Pre Programme (n = 181)	Post-Programme (n=177)	6 month (n=53)	% Change (Pre-6mth)
Back Extension (s)	35.9 (38.7)	49.3 (40.9)*	50.2 (47.8)	40
Back Flexion (s)	61.4 (43.1)	71.9 (41.0)*	70.4 (48.3)	15
Grip Strength – Left (kg)	29.9 (11.4)	31.5 (12.1) *	30.3 (11.0)	1.3
Grip Strength – Right (kg)	31.4 (11.5)	32.4 (11.9)	31.9 (11.0)	1.6
Predicted Aerobic Fitness ($mL \cdot kg^{-1} \cdot min^{-1}$)	27.5 (15.3)	31.1 (14.5) *	32.6 (12.5)	13
Pedometer Count	4570 (2403)	7163 (9825)*	n/a	57
Oswestry Disability Rating	30.9 (19.3)	25.4 (19.1) *	27.6 (19.6)	-11

*** Denotes significantly different from pre-programme $p<0.05$**

Analysis of the MODQ revealed significant ($P<0.05$) pre-post programme improvements (19%) in disability rating (30.9(19.3) to 25.4 (19.1)) that reached clinical significance [40]. The moderate classification remained unchanged ($p>0.05$) at the post six-months measurement occasion (27.6 (19.6)). Paired samples t-test revealed that pedometer assessed physical activity levels improved ($p<0.05$) pre-post programme from 4570 (2403) to 7163 (9825) by 57%, although no data were available for follow-up analysis as few patients continued using the devices.

There were no meaningful relationships identified between variables following correlation analysis.

DISCUSSION

The main finding of this study was that six-weeks of group physical activity was sufficient to provide significant improvements in aerobic fitness (15%), physical activity (57%), muscular strength and endurance (5%) and disability (-11%) of back pain patients. Moreover, six months after the programme had finished these physical and perceptual benefits had not diminished, and significant reductions in body fat % (-3.9) had begun to emerge.

Evidence supporting 8-12 weeks aerobic exercise as a treatment for back pain has been documented [22,34,37]. Similarly, our intervention emphasised aerobic exercise, but in contrast to the other studies, was less tightly controlled to reflect our objective to encourage self-management and behaviour change. Instead, our approach focused on strategies to encourage patients to better self-regulate physical activity utilising principles learnt during the programme to optimise volume and intensity according to pain, fatigue and their own environmental constraints. Patients were issued pedometers to support self-monitoring of home based activity and review their own weekly goals. The finding that patients' physical fitness improvements remained six-months post programme was particularly welcome, supporting the programme's holistic and self-mediated approach to exercise therapy. Not only was our programme less prescribed than others [22,34,37] it was also significantly (50%) shorter. Kuukkanen and Mälkiä [29] and Chatzitheodorou *et al*. [22] lasted twelve weeks, Oldervoll *et al*. [34] lasted fifteen weeks and Hurwitz *et al*. [37] lasted eighteen months. Our programme was only six weeks thereby demonstrating potential cost savings for health service commissioners.

The MODQ has been shown to be a reliable measure when detecting changes in disability [41]. Our MODQ results (Table 3) suggest that the programme was effective at decreasing the disability of the group. Although the disability rating remained in the moderate classification, a significant 19% decrease in disability is recognised as clinically significant [40]. Programmes that have adopted a single exercise therapy such as core stabilisation [23,25–27] muscular strength [24] and aerobic fitness [22,34,37], have reported significant reductions in back pain with corresponding decreases ranging from 43.7% - 76.8%. Our improvements were more modest (19%), perhaps reflecting the holistic nature of the programme that focused on physical activities pertaining to ADL.

The finding that none of the measures in our programme were correlated to decreases in disability is consistent with others that have focused on aerobic fitness [42] and flexibility [29]. In contrast, Van der velde & Mireau [43], reported improvements in aerobic capacity were associated with greater decreases in back pain ($p<0.05$). Discrepancies are difficult to interpret, yet the nature of back pain reflects multi-factorial causation that has yet to be identified in most cases and it follows that no single treatment modality it likely to be successful. Our multi-component approach that encourages

patients to experience a range of physical activities for which they can integrate into daily life, is better able to address patient heterogeneity and personal circumstance. This person-centred approach, encourages sustainable self-management as reflected by patients reporting functional and physiological improvements six-months after the programme had completed.

This paper is novel given that it examines a new approach to exercise therapy, as adopted by a community back pain service from which outcomes are not routinely reported. However, the lack of control group requires caution when interpreting the main findings. The tests included in the programme were used as an educational opportunity for patients to learn about improving their back pain management, but this may have introduced further measurement bias. Similarly, only 30% of those who completed the initial six-week programme returned for the six-month follow-up, explained in part by the opportunity being made available only after the six-week programme had finished. Nevertheless, there is increasing demand on primary and secondary care for musculoskeletal conditions that can be better self-managed. Our approach to group physical activity in promoting ADL, rather than prescriptive exercise, shows promise as a sustainable and cost effective conservative option to help patients self-manage back pain.

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Week Two	**Motion patterns and core activation**	Small group discussion of daily diary, pedometers.	Chair based warm-up; sit to stands; calf raises; balance work; glut activation	Back saving motion patterns; hip hinge in context of daily tasks; explore neutral spine	Outside walk focusing on technique, pace, core activation and posture	Introduction to Nordic Walking focusing on co-ordination	Core strengthening; introduction to bird-dog, back saver sit up and side-plank	Individualized exercise therapy and rehabilitation Personalised goal setting	Social drinks tea/coffee
Week Three	**Aerobic Fitness**	Small group discussion of daily diary, pedometers. Larger group sharing as appropriate	Relaxation techniques: Lifestyle integration of learnt skills	Induction to fitness gym and aerobic equipment & education	Explore aerobic equipment; 5-8 minutes on up to 4 different ergometers	Progressions of bird-dog, back saver sit up and side-plank; glut max and med strengthening	Flexibility of major muscle groups; Review of achievements since starting the programme	Individualized exercise therapy and rehabilitation Personalised goal setting	Social drinks tea/coffee
Week Four	**Muscular Strength and Endurance**	Small group discussion of daily diary, pedometers. Larger group sharing as appropriate. Larger group sharing as appropriate	Introduction to resistance bands for home use	Nutrition and healthy food discussion. Food diary task	Aerobic warm up – patient led based on learnt exercise principles & increased self-efficacy	Introduction to resistance equipment in the fitness gym & education	Patient led core and flexibility exercises. Trouble shooting and adaptations	Individualized exercise therapy and rehabilitation Personalised goal setting	Social drinks tea/coffee
Week Five	**Free flow: Water, land & Exergaming**	Small group discussion of daily diary, pedometers. Larger group sharing as appropriate	Analysis of food diaries and group comments / observations	Aqua aerobics or land based options: Exercise gaming; aerobic exercise; Pilates; Nordic walking; Resistance exercise; fitness suite; flexibility; Floor based exercises (bird-dog, back saver sit up and side-plank; glut max and med strengthening)			Discussion around exit programme options. Barriers to exercise	Individualized exercise therapy and rehabilitation Personalised goal setting.	Social drinks tea/coffee
Week Six	**Summary & retest**	Small group discussion of daily diary, pedometers. Larger group sharing as appropriate	Retest baselines measures Chester step test; Body composition assessment; Core flexion extension; Questionnaires;			Individualized exercise therapy and rehabilitation		Café Group discussion Programme reflections Finish	

Table 2: Body composition

Measure	Pre-Programme [(a)] (n-181)	Post-Programme [(b)] (n = 177)	6 month [(c)] (n=53)	% Change (Pre - 6 month)
Total Mass (kg)	84.2 (21.5)	83.4 (22.0)	83.6 (19.9)	-0.7
Body Fat Percentage (%)	34.2 (8.3)	33.8 (8.7) [c]	32.9 (8.7) [b]	-3.8
Lean Mass (kg)	54.3 (12.7)	54.3 (11.7)	54.8 (11.1)	+0.9
BMI	30.5 (7.0)	30.3 (7.0) [a]	30.4 (6.9)	-0.7

[a,b,c] Denotes statistical significance p<0.05

Table 3: Performance measures of physical fitness and disability

Measure	Pre Programme (n = 181)	Post-Programme (n=177)	6 month (n=53)	% Change (Pre-6mth)
Back Extension (s)	35.9 (38.7)	49.3 (40.9)*	50.2 (47.8)	40
Back Flexion (s)	61.4 (43.1)	71.9 (41.0)*	70.4 (48.3)	15
Grip Strength – Left (kg)	29.9 (11.4)	31.5 (12.1) *	30.3 (11.0)	1.3
Grip Strength – Right (kg)	31.4 (11.5)	32.4 (11.9)	31.9 (11.0)	1.6
Predicted Aerobic Fitness ($mL \cdot kg^{-1} \cdot min^{-1}$)	27.5 (15.3)	31.1 (14.5) *	32.6 (12.5)	13
Pedometer Count	4570 (2403)	7163 (9825)*	n/a	57
Oswestry Disability Rating	30.9 (19.3)	25.4 (19.1) *	27.6 (19.6)	-11

*** Denotes significantly different from pre-programme $p<0.05$**