International Journal of Orthopaedic and Trauma Nursing (2016) 23, 14–24

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International Journal of Orthopaedic and Trauma Nursing

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A cycling and education programme for the treatment of hip osteoarthritis: a quality improvement study

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KEYWORDS
Hip osteoarthritis;
Exercise therapy;
Patient education as topic;
Self-care;
Group exercise, cycling

Abstract Osteoarthritis of the hip is associated with pain, stiffness and limitations to activities of daily living. The aims of this quality improvement project were to introduce a service developed to promote the self-management of hip osteoarthritis through exercise and education and to assess the impact of the programme on pain, function and quality of life. The service was a six-week cycling and education programme and 119 participants took part. Statistically significant improvements were found for Oxford Hip Scores (Mean (SD) change 4.14, 95%, CI 3.02, 5.25, $p < 0.001$); Sit-to-stand scores (mean change 3.06, 95%, CI 2.33, 3.79, $p < 0.001$); EQ5D-5L Utility (mean change 0.06, 95%, CI 0.03, 0.09, $p < 0.001$); EQ5D VAS (mean change 7.05, 95%, CI 4.72, 9.39, $p < 0.001$); pain on weight-bearing (WB) (mean change 1.56, 95%, CI 0.77, 2.36, $p < 0.001$), HOOS function (median change (IQR) 7.35, 1.84 to 19.12, $p < 0.001$) and TUG test (median change 1.11, 0.31 to 2.43, $p < 0.001$). Participants reported improvements in pain and function; increased confidence in managing hip pain and an increase in motivation to exercise. These findings were supported by a patient and public involvement forum who suggested extending the programme to eight weeks. These results suggest that the service has potential in the management of hip osteoarthritis.

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http://dx.doi.org/10.1016/j.ijotn.2016.02.004

Editors comments

Surgical intervention is not always the answer to every musculoskeletal problem as the innovation at the centre of this study shows. For hospital-based orthopaedic practitioners, there is a danger that medication and arthroplasty are seen as the only alternatives in managing pain and disability for patients with osteoarthritis. What is demonstrated here is the value of the strengthening of muscles and exercise of joints in improving the lives of osteoarthritis sufferers without the need for pharmacology or invasive intervention as well as their motivation to use exercise as a way of managing their pain. That is potentially true of other conditions, injuries and arthropathies. The intervention itself and its implementation are described here in detail so that others might try it out with their own patients, as feasibility is assured in the population studies here. Even if surgery is an ultimate intervention, exercise has to be an effective way to improve fitness and, hence, prepare those patients for surgery.

Introduction

In the UK a third of people aged over 45 years have sought treatment for osteoarthritis and projections indicate that by 2035 this proportion could nearly double as a result of increasing levels of obesity and an ageing population (Arthritis Research UK, 2013). Osteoarthritis is a chronic degenerative joint disorder usually associated with ageing and it is estimated that a quarter of people affected by osteoarthritis have osteoarthritis of the hip (2.12 million people, 8% of the UK population). Hip osteoarthritis is associated with hip pain, stiffness and limitations to activities of daily living and is the most common reason for a total hip replacement.

Hip replacement is a very successful operation (Learmonth et al., 2007). In 2014 there were 83,125 primary hip replacements in England, Wales and Northern Ireland. Since April 2003 ninety-three percent of hip replacement patients had a diagnosis of osteoarthritis (National Joint Registry, 2015a).

There is no known cure for osteoarthritis so non-surgical management for people with symptoms not yet severe enough for surgery mainly focuses on alleviating pain and maximising function by addressing aspects which can be modified. The National Institute for Health and Care Excellence (NICE) guidelines (2014) state that three core treatments should be the first line management for patients with osteoarthritis. These are; education and advice, exercise (aerobic and local muscle strengthening) and weight loss where appropriate. However there is no specific guidance on type of exercise, dose or intensity. It is also important to note that, other than exercise, a recent review by Bennell et al. (2015) confirms that the efficacy and role of other physical therapy interventions in the treatment of osteoarthritis is limited.

To date, studies have used exercises of low to moderate intensity with low to moderate success, but as yet there is little research on whether increasing the intensity of exercise in a safe way can increase the benefit of the exercise. It is important that appropriate models of prevention and treatment are developed to support and treat osteoarthritis sufferers.

The Cochrane Collaboration's 2014 review of studies of exercise for hip osteoarthritis found evidence supporting the use of exercise to reduce pain and improve physical function (Fransen et al., 2014) and these benefits continued for at least three to six months after the intervention. However, whilst physical exercise is the recommended treatment for osteoarthritis patients, the working mechanism behind the positive effects of physical exercise on pain and function remains a black box phenomenon (Runhaar et al., 2015). In their recent review to identify potential working mechanisms behind the positive effects of exercise therapy on pain and function in osteoarthritis, Runhaar et al. (2015) found that an increase of upper leg strength, a decrease of extension impairments and an improvement in proprioception were all possible mediators in the positive association between exercise and osteoarthritis symptoms in the lower limb.

The possible mediators proposed by Runhaar et al. (2015) are all promoted by the activity of cycling and, given the biomechanics of cycling, are relevant to the hip joint. In a recent review evaluating the role of muscles in the affected leg in hip osteoarthritis, Louriero et al. (2013) highlight the need to address muscle weakness. Cycle training induces muscle hypertrophy, with increased strength gains seen more favourably in older adults (Ozaki et al., 2015). In the power phase or 'downstroke' of cycling the hip, knee and ankle joints extend simultaneously for the pushing action (So et al., 2005) and, as a consequence, cycling is an excellent method of addressing and improving extension impairments in the hip, knee and ankle joints. In addition to the strengthening benefits of cycling, improvements to balance and proprioception have also been found (Rissel et al., 2013).

Cycling may also be of benefit in comparison to other forms of exercise because it is a healthy form of physical activity (Bauman and Rissel, 2009) and a non-weight bearing activity that is considered less stressful on the body than impact or other running sports (Rissel et al., 2013). Positive relationships between cycling and increased cardiorespiratory fitness, increased functional ability and disease risk factor profiles have also been found (Oja et al., 2011). There is also evidence from longitudinal epidemiological studies that cycling can lead to significant risk reduction for all-cause and cancer mortality, cardiovascular disease, colon and breast cancer and obesity morbidity in the middle-aged and elderly (Oja et al., 2011).

Local problem

The study setting is a conurbation with a high percentage of people aged over 65 where 30% of the population in one district is over 65; double the national average of 16% (Office for National Statistics, 2013). One local acute general hospital has a high volume hip and knee replacement unit, performing over 2000 joint replacements a year (National Joint Registry, 2015b) and a second acute general hospital in the area performed over 900 operations for hip fracture in 2014. The demographics indicate that effective non-surgical solutions need to be explored.

Effective models of care to deliver the non-surgical interventions recommended by NICE (2014) are yet to be developed locally. Discussion with local primary care providers suggested that 'standard care' for patients reporting hip stiffness to their GP can be varied and inconsistent, ranging from general advice, advice on analgesia and/or physiotherapy and self -management. Discussions with local physiotherapists affirmed wide variations in practice.

The CHAIN (Cycling against Hip pAIN) programme was conceived by a consultant orthopaedic surgeon and a physiotherapist as a way of implementing the NICE guidance (2014). It was developed by gaining consensus through further discussion with local orthopaedic teams and physiotherapists and in partnership with the local general hospital, the county commissioning group, general practitioner localities, the county sports partnership, the borough council and the university. The aim of the programme was to reduce pain and encourage mobility through a six week programme of education and static cycling sessions and to equip participants with the confidence to self-manage their condition.

Delivery of the programme was modelled on the established cardiac rehabilitation model utilised at the Royal Bournemouth Hospital (Bournemouth Heart Club, 2012) whereby progressive and structured exercise is accompanied with education in order to provide participants with the confidence to exercise.

Health referral advisors led by an experienced exercise instructor were trained on how to complete assessments prior to and following the programme and on testing participants' fitness for the programme. A senior physiotherapist led the education sessions and a trained static cycling instructor led the static cycling sessions.

Purpose

This study evaluated data collected from 119 participants who enrolled on the CHAIN programme using a pre-post design. It investigated whether those who undertook the six-week education and cycling programme experienced improvement in their pain, function and quality of life measures, and reviewed the experiences of the patients on the programme.

Methods

The PDSA (Plan, Do, Study and Act) cycle (NHS Institute for Innovation and Improvement, 2008) was the model of continuous quality improvement used to guide the process. The model has four stages: firstly the objectives of the service are define along with questions to be answered and predictions. The service is then delivered and data collected. Next the data are analysed, compared to predictions and the learning outcomes reflected on. The next cycle is then planned and a decision made to either refine the change or implement it fully.

The NHS Health Research Authority decision tool (NHS Health Research Authority, http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-uk--england-and-wales--scotland-and-northern-ireland/2013/stb---mid-2013-uk-population-estimates.html) and Research Department at The Royal Bournemouth Hospital confirmed that ethical approval was not required as this study was a service evaluation. In keeping with good practice, the principles outlined in the Declaration of Helsinki (World Medical Association, 2013) were followed and the SQUIRE guidelines (http://www.squire-statement.org/) for quality improvement reporting were used in this article to maximise the generalisability of findings.

Service delivery

The programme took place at two community-based leisure centres with good access to transport and

parking. The centres were chosen over hospital settings because of the dedicated exercise facilities and equipment needed and in order to introduce and familiarise people who don't usually exercise at a specific exercise environment. The programme was targeted at 45–75 year olds and funding was provided by the local Clinical Commissioning Group.

Participants were recruited to the programme through referral from their General Practitioner (GP). Participants were excluded if they were unable to meet criteria set by GPs for exercise referral. These exclusion criteria were: unstable angina; poorly controlled heart failure; new or uncontrolled arrhythmias; resting or uncontrolled tachycardia (resting heart rates >100 bpm); resting systolic blood pressure > 180 and/or resting diastolic blood pressure > 100; symptomatic hypotension; unstable diabetes; febrile disease (temporary); high levels of frailty and/or significant functional limitations.

Table 1 gives an overview of the programme. Participants had a one-to-one baseline assessment. The first five groups of participants (n = 58) were asked for details of their relevant past medical history and were timed for the Sit-to-Stand test (time taken to do 5 Sit-to-Stands) (Rehab Measures Database). They were also asked to complete the following validated patient reported outcome measures: Oxford Hip Score (Dawson et al., 1996), Harris Hip Score (Harris, 1969), Non-arthritic Hip Score (Christensen et al., 2003), EQ5D-5L Utility Score and EQ5D Visual Analogue Score (Euroqol Group, 2014). Participants were also asked verbally for three personal goals they would like to achieve by the end of the programme.

Following an interim evaluation after 58 patients, the last five groups of participants (n = 61) were additionally asked to do a Timed Up and Go Test (time taken to rise from chair, walk 3 metres, turns, walk back to chair and sit down) (Podsiadlo and Richardson, 1991), complete the Hip Disability Osteoarthritis Outcome (HOOS) function questionnaire (Klassbo et al., 2003) and assess pain at rest and on weight-bearing on a visual analogue scale (VAS).

Participants were given hip stretching exercises to do daily at home and were asked to complete a diary for the six weeks detailing the number of times they cycled in the week and other exercise taken. They were encouraged to cycle at least twice per week.

The education and cycling element of the programme consisted of a 30 minute education session, followed by 30 minutes of static cycling carried out one evening a week for six weeks. Content of the education sessions reflected NICE guidelines and can be seen in Table 1. The static cycling sessions were designed with an entry level session at week one progressing to a standard static cycling class equivalent at week 6.

At the end of the programme participants again had a one-to-one assessment in which earlier tests were repeated. The assessors also asked participants verbally whether their goals had been attained and what three things they found most useful about the programme. The assessors recorded the answers as free text.

Participants were emailed after they had completed the programme with details on how their assessments had changed over the six week programme.

The interim evaluation of the first five groups to take part in the programme was undertaken as part of the first PDSA cycle and findings were disseminated to the programme's stakeholders so that they could be reflected and acted upon. This was completed due to the novel nature of the programme and the desire to improve its delivery to patients. Resulting improvements were then put into place for following groups. These included adding the HOOS function score as an assessment as it was thought that the Oxford Hip Score might not be sensitive enough for this group of osteoarthritic patients; removing the Harris Hip Score and Non-arthritis hip score questionnaires as it was thought that the function and pain elements were sufficiently covered by other assessments; asking participants to do the Timed Up and Go (TUG) test as more information on function was required and asking them to assess pain at rest and on weight-bearing on a visual analogue scale as previous assessments of pain weren't quantifiable. The assessors were also asked to ensure that all questions were answered to minimise missing data.

The first three groups (n = 36) to take part in the programme were emailed and invited to take part in a Patient and Public Involvement (PPI) forum. Six former participants agreed to take part and, at the forum, they were consulted on their experiences of the programme and how it could be improved. The forum was also asked to advise on how a future proposed RCT based on the programme should be designed and which outcomes should be measured. This process has been published (Andrews et al., 2015).

Methods of evaluation

SPSS Predictive Analytics Software (SPSS Inc, Chicago, IL, USA) was used to analyse outcomes. Two-sided paired t-tests were used to investigate the changes from pre-programme to post-programme for the Oxford Hip Score, Sit-to-stand test, EQ5D-5L Utility and VAS scores, VAS scores for pain at rest and on weight bearing and means and standard deviations reported. The HOOS function and the TUG test had differences in pre and post-scores that were not normally distributed, so medians and interquartile ranges are

Table 1 Chain programme summary

Week	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Education session (30 mins)	Introduction	Review of last session	Review of last session and activity diary	Review of last session and activity diary	Review of last session and activity diary	Review of last session and activity diary
	Aims of the programme	Introduction to activity diary	Complementary therapies	Pacing	Benefits of exercise for OA Part III	Summary of previous sessions
	Introduction to osteoarthritis (OA) and the hip joint	Introduction to Home Exercise Programme (HEP)	Assistive devices	Optimising pain relief	Alternative exercise options	Self-management planning
	Benefits of exercise for OA Part I	Benefits of exercise for OA Part II	Diet, nutrition and supplements	Review of HEP and feedback on programme	Post programme exercise planning	Support networks
	Cycling technique Part I (Basics of pedal stroke)	Cycling technique Part II (How to use cleats)	Cycling technique Part III (Improving down and up stroke)	Cycling technique Part IV (Improving symmetry)	Cycling technique Part V (Breathing and upper body)	Social events
Static Cycling Session	30 minutes	30 minutes	30 minutes	30 minutes	30 minutes	30 minutes
Home Exercise Programme	Hip stretching exercises to be done daily 2×30 mins cycling per week	Hip stretching exercises to be done daily 2×30 mins cycling per week	Hip stretching exercises to be done daily 2×30 mins cycling per week	Hip stretching exercises to be done daily 2×30 mins cycling per week	Hip stretching exercises to be done daily 2×30 mins cycling per week	Hip stretching exercises to be done daily 2×30 mins cycling per week

reported and the Wilcoxon Signed Rank test was used for analysis of the changes from pre-programme to post-programme. Cases with complete pre and post data for each measure were selected so analyses were based on variable sample sizes if data were missing.

Data from the open ended questions on participants' experiences of the impact of the programme were thematically analysed (Denzin and Lincoln, 2005) using the constant comparative method of comparing themes from new data generated with those already identified from older data and iteratively refining them. TI developed the coding and carried out analysis for the first 39 participants. TW independently analysed this data and discussed and agreed with TI any discrepancies in the analysis. Emerging themes were identified through discussion between TW, TI and RM. Data for the final 80 participants were coded by TI when available. Discussion between the authors enabled themes to be refined and additional data collected from the PPI Forum enabled the veracity and credibility of findings to be checked.

Results

One hundred and nineteen participants were enrolled onto the CHAIN programme and 96 completed, of which 44 were men and 52 were women (Table 2); 78% already had a diagnosis of osteoarthritis, 25% of participants had a BMI under 25.0, 33% between 25.0 and 29.9, 25% were 30 and over and 16% were not known. The mean age of participants was 62.23 and the mean baseline Oxford Hip Score was 33.07.

Fig. 1 shows the flow of participants through the programme. Of the 23 who did not complete; 2 did not attend the first assessment; 3 withdrew before taking part in the programme as in pain from first assessment; 16 withdrew during the programme (7 had an increase in pain, 2 had chest infections, 2 had unrelated broken bones, 1 moved house, 4 unknown) and 2 did not attend the final assessment.

Statistically significant improvements were found for the Oxford Hip Score (Mean (SD) change 4.14 95% CI (3.02, 5.25), $p < 0.001$); Sit to stand score (mean change 3.06, 95% CI (2.33, 3.79), $p < 0.001$); EQ5D-5L Utility (mean change 0.06 (95% CI 0.03,0.09), $p < 0.001$); EQ5D VAS (mean change 7.05 (95% CI 4.72,9.39) $p < 0.001$); pain at rest (mean change 1.25 (95% CI 0.38,2.11), $p = 0.006$); and pain on weight-bearing (WB) (mean change 1.56 (95% CI 0.77,2.36), $p < 0.001$) (see Table 3). Statistically significant changes in HOOS function (median change (IQR) 7.35 (1.84 to 19.12), $p < 0.001$) and TUG test (median change 1.11 (0.31 to 2.43), $p < 0.001$) were also found (see Table 4).

Fig. 2 confirms that at least 60% of participants had positive changes for EQ5D VAS and EQ5D-5L utility scores and pain at rest and weight-bearing. Over 78% of participants had improvements in the Oxford Hip Score, HOOS function, Sit-to-stand and TUG scores.

Responses to the questions asked by assessors after the programme on participants' experiences of the programme could be divided into three main themes: perceived improvement in pain and function; increased confidence in managing hip pain and an increase in motivation to exercise. When asked whether they felt they had achieved their goals for the programme participants reported improved flexibility, less disturbed sleep and a reduction in pain and the need to take analgesics. They said they were finding activities of daily living easier, feeling fitter and stronger and some reported weight loss and delaying/reducing the need for a hip replacement. One participant reported:

"I knew I was fitter and had lost weight, but I was very pleased with the much improved flexibility of hip and pelvis."

Table 2 Participant characteristics

Gender n(%)	Male	44 (46%)
	Female	52 (54%)
Primary Diagnosis n (%)	No diagnosis	10 (10%)
	Osteoarthritis	75 (78%)
	Rheumatoid Arthritis	1 (1%)
	Post Traumatic	1 (1%)
	Other	6 (6%)
	Not stated	3 (3%)
BMI n (%)	Under 25.0	24 (25%)
	25.0–29.9	33 (34%)
	30.0 and over	24 (25%)
	Not stated	15 (16%)
Age mean (SD)		62.23 (9.27)
Baseline Oxford Hip Score mean (SD)		33.07 (8.18)

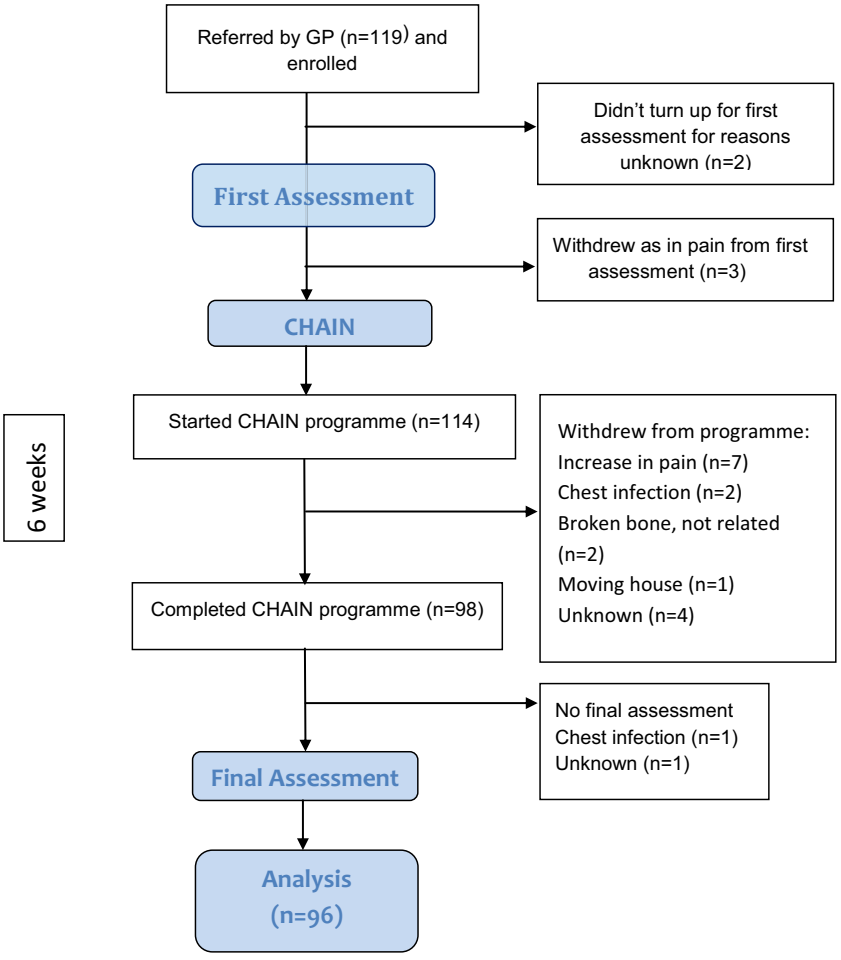

Fig. 1 CHAIN recruitment flow diagram

Participants also reported feeling more motivated to continue exercising and some had bought bikes or joined a gym. Saturation of the data was confirmed as responses were coded to the same categories many times (Glaser and Strauss, 1967).

Seven participants reported that their symptoms had not improved and some had increased pain following the programme, although all but one said they found the education sessions beneficial. Three further participants were unable to take part fully in the programme due to an unrelated abscess in the groin, plantar fasciitis and neck problems causing dizziness.

In response to the question on what three things they found useful about the programme, participants

Table 3 Pre and post CHAIN mean outcome scores

	n	Pre CHAIN Mean (SD)	Post CHAIN Mean (SD)	Mean (95% CI) of pre-post improvement	p (2-tailed)
Oxford	96	33.07 (8.18)	37.21 (7.74)	4.14 (3.02 to 5.25)	<0.001
Sit-to-stand	95	14.94 (5.51)	11.86 (3.78)	3.06 (2.33 to 3.79)	<0.001
EQ5D-5L Utility	96	0.70 (0.18)	0.76 (0.18)	0.06 (0.03 to 0.09)	<0.001
EQ5D VAS	94	74.59 (13.78)	81.71 (12.73)	7.05 (4.72 to 9.39)	<0.001
Pain at rest VAS	46*	3.08 (2.56)	1.79 (2.27)	1.25 (0.38 to 2.11)	0.006
Pain on weight bearing VAS	46*	3.76 (2.49)	2.16 (2.17)	1.56 (0.77 to 2.36)	<0.001

* These assessments were only carried out for last 46 participants.Oxford Hip Score: scored 0–48 with score of 40 + suggesting satisfactory function.Sit-to-Stand test: time in seconds taken to do 5 Sit-to-stands.EQ5D-5L Utility Score: scored −0.6 to 1.0, 1.0 being the best score.EQ5D VAS: scored 0–100, 100 being the best health imaginable.Pain at rest VAS and Pain on weight bearing VAS: scored 0–10, 0 being no pain.

Table 4 Pre and post CHAIN median outcome scores

Outcome	n	Pre CHAIN Median (IQR)	Post CHAIN Median (IQR)	Median (IQR) of pre-post improvement	p
HOOS function	44*	66.18 (49.26 to 81.62)	79.41 (63.60 to 88.24)	7.35 (1.84 to 19.12)	<0.001
TUG test	46*	9.06 (7.50 to 10.50)	7.53 (6.32 to 8.69)	1.11 (0.31 to 2.43)	<0.001

* These assessments were only carried out for last 46 participants (data missing for two participants for HOOS function).HOOS function score: scored 0–100, 100 indicates no problems.TUG Test: time in seconds taken to rise from chair, walk 3 metres, turn, walk back to chair and sit down.

spoke of being introduced to the benefits of cycling and exercise as a lifestyle both socially and physically and their increasing confidence in exercising. They found the group setting very motivating and supportive as they were able to discuss managing hip pain with people with the same issues. The education sessions were found to be very helpful as was the realisation that you do not have to accept the pain and can exercise without pain increasing. Participants were also keen to hear about other suitable exercise opportunities offered locally, such as the free guided bike rides. One participant reported:

"As a result of the course I did join the 37 mile Sky Ride through The New Forest two weeks ago and thoroughly enjoyed it".

Findings from the PPI Forum were very positive and affirmed findings from participant experiences reported at the post-programme assessment. Forum participants reported that the programme built up confidence in exercising and increased knowledge about managing hip pain, as well as general health. They liked the feedback they were given on how the programme had impacted on their assessments. The Forum suggested extending the programme to 8–10 weeks so that the last two weeks could focus more on the cycling and encourage participants to keep up with the cycling once the programme had finished.

Study limitations

This study is a service evaluation and whilst it is entirely appropriate for reporting these initial findings, there is no comparison with a control group. Generalisability in this report has been maximised by the use of the SQUIRE guidelines and the authors are applying for funding to complete a randomised controlled trial (RCT) to compare the programme with standard physiotherapy care. Recruitment bias can then be controlled as it is possible there may have been an element of self-selection in this study. Some participants asked to be referred if they wanted to take part in the programme and so were probably already aware of the benefits of exercise and motivated to take part.

Not all participants completed their diary and there were wide variations in the amount of exercise done each week by participants both cycling and at home, with some just cycling once a week as part of the programme and others cycling for an additional 2–3 times

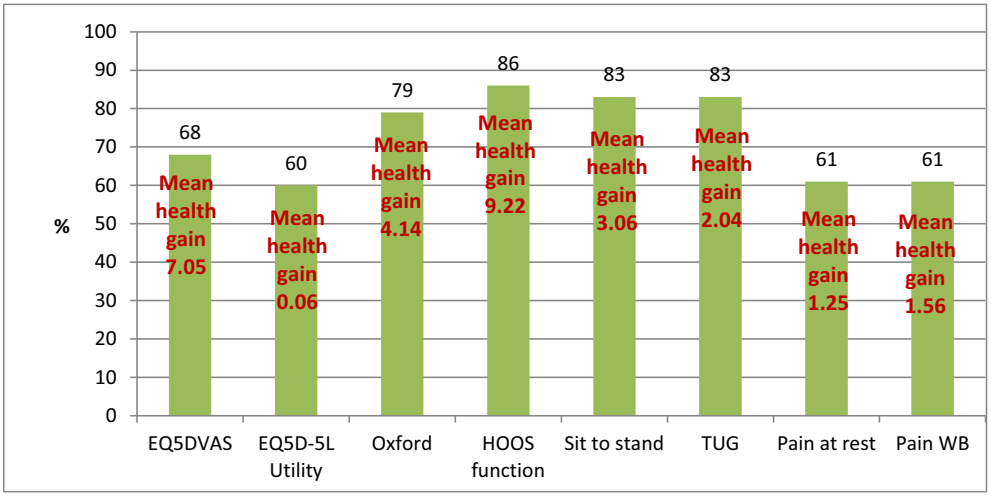

Fig. 2 Percentage of participants with improved outcome

per week. This is consistent with many physiotherapy studies where compliance with home exercise has been varied (Picorelli et al., 2014). If anything, compliance was less than anticipated and so the positive effects of the programme could, in fact, be greater when evaluated as part of a randomised controlled trial.

It should be highlighted that multiple significance tests were carried out in the analyses (eight tests) so care should be taken accordingly with the findings.

Discussion

The findings from this service evaluation suggest that participants may benefit from the programme. Function, pain and quality of life outcomes improved for the majority of participants and feedback from the programme was very positive with all participants saying they would recommend it. Participants were able to tolerate the increase in intensity of the cycling sessions over the six week programme, thus gradually building up exercise tolerance. This shows that increased exercise intensity is feasible in these patients and even for those with complex presentations (Wainwright et al., 2015). The findings suggest that the intensity of the exercise was sufficient to bring about change, although further studies are required to provide evidence on the role of exercise type, timing and dosage.

Participants' ages ranged from 39 to 81 indicating that the programme was suitable for a wide age range. Participants with comorbidities, such as type 2 diabetes and hypertension successfully participated in the programme suggesting these patients can benefit from exercise therapy interventions that stress the cardiovascular system, although it is important they are assessed and supervised appropriately. More research is needed for guidance on the best form of exercise.

Only seven participants reported that they felt no improvement in symptoms following the programme. Two of these were subsequently booked to have hip replacements, although they were supportive of the programme and just felt that they were "too far along" to benefit and one of these participants reported that her unaffected hip had benefitted from the exercise. The remaining five were also supportive of the programme and four of them reported finding the education sessions informative. Future discussions with stakeholders could include discussion on adapting the programme so it can also prepare participants for total hip replacement by getting them fitter for surgery and advise on self-management following their operation.

The programme was refined as it progressed as a result of feedback given at the post-programme assessment. The programme was adapted so that clearer static cycling instructions were given; the educational content was expanded and made less repetitive; more information and more detailed advice was given on stretching and home exercises and participants were encouraged each week to do their home exercises and complete their diary. It was decided to extend the programme to 8 weeks for the planned RCT so that participants had more time for cycling.

The positive findings suggest that the right approach was taken in introducing participants to the benefits of low-impact exercise and the availability of pre and post assessments enabled the service evaluation to have valid measures of change. As discussed it is planned to apply for funding for an RCT comparing the CHAIN programme with standard care in order to get further evidence on the impact of the programme and to evaluate whether the programme is more cost-effective than standard care. For this evaluation, costs per session were less than those for a private physiotherapy session, or an orthopaedic outpatient appointment but further work needs to be done on costs of rolling out the programme more extensively.

Conclusions

At present the NICE (2014) recommendations on the treatment of osteoarthritis offer no guidance on the type of exercise needed, its intensity or how it should be delivered. There is no uniform pathway for delivery of the recommended treatment and discussions with local health professionals indicate there is a wide variation in the types of therapeutic interventions adopted.

The early results from the CHAIN programme suggest that the service can improve pain, function and quality of life outcomes for hip osteoarthritis sufferers and it therefore has great potential in the management of hip pain. The improvements are consistent with current evidence and future work should be centred around evaluating the programme against standard physiotherapy care and other forms of physical activity. In parallel, further work is required to understand the "black box" of the working mechanisms of how physical exercise can positively affect pain and function in osteoarthritis.

Conflict of interest statement

There are no conflicts of interest.

Funding source

Funding for the programme and its evaluation was provided by the Dorset Clinical Commissioning Group, Active Dorset and Bournemouth Council.

Acknowledgements

We would like to acknowledge the CHAIN Partnership Group below who enabled our study to happen, and in particular Kate Rogers and Pauline Docherty at BH Live. We would also like to thank The Royal Bournemouth Hospital, Bournemouth and Christchurch General Practitioner Localities, Dorset Clinical Commissioning Group, Bournemouth University, BH Live, Active Dorset, and Bournemouth Borough Council.

References

Andrews, L.M., Allen, H., Sheppard, Z.A., Baylis G., Wainwright T.W., 2015. More than just ticking a box . . . how patients and public involvement improved the research design and funding application for a project to evaluate a cycling intervention for hip osteoarthritis. Research Involvement and Engagement 1 (13), doi:10.1186/s40900-015-0013-8.

Arthritis Research UK, 2013. Osteoarthritis in General Practice. Data and perspectives. Chesterfield: Arthritis Research UK.

Bauman, A.E., Rissel, C., 2009. Cycling and health: an opportunity for positive change? Medical Journal of Australia 190 (7), 347–348.

Bennell, K.L., Buchbinder, R., Hinman, R.S., 2015. Physical therapies in the management of osteoarthritis: current state of the evidence (Review). Current Opinion in Rheumatology 27 (3), 304–311.

Bournemouth Heart Club, 2012. Available from: <http://bournemouth-heart-club.org.uk/index.php/cardiac-rehabilitation> (accessed 07.01.16.).

Christensen, C.P., Althausen, P.L., Mittleman, M.A., Lee J.A., McCarthy J.C., 2003. The non-arthritic hip score: reliable and validated. Clinical Orthopaedics and Related Research 406, 75–83.

Dawson, J., Fitzpatrick, R., Carr, A., Murray, D., 1996. Questionnaire on the perceptions of patients about total hip replacement. The Bone & Joint Journal 78 (2), 185–190.

Denzin, N.K., Lincoln, Y.S., 2005. The sage handbook of qualitative research. Sage, London.

Euroqol Group, 2014. What is EQ5D? Available at: <http://www.euroqol.org/> (accessed 07.01.16.).

Fransen, M., McConnell, S., Hernandez-Molina, G., Reichenbach, S., 2014. Exercise for osteoarthritis of the hip (Review). Cochrane Database of Systematic Reviews (4), doi:10.1002/14651858.CD007912.pub2.

Glaser, B., Strauss, A.L., 1967. The discovery of grounded theory: strategies for qualitative research. Aldine, Chicago.

Harris, W.H., 1969. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. The Journal of Bone & Joint Surgery 51 (4), 737–755.

Klassbo, M., Larsson, E., Mannevik, E., 2003. Hip disability and osteoarthritis outcome score. An extension of the Western Ontario and McMaster Universities Osteoarthritis Index. Scandanavian Journal of Rheumatology 32, 46–51.

Learmonth, I.D., Young, C., Rorabeck, C., 2007. The operation of the century. The Lancet 370 (9597), 1508–1519.

Louriero, A., Mills, P.M., Barrett, R.S., 2013. Muscle weakness in hip osteoarthritis: a systematic review. Arthritis Care and Research 65 (3), 340–352.

National Institute for Health and Care Excellence (NICE), 2014. Osteoarthritis. Care and management in adults. NICE Clinical Guideline 177. Available from: <http://www.nice.org.uk/guidance/CG177> (accessed 07.01.16.).

National Joint Registry, 2015a. *12th Annual Report, 2015. National Joint Registry for England, Wales, Northern Ireland and the Isle of Man. Surgical data to 31st December 2014*. Hemel Hempstead: NJR Centre. Available from: <http://www.njrcentre.org.uk/njrcentre/Portals/0/Documents/England/Reports/12th%20annual%20report/NJR%20Online%20Annual%20Report%202015.pdf> (accessed 07.01.16.).

National Joint Registry, 2015b. Implant and unit-level activity and outcomes. 12th Annual Report, 2015. National Joint Registry for England, Wales, Northern Ireland and Isle of Man. Available from: <http://www.njrcentre.org.uk/njrcentre/Portals/0/Documents/England/Reports/12th%20annual%20report/06898%20NJR%20AR%202015%20Part%204.pdf> (accessed 07.01.16.).

NHS Health Research Authority, Is my study research? <http://www.hra-decisiontools.org.uk/research/> (accessed 11.11.15.).

NHS Institute for Innovation and Improvement, 2008. Plan, Do, Study, Act (PDSA). Available from: <http://www.institute.nhs.uk/quality_and_service_improvement_tools/quality_and_service_improvement_tools/plan_do_study_act.html> (accessed 07.01.16.).

Office for National Statistics (ONS), 2013. Annual mid-year population estimates, 2013. Available from: <http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-uk-england-and-wales-scotland-and-northern-ireland/2013/stb—mid-2013-uk-population-estimates.html> (accessed 07.01.16.).

Oja, P., Titze, S., Bauman, A., de Geus B., Krenn P., Reger-Nash B., et al., 2011. Health benefits of cycling: a systematic review. Scandinavian Journal of Medicine and Science in Sports 21, 496–509.

Ozaki, H., Loenneke, J., Thiebaud, R., Abe T., 2015. Cycle training induces muscle hypertrophy and strength gain: strategies and mechanisms. Acta Physiologica Hungarica 102 (1), 1–22.

Picorelli, A.M.A., Pereira, L.S.M., Pereira, D.S., Felício D., Sherrington C., 2014. Adherence to exercise programs for older people is influenced by program characteristics and personal factors: a systematic review. Journal of Physiotherapy 60, 151–156.

Podsiadlo, D., Richardson, S., 1991. The timed "Up & Go" test: a test of basic functional mobility for frail elderly persons. Journal of American Geriatric Society 39, 142–148.

Rehab Measures Database, Five times sit to stand test. Available from: <http://www.rehabmeasures.org/Lists/RehabMeasures/DispForm.aspx?ID=1015> (accessed 07.01.16.).

Rissel, C., Passmore, E., Mason, C., Merom D., 2013. Two pilot studies of the effect of bicycling on balance and leg strength among older adults. Journal of Environmental and Public Health 2013, 686412. doi:10.1155/2013/686412.

Runhaar, J., Lujisterburg, P., Dekker, J., Bierma-zeinstra, S.M., 2015. Identifying potential working mechanisms behind the positive effects of exercise therapy on pain and function in osteoarthritis; a systematic review. Osteoarthritis and Cartilage 23 (7), 1071–1082.

So, R.C.H., Ng, J.K.-F., Ng, G.Y.F., 2005. Muscle recruitment pattern in cycling: a review. Physical Therapy in Sport 6 (2), 89–96.

SQUIRE, Standards for Quality Improvement Reporting Excellence. Available from <http://www.squire-statement.org/> (accessed 07.01.16.).

Wainwright, T.W.W., Immins, T., Middleton, R.G., 2015. Hip osteoarthritis: patients with complex comorbidities can make exceptional improvements following intensive exercise and education. BMJ Case Reports, doi:10.1136/bcr-2014-208529.

World Medical Association Declaration of Helsinki, 2013. Ethical Principles for Medical Research involving human subjects. Available from: <http://www.wma.net/en/30publications/10policies/b3/> (accessed 07.01.16.).