

OARSI category: Clinical Aspects & Outcomes in OA

Title: A comorbidity-tailored exercise intervention for people aged 80 years or older with hip/knee osteoarthritis: intervention development using behaviour change theory.

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Word count (max 5000 characters): 2,837 + 200 (tables)

ABSTRACT

Background: Hip and knee osteoarthritis are becoming more common as the population ages, and the accompanying costs are increasing dramatically. Exercise is recommended for all people with hip/knee osteoarthritis. However, these recommendations are based on clinical trials including people aged in their 60's and 70's, often with few comorbidities. These findings cannot be reliably applied to people aged 80 years and older, who commonly manage multiple comorbidities. An exercise intervention developed specifically with, and for people aged 80 years and older with hip/knee osteoarthritis and tailored to comorbidities may facilitate the use and uptake of therapeutic exercise in this population.

The objective of this study was to describe the development of, and rationale for, a comorbidity-tailored exercise intervention for people aged 80 years or older with hip/knee osteoarthritis.

Methods: The Tailored Exercise Management for People aged 80 years and older with hip/knee Osteoarthritis (TEMPO) intervention was developed over three phases. Phase 1 included a systematic review of existing exercise interventions for community-dwelling adults aged 80 years and older, collating relevant condition-specific exercise guidelines and identifying which comorbidities to tailor the intervention to. Phase 2 involved qualitative interviews to identify barriers and facilitators to exercise, and exercise preferences among this population. Identified barriers and facilitators were mapped to the Theoretical Domains Framework (TDF). Phase 3 involved utilising the Theories and Techniques Tool to select the most effective behaviour change techniques (BCTs) to include in the intervention which linked to the relevant domains of the TDF.

Results: Based on existing literature, cohort analysis, qualitative interviews and behaviour change theory, a comorbidity-tailored exercise intervention was developed for people aged 80 years or older with hip/knee osteoarthritis. The systematic review and cohort analysis have been previously published. The following comorbidities, that were both common among people with hip/knee OA and had a significant impact on function and/or mobility were selected to tailor exercise adaptations for: angina/cardiac conditions; hypertension; Type 2 diabetes; cognitive impairment; hearing difficulties; visual difficulties; anxiety and depression. Interviewees expressed preference for individual exercise sessions with a physiotherapist (in-person initially with the option of telephone or video) combined with a home exercise programme. Barriers to exercise identified in the interviews most commonly mapped to the 'Beliefs about capabilities' and 'Beliefs about consequences' domains of the TDF. A total of 8 barriers and 6 facilitators to exercise participation were selected to target within the intervention. Twenty-five BCTs, which mapped to the barriers and facilitators were selected to use in the intervention (Tables 1 & 2).

Conclusion: A comorbidity-adapted exercise intervention for people aged 80 years or older with hip/knee osteoarthritis was systematically developed over three phases, utilising behaviour change theory. To evaluate the feasibility of delivering this intervention, a feasibility randomized clinical trial is currently underway.

Table 1. Identified barriers mapped to behaviour change techniques used in the TEMPO programme

Barrier	TDF domain	BCT's used within the TEMPO intervention
Painful joints limiting perceived ability to exercise.	4. Beliefs about capabilities	1.4. Action planning. 5.1. Information about health consequences (written and verbal). 6.2. Social comparison - encourage reading of patient success stories. 15.1. Verbal persuasion about capability.
Concern that exercise will increase pain and joint damage.	1. Knowledge 6. Beliefs about consequences	1.2. Problem solving. 1.4. Action planning. 5.1. Information about health consequences – explanation that exercise will not worsen joint damage (written and verbal). 8.7. Graded tasks.
Uncertainty about ability to exercise with other health conditions.	4. Beliefs about capabilities	1.4. Action planning. 5.1. Information about health consequences 6.2. Social comparison - encourage reading of patient success stories. 8.7. Graded tasks. 15.1. Verbal persuasion about capability.
Concern about effect of exercise on other health conditions.	6. Beliefs about consequences	1.4. Action planning 5.1. Information about health consequences – explanation about safety and benefits of exercise for other health conditions (written and verbal). 8.7. Graded tasks.
Fear of falling when exercising.	6. Beliefs about consequences	1.4. Action planning. 4.1. Instruction on how to perform the behaviour. 6.1. Demonstration of the behaviour. 8.1. Behavioural practice. 11.2. Reduce negative emotions. 12.1 Restructuring the physical environment.
Belief that nothing can be done to help joint pain.	6. Beliefs about consequences	5.1. Information about health consequences 6.2. Social comparison - encourage reading of patient success stories. 13.2. Framing/reframing.
Negative attitude to exercise due to previous experience.	6. Beliefs about consequences 13. Emotion	1.2. Problem solving 10.3. Non-specific reward – positive reinforcement. 13.2. Framing/reframing.
Forgetting to do exercises.	10. Memory, attention and decision processes	1.4. Action planning – use of a plan stating how often to exercise and which exercises to do. 7.1. Prompts/cues - prompt cards provided, encouragement to use reminders to exercise. 2.3. Self-monitoring of behaviour – exercise diary provided and reviewed at each session. 10.9. Self reward. 3.1. Social support (unspecified) – encouraged to involve partner, carer or family when exercising at

		home. 8.3. Habit formation.
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TDF: Theoretical Domains Framework

BCT: Behaviour Change Technique

Table 2. Identified facilitators mapped to behaviour change techniques used in the TEMPO programme

Facilitator	TDF domain	BCT's used within the TEMPO intervention
Belief in benefits of exercises.	6. Beliefs about consequences	5.1. Information about health consequences (written and verbal). 6.2. Social comparison - Encourage reading of patient success stories (included in workbook).
Exercises clearly linked to functional activities.	6. Beliefs about consequences	1.3. Goal setting (outcome). 8.6. Generalisation of target behaviour. 8.7. Graded tasks.
Fitting exercise in with usual routines.	14. Behavioural regulation	1.2 Problem solving. 1.4. Action planning. 3.1. Social support (unspecified) – encouraged to involve partner, carer or family when exercising at home. 7.1. Prompts/cues - prompt cards provided, encouragement to use reminders to exercise. 8.3. Habit formation.
Maintaining control and independence.	4. Beliefs about capabilities	1.1. Goal setting (behaviour). 1.3. Goal setting (outcome). 1.5. Review of goals (behaviour). 1.7. Review of goals (outcome). 6.2. Social comparison - encourage reading of patient success stories. 10.3. Non-specific reward – positive reinforcement.
Personalised exercise – adapted to ability; able to work at own pace.	11. Environmental context and resources	1.2. Problem solving. 8.7. Graded tasks. 12.1 Restructuring the physical environment.
Knowledgeable advice to exercise.	7. Reinforcement	2.2. Feedback on the behaviour – review and correction of exercise technique. 4.1. Instruction on how to perform the exercises. 6.1. Demonstration of how to perform exercises. 9.1. Credible source.

TDF: Theoretical Domains Framework

BCT: Behaviour Change Technique