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Running head:

Attitudes, beliefs and physical activity in older adults with knee pain

Title:

The relationship between attitudes, beliefs and physical activity in older adults with knee pain: secondary analysis of a randomised controlled trial

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Abstract

Objective

To investigate how attitudes and beliefs about exercise relate to physical activity behaviour in older adults with knee pain attributable to osteoarthritis (OA).

Design

Secondary data analyses of a randomised controlled trial of exercise interventions (ISRCTN 93634563). Participants were adults over 45 years old with knee pain attributable to OA (n=514). Crude and adjusted cross-sectional and longitudinal associations between baseline i) Self-Efficacy for Exercise (SEE), ii) Positive Outcome Expectations for Exercise (POEE), iii) Negative Outcome Expectations for Exercise (NOEE) and physical activity level at baseline, 3 and 6 months follow-up (measured by the self-report Physical Activity Scale for the Elderly (PASE)) and important increase in physical activity level (from baseline to 6 month follow-up) were investigated using multiple linear and logistic regression.

Results

Cross-sectional associations were found between SEE and PASE β= 4.14 (95% Confidence Interval 0.26, 8.03) and POEE and PASE β= 16.71 (1.87, 31.55) adjusting for sociodemographic and clinical covariates. Longitudinal associations were found between baseline SEE and PASE at 3 months β= 4.95 (1.02, 8.87) and 6 months β= 3.71 (0.26, 7.16), and baseline POEE and PASE at 3 months β= 34.55 (20.13, 48.97) and 6 months β= 25.74 (11.99, 39.49) adjusting for baseline PASE score and intervention arm. However, no significant associations with important increase in physical activity level were found.

Conclusions

Higher exercise self-efficacy and more positive exercise outcome expectations were associated with higher current and future physical activity levels. These may be targets for interventions aimed at increasing levels of physical activity.

Significance and innovations:

- Attitudes and beliefs about exercise, specifically exercise self-efficacy and positive outcome expectations for exercise, were found to be associated with current and future physical activity level in older adults with knee pain attributable to OA
- These attitudes and beliefs may be modifiable targets for interventions aimed at increasing physical activity level in older adults with knee pain attributable to OA

Knee pain attributable to osteoarthritis (OA) is common and often disabling in older adults (1). Clinical guidelines recommend exercise and physical activity as a core treatment for adults with OA, with associated benefits including pain reduction, improvement in physical functioning, reduction in risk of comorbidities and improved quality of life (1–3). However, physical activity levels in this population are low; less than half are sufficiently active to meet recommended activity levels (4–6). As a result, many older adults with knee pain are not gaining the health and clinical benefits associated with regular physical activity (7,8). Physical activity level can be considered a complex interplay of personal, social, environmental and governmental policy factors (8,9) with some factors acting as barriers and some as facilitators (10–13).

Attitudes and beliefs about exercise are theoretically important personal factors in explaining why physical activity varies between individuals, and are of clinical interest since they are potentially modifiable through specific interventions (9). Self-efficacy for exercise and outcome expectations for exercise have been linked with physical activity behaviour within social cognition theory and qualitative research in older adults with knee pain (9–12). Self-efficacy relates to the confidence an individual has in their ability and resources to carry out a behaviour successfully to reach desired outcomes (9) and is theoretically important in incentivising them to act and persevere in the face of difficulties (14). Outcome expectation beliefs and perceived risks are judgements regarding the consequences of behaviour (15). Although cross-sectional associations between these attitudes and beliefs and physical activity level have been found in general arthritis populations (16,17), such relationships have not been investigated in older adults with knee pain due to OA. It is also unknown if

baseline attitudes and beliefs about exercise can predict important increases in physical activity level following exercise interventions. Understanding this temporal relationship is important in inferring if attitudes and beliefs about exercise are determinants of physical activity level in this population. If this is the case, this has implications for the design of interventions targeting such attitudes and beliefs in order to increase physical activity and improve clinical outcomes in older adults with knee pain. The aims of this study were therefore to: 1) investigate the cross-sectional associations between i) self-efficacy for exercise ii) outcome expectations for exercise, and physical activity level in older adults with knee pain; 2) determine whether these attitudes and beliefs predict future physical activity levels; and 3) determine whether attitudes and beliefs about exercise predict an important increase in physical activity level following exercise intervention.

Patients and Methods:

Design

Secondary analysis of cross-sectional and longitudinal data from a three-armed randomised controlled trial of physical-therapist-led exercise interventions (The Benefits of Effective Exercise for knee Pain (BEEP) trial ISRCTN 93634563) (18). Full detail of the BEEP trial is available elsewhere (18), whilst a brief summary is provided below.

Participants:

Participants were adults with knee pain attributable to OA (n=514). Clinical OA diagnosis (representative of usual care in the UK) (1) was made by either a general practitioner or a research nurse based on age (being 45 years old or older), the presence of pain and/or

stiffness in one or both knees and the exclusion of pain caused by recent trauma or injury and other pathologies such as rheumatoid arthritis and malignancy (18).

Participants were recruited from 65 general practices in the midlands and north west of England into the BEEP trial after identification by one of three methods: i) records of those consulting their general practitioner in the last year with knee pain, ii) those referred to physical therapy and, iii) adults registered at participating general practices who responded to a questionnaire and reported knee pain. Those unable to travel to physical therapist treatment centres, those with previous total knee replacements and those with contraindications to exercise (such as those with unstable cardiovascular disorders, severe hypertension or congestive heart failure) were excluded (18).

Trial intervention arms:

The trial comprised three intervention arms: usual physical therapy care (UC), individually tailored exercise (ITE) and targeted exercise adherence (TEA). All participants received an advice and information booklet in addition to a one-to-one physical therapist-led exercise programme. In summary following randomisation, UC comprised up to four clinic sessions of advice and lower limb exercise programme over 12 weeks, plus a home exercise programme. ITE involved six to eight clinic sessions over 12 weeks of advice and individually tailored, supervised and progressed lower limb exercises plus a home exercise programme. TEA included eight to ten treatment contacts (in clinic or over the telephone) over 6 months of advice, individually tailored, supervised and progressed lower limb exercises and general physical activity, specifically supporting patients to adhere to exercise and engage in long term physical activity (see Appendix 1).

Outcomes:

Physical activity level

Physical activity level was measured using the self-report Physical Activity Scale for the Elderly (PASE) (19). This scale captures the frequency and duration of household, leisure time and work-related physical activity in the previous week and is summed with weighting specific to the intensity of those activities. It gives a continuous score from 0 to over 400 with higher scores indicating higher levels of physical activity. The scale has construct validity in terms of correlation with 6 minute walk test (r=0.35) and knee strength (r=0.41) in older adults with knee pain (20). It has also been shown to have good test-retest reliability (intra class correlation= 0.75) in older adults (19) and has been used in a number of longitudinal empirical studies of knee pain and OA (21,22).

Important increase in physical activity level between baseline and six months was calculated by two distribution based methods in the absence of a suitable anchor for clinically important physical activity change in older adults with knee pain (23). Method one involved the use of 0.5 of a standard deviation of the baseline PASE score (43.5) (24), which is equivalent to a "medium effect size" (25), whilst method two involved the minimal detectable change score (MDC) for the PASE (87) from a similar sample of older adults with lower limb OA (26). Clinically important change should ideally be larger than measurement error so a cut off score of at least 87 was deemed appropriate as the study working definition.

Determinants:

Attitudes and beliefs about exercise

Exercise self-efficacy was measured using the Self-Efficacy for Exercise Scale (SEE) which has been validated in older adults (27). This scale is scored from 1-10 with higher scores indicating greater self-efficacy for exercise. The SEE has some evidence for construct and criterion validity being significantly associated with mental and physical health measured by the 12 item short-form health survey and aerobic exercise activity in the previous three months (27). It has excellent internal consistency reliability as indicated by a Cronbach's α score of 0.92 (27) and has been used in previous studies of older adults with joint pain (17).

Exercise outcome expectations were measured using the Outcome Expectations for Exercise Scale (28) split into positive outcome expectations for exercise (POEE) and negative outcome expectations for exercise (NOEE). The positive and negative OEE subscales are scored from 1-5 with higher scores, on both subscales, indicating more positive outcome expectations for exercise. They have been shown to be significantly correlated with self-report physical activity level measured by the Yale Physical activity Scale (Pearson's correlations of 0.32 and 0.34 respectively) and SEE (0.69 and 0.61 respectively) in older adults (28). The Positive OEE has excellent internal consistency with a Chronbach's α score of 0.93 and the negative OEE has very good internal consistency with a Chronbach's α of 0.80.

Potential confounders:

The BEEP trial dataset included sociodemographic and clinical variables that were used for adjustment due to their potential association with attitudes and beliefs about exercise and with physical activity level (8,29). These included age, gender, Body Mass Index (BMI), individual socioeconomic status (30), employment status, comorbidities (categorised into none, one or two or more), depression measured by the Personal Health Questionnaire

(PHQ 8) (31), anxiety measured by the Generalized Anxiety Disorder Questionnaire (GAD-7) (32), pain and physical function measured by the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) (33) and widespread pain measured by the Manchester Widespread Pain criteria (34).

Analyses:

Descriptive statistics

Analyses were carried out using Stata version 13.1. (Statacorp. 2013. Stata Statistical Software: Release 13. College station TX: StataCorp LP). Baseline characteristics and longitudinal descriptive statistics of attitudes and beliefs about physical activity (SEE, POEE, NOEE) and physical activity levels (PASE) were summarised using frequency and percentage or mean and standard deviation as appropriate.

Analyses to investigate the cross-sectional association between attitudes and beliefs about exercise and physical activity level

All cross-sectional analyses utilised complete case data due to low levels of missing data at baseline (<10% missing data in key variables). Baseline univariable associations between SEE, POEE, NOEE and PASE at baseline were investigated using simple linear regression. Adjusted associations between each of the individual attitude and belief scales and physical activity were modelled adjusting for potential confounders and the trial intervention arm. Model building was carried out in three stages. In order to reduce the problem of collinearity within adjusted models (35), model building began with the investigation of Pearson's correlations between pairs of potential confounders (see Table II) followed by the removal of one variable from each pair that were highly correlated (Pearson's correlations

higher than 0.7) based on perceived clinical importance and previous evidence of association with physical activity level. Stage two of model building involved entering either SEE, POEE or NOEE and all remaining potential confounders. The specific attitude and belief scale together with the trial intervention arm were held constant within the model, followed by the manual iterative elimination of non-significant potential confounders using backwards elimination (36) until all remaining covariates were significant within the model. Stage three involved multiple linear regression assumption checking, further collinearity checking using the Variance Inflation Factor Statistic and checking for post-hoc model overfit using a conservative estimate of 10 participants per variable within the model (36,37).

Analyses to investigate if attitudes and beliefs about exercise can predict future physical activity level

Multiple imputed data (25 imputations) were utilised for the longitudinal data analyses in order to maximise sample size and reduce the possible bias associated with loss to follow-up and missing data (38) since there were higher levels of physical activity missing outcome data at three (30%) and six months (25%). Assumptions of data missing at random were made (38). Univariable associations between SEE, POEE, NOEE and PASE at three and subsequently six months follow-up were investigated using simple linear regression. Adjusted associations were investigated using multiple linear regression model building as above but using PASE at three and six month follow-up as the outcome variable and including the intervention arm within models a priori to account for any treatment effect within the trial.

Analysis to investigate if attitudes and beliefs about exercise can predict important increase in physical activity level

Univariable associations between SEE, POEE, NOEE and participants who increased their PASE score by at least 87 points between baseline and six months were calculated using logistic regression of multiple imputed data. Adjusted associations were investigated using multiple logistic regression model building as above without stage three and using important change in PASE as the outcome variable.

Results:

The baseline characteristics of the BEEP sample (n=514) are summarised in Table I. In total, 51% of the sample were female with a mean age of 62.8 years old (Standard Deviation 9.7) and the majority were either overweight (42%) or obese (39%). Participants had, on average, moderate pain and functional disability (mean WOMAC pain score 8.4 (3.5), mean WOMAC physical function score 28.1 (12.2)), low levels of physical activity (mean PASE score 177 (83.3)) and they were, on average, moderately positive about exercise (SEE mean score 5.4 (2.3), POEE mean score 3.9 (0.6) and NOEE mean score 3.5 (0.8) (see Table I). Table II summarises the change over time in physical activity and attitudes and beliefs about exercise.

Cross-sectional associations

Greater self-efficacy for exercise, more positive outcome expectations for exercise and less negative outcome expectations were all significantly associated with higher levels of physical activity in univariable models ($P<0.05$) (see Table III, column one). Every extra point on the SEE score was associated with an increase of 5.50 (95% Confidence Interval 2.21, 8.20) on the PASE. Similarly, for every extra point on the POEE and NOEE scales, there was an associated increase in PASE score of 19.58 (6.85, 32.30) and 20.16 (11.38, 28.94) respectively (N.B. higher NOEE scores indicate more positive outcome expectations).

The adjusted multivariable models are shown in Table III. Self-efficacy for exercise β= 4.14 (95%CI 0.26, 8.03) and positive outcome expectations for exercise β= 16.71 (1.87, 31.55) remained positively associated with physical activity level. However, negative outcome expectations were no longer significantly associated despite best estimates showing trends of association between higher scores (less negative outcome expectations) and higher levels of physical activity β= 4.47 (-6.39, 15.33).

Longitudinal associations

All three baseline attitude and belief variables predicted physical activity level at three and six months follow-up in univariable models (see Table IV and V column one). Higher levels of self-efficacy for exercise were associated with higher levels of physical activity at three β= 7.28 (3.33, 11.23) and six months β= 6.02 (2.30, 9.75). More positive outcome expectations for exercise were associated with higher physical activity levels at three and six months respectively β= 34.55 (20.13, 48.97) and 25.74 (11.99, 39.49) as were less negative outcome expectations for exercise β= 16.74 (6.51, 26.97) and β= 11.72 (1.81, 21.64).

Adjusting for baseline physical activity level and the trial intervention arm, higher SEE remained significantly associated with physical activity at three β= 4.95 (1.02, 8.87) and six months β= 3.71 (0.26, 7.16) as was POEE β= 25.48 (12.33, 38.62) and β= 13.93 (1.32, 26.54) (see Table IV and V). However, NOEE was no longer significantly associated with physical activity level at three β= 7.40 (-2.46, 17.25) or six months β= -1.59 (-11.31, 8.13) in adjusted models.

Predicting important change in physical activity level

Participants with greater baseline SEE and POEE were more likely to make important increases in physical activity level (PASE) between baseline and six month follow-up OR 1.07 (0.96, 1.20) and OR 1.36 (0.88, 2.10) respectively although these associations did not reach statistical significance (Table VI).

Adjusting for baseline PASE and the intervention arm, best estimates suggest participants with greater SEE OR 1.10 (0.98, 1.24), greater POEE OR 1.54 (0.99, 2.40) and less NOEE OR 1.09 (0.79, 1.51) were more likely to make important increases in physical activity level (see Table VI). However, these findings did not reach statistical significance.

Discussion:

As far as we know, this is the first study to investigate the relationship between attitudes and beliefs about exercise and physical activity behaviour in older adults with knee pain due to OA. Self-efficacy for exercise and positive outcome expectations for exercise were associated with current and future physical activity level in both crude and adjusted models. However, despite crude associations, negative outcome expectations for exercise were not associated with current or future physical activity levels in adjusted models. None of the investigated attitude and beliefs variables were able to predict clinically important increase in physical activity from baseline to six month follow-up.

Cross-sectional associations

Greater self-efficacy and positive outcome expectations remained significantly associated with physical activity level in adjusted models, which was in agreement with existing studies in older adults with arthritis generally (16,17,39). Believing that exercise is achievable, safe and likely to benefit health-related outcomes appears to be motivational in older adults with knee pain carrying out and persevering with physical activity such as exercise (9,10,12)

and this finding is independent of age, socioeconomic status, work status, comorbidities and depression. However, negative outcome expectations for exercise were no longer associated with physical activity level in adjusted models. Depression appeared to overlap with negative outcome expectations and explain similar variance in physical activity level, acting as a strong confounder. Conceptually both constructs also overlap since depression has been cognitively defined as negative views of the self and of the world and hopelessness about the future (40) and as emotional distress, negative thinking and motivational deficits (41).

In interpreting whether different attitude and belief constructs have different magnitudes of association with physical activity (and hence different potential clinical importance), it is important to consider both the size of regression model β coefficients and also the comparative attitude and belief scale ranges. Nevertheless, even taking this into account, positive outcome expectations for exercise appear to have the strongest magnitude of association with physical activity behaviour.

Longitudinal associations

Whilst physical activity behaviour in older adults with knee pain is complex and multifactorial (9), our longitudinal data suggests that self-efficacy for exercise and positive outcome expectations for exercise appear to be determinants predicting future physical activity level independent of baseline physical activity level or intervention arm. However, they may be weaker predictors over longer time-periods since the magnitude of associations with physical activity level were attenuated at six months when compared to three months. This attenuation may be due to either changes in attitudes and beliefs about exercise over time or changes in other confounders. Negative outcome expectations for

exercise were only significantly associated with future physical activity level in crude models suggesting that baseline physical activity level confounds any predictive relationship. Indeed, baseline physical activity level was an important and consistent confounder of all univariable relationships suggesting that physical activity level is relatively habitual and previous physical activity is the strongest predictor of future physical activity level (42,43). Despite being included in adjusted models a priori, the trial intervention arm was not significantly associated with physical activity level, suggesting that there was no significant between intervention group physical activity effect.

Predicting important increase in physical activity level

The null associations between all attitude and beliefs about exercise and important increase in physical activity level were similar to an existing longitudinal cohort study of 692 insufficiently active Australian older adults with arthritis generally, reported by Peeters and colleagues (7) who found that self-efficacy for regular exercise and motivation to exercise for social and health well-being were not significantly associated with increase in physical activity level at two year follow-up. It is possible that limitations in PASE responsiveness have contributed to the null findings (44) or that change in attitudes and beliefs about exercise may be better predictors of subsequent increase in physical activity (17).

Strengths and limitations:

Methodological strengths include analyses of both cross-sectional and prospective longitudinal data, allowing investigation of the temporal relationship between theoretically important attitudes and beliefs about exercise and future physical activity level. Multivariable model building allowed inferences to be drawn regarding potential confounders (45).

Limitations include the secondary nature of the data analyses, meaning it was not possible to investigate an exhaustive range of theoretically important attitude and belief constructs and potential confounders (such as environmental factors). To the authors' knowledge, no measures of attitudes and beliefs about exercise have specifically been designed for older adults with joint pain attributed to OA. Although SEE and OEE included items regarding pain they are unable to capture all condition-specific information (such as beliefs about "wear and tear" with exercise). Despite being validated in older adults with knee pain (20), the self-report PASE may both overestimate and underestimate physical activity level, be prone to recall bias and misclassification (46), whilst the scale output magnitude is not easy to interpret. Although guidelines exist stating recommended physical activity levels for adults (47,48), which the majority of older adults with knee pain attributed to OA are not meeting (5,6), there is no agreed cut-off in the published literature as to what constitutes an important increase in physical activity level for this population. Hence we were only able to use distribution methods for defining important increase in physical activity level outcome (23). Missing physical activity outcome data was relatively high at three and six months (30% and 25% respectively) which may lead to bias in the longitudinal association findings if participants who were lost to follow-up were systematically different to those remaining under observation (45). Comparing the baseline characteristics of follow-up responders and non-responders revealed slightly higher pain, poorer physical functioning and lower self-efficacy for exercise in non-responders (results not shown). Although steps were taken to manage this using multiple imputation for the longitudinal analyses, if some of the missing data were "missing not at random" (i.e. also as a result of unobserved factors) the findings would remain at risk of bias (38). In terms of generalisability, older adults with knee pain who met the inclusion criteria for the BEEP trial are systematically different from the

broader population of older adults with knee pain, (although the population is similar in terms of age and clinical severity to other trials conducted in primary care and community settings in the UK and the US). For example, those residing in nursing homes or those unable to attend treatment clinics were excluded and such individuals may have different attitudes and beliefs about exercise. We also recruited a clinical OA sample which may affect the generalisability to other settings where radiographic OA diagnosis is the norm.

Implications:

In line with NICE guidance (1) the findings support the clinical assessment of patients' attitudes and beliefs regarding physical activity alongside the assessment of current and previous physical activity levels. This information could be used to predict future physical activity levels. Furthermore, since self-efficacy for exercise and positive outcome expectations are predictive of future physical activity and theoretically modifiable they may also be targets for interventions aimed at increasing physical activity in insufficiently active older adults with knee pain (7).

Future research could investigate additional theoretically important attitudes and beliefs about physical activity and compare which constructs and measures are most predictive of physical activity behaviour. Beliefs about normal physical activity behaviour, perceived physical activity expectations from important others, catastrophizing, fear of movement, harm and falls all warrant further investigation in this population (9,49,50). This information could subsequently be used to design a composite tool that measures core attitudes and beliefs about physical activity in older adults with joint pain attributed to OA for standardised use across studies. Finally, for attitudes and beliefs to be considered targets for interventions aimed at increasing physical activity level, it is important for future

research to investigate whether changing these factors helps explain changes in clinical outcomes and or physical activity level following exercise interventions (17). Sperber and colleagues (2014) found change in self-efficacy for exercise to be associated with change in physical activity level in adults with more general "arthritis" undergoing a lifestyle physical activity intervention, however, the association between change in outcome expectations for exercise and change in physical activity level and clinical outcome has not been investigated.

Conclusions:

Higher self-efficacy for exercise and more positive outcome expectations for exercise were associated with current and future physical activity levels in older adults with knee pain due to OA. These attitudes and beliefs may be important targets for interventions aimed at increasing levels of physical activity.

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Table I Summary of BEEP trial participant baseline characteristics

Characteristic	Total (n=514)
Age categories (years), *n* (%)	
45-49	52 (10)
50-59	153 (30)
60-69	183 (36)
70-79	99 (19)
≥80	27 (5)
Female, *n* (%)	262 (51)
BMI, *n* (%), *	
Underweight/ normal	97 (20)
Overweight	208 (42)
Obese	192 (39)
Currently employed, *n* (%) *	214 (42)
Socioeconomic category, *n* (%) *	
Professional	166 (43)
Intermediate	94 (25)
Routine and manual work	124 (32)
Comorbidities, *n* (%)	
None	164 (32)
1 comorbidity	180 (35)
2 or more comorbidities	170 (33)
PHQ 8, 0-24, mean (SD) *	4.0 (+/-4.7)
GAD 7, 0-21, mean (SD) *	3.3 (+/-4.5)
WOMAC, mean (SD)	
Pain, 0-20, *	8.4 (+/-3.5)
Function, 0-68, *	28.1 (+/-12.3)
Stiffness, 0-8, *	3.7 (+/-1.7)
Knee pain duration (years), *n* (%) *	
≤ 1	125 (25)
More than 1 but <5	198 (39)
More than 5 but <10	94 (19)
10+	91 (18)
Widespread pain, *n* (%) *	
Yes	79 (15)

Footnote: Baseline complete case analysis; *=subject to missing data (hence individual item frequencies may not add to total sample). Body Mass Index: less than 25=underweight/ normal, 25 or more but less than 30=overweight, 30 or more=obese. Comorbidities included (in descending order of frequency) Hypertension, Asthma, Diabetes, Angina, Heart attack and Heart failure.

Abbreviations: BMI=Body Mass Index, GAD 7=Generalised Anxiety Disorder Questionnaire; PHQ 8=Personal Health Depression Questionnaire (higher scores indicate lower mood); SD=standard deviation; Widespread pain=Manchester Widespread Pain (34); WOMAC=Western Ontario and McMaster Universities Osteoarthritis Index.

Table II Summary statistics from BEEP variables over time

Variables (range)	Baseline	3 months	6 months
PASE (0-400+)	177.0 (83.3)	192.1 (87.9)	190.5 (89.3)
SEE (0-10)	5.4 (2.3)	5.7 (2.3)	5.6 (2.2)
Positive OEE (1-5)	3.9 (0.6)	4.0 (0.6)	4.0 (0.6)
Negative OEE (1-5)	3.5 (0.8)	3.8 (0.8)	3.8 (0.8)

Footnote: Multiple imputed data (combined results from 25 imputed datasets). All values are mean scores (standard deviation). All scores indicate higher levels of the variable except Negative OEE with higher scores indicating more positive outcome expectations for exercise.

Abbreviations: OEE=Outcome Expectations for Exercise; PASE=Physical Activity Scale for the Elderly; SEE=Self-Efficacy for Exercise.

Table III: Cross-sectional associations between attitudes and beliefs about exercise and physical activity at baseline

	Physical activity level (PASE) at baseline			
	Unadjusted	Adjusted SEE model A	Adjusted POEE model B	Adjusted NOEE model C
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Attitudes & beliefs				
SEE	5.50** (2.21, 8.20)	4.14* (0.26, 8.03)		
Positive OEE	19.58** (6.85, 32.30)		16.71* (1.87, 31.55)	
Negative OEE#	20.16** (11.38, 28.94)			4.47 (-6.39, 15.33)
Potential confounders				
Socio-economic category (ref professional)				
Intermediate	11.79 (-10.48, 34.06)	10.28 (-10.96, 31.51)	10.23 (-10.94, 31.39)	8.39 (-12.90, 29.68)
Routine/ Manual job	27.38** (7.05, 47.71)	28.59** (8.92, 48.27)	29.20** (9.56, 48.84)	28.36** (8.47, 48.26)
Currently in paid work (ref working)	-57.83** (-72.49,-43.17)	-38.92** (-56.12,-21.73)	-37.44** (-54.58,-20.29)	-38.51** (-55.86, -21.16)
Comorbidities (ref none)				
1 other condition	-20.56* (-38.83, -2.28)	-12.72 (-33.08, 7.65)	-10.07 (-30.43, 10.30)	-11.09 (-31.49, 9.31)
2+ other conditions	-48.35** (-66.89,-29.81)	-26.75* (-49.02,-4.49)	-25.86* (-48.09,-3.62)	-26.31* (-48.70, -3.93)
PHQ8 depression	-3.82** (-5.40, -2.24)	-2.59** (-4.47, -0.72)	-2.93** (-4.74, -1.13)	-2.91** (-4.80, -1.03)

Key: Adjusted SEE Model A (Self Efficacy for Exercise)
Adjusted POEE Model B (Positive Outcome Expectations for Exercise)
Adjusted NOEE Model C (Negative Outcome Expectations for Exercise)

Footnotes: Complete case data, all variables were measured at baseline, multiple linear regression adjusted models selected via backwards elimination holding one of self-efficacy for exercise (Model A) n=338, positive outcome expectations for exercise (Model B) n=339, and negative outcome expectations for exercise (Model C) n=340 within the model. Higher PASE score indicates higher level of physical activity. Higher scores on self-efficacy for exercise and positive outcome expectancies indicate higher self-efficacy and positive outcome expectancies. *=statistically significant β coefficient P<0.05; **= statistically significant β coefficient P<0.01; #=Higher score on the negative outcome expectancy scale indicates less negative outcome expectancies. Higher depression scores indicate worse depression. Potential confounders included in initial multivariable models and excluded during model building include: age, Body Mass Index, gender, anxiety-General Anxiety Disorder 7, pain duration, partner status, Western Ontario and McMaster Osteoarthritis Index pain and function subscales and widespread pain.

Abbreviations: β=unstandardized coefficient; CI=Confidence Interval; OEE=Outcome Expectations for Exercise (positive and negative subscales); SEE=Self-Efficacy for Exercise; PHQ8=Personal Health depression Questionnaire.

Table IV: Longitudinal associations between baseline attitudes and beliefs about exercise and physical activity level at three months follow-up

	Physical activity level (PASE) at three month follow up			
	Unadjusted	Adjusted SEE model A	Adjusted POEE model B	Adjusted NOEE model C
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Attitudes & beliefs				
SEE	7.28** (3.33, 11.23)	4.95* (1.02, 8.87)		
Positive OEE	34.55** (20.13, 48.97)		25.48** (12.33, 38.62)	
Negative OEE#	16.74** (6.51, 26.97)			7.40 (-2.46, 17.25)
Potential confounders				
PASE baseline physical activity	0.50** (0.39, 0.61)	0.49** (0.37, 0.60)	0.48** (0.37, 0.59)	0.49** (0.38, 0.60)
Intervention arm (ref usual physical therapy)				
Individually tailored exercise	-8.70 (-30.03, 12.63)	-7.83 (-27.50, 11.84)	-8.23 (-27.69, 11.23)	-8.01 (-27.76, 11.74)
Targeted exercise adherence	-3.72 (-24.64, 17.20)	-4.49 (-23.71, 14.72)	-6.61 (-25.81, 12.58)	-4.45 (-23.99, 15.09)

Key: Adjusted SEE Model A (Self Efficacy for Exercise)
Adjusted POEE Model B (Positive Outcome Expectations for Exercise)
Adjusted NOEE Model C (Negative Outcome Expectations for Exercise)

Footnotes: Multiple imputed data (combined results from 25 imputed datasets), all independent variables were measured at baseline, multiple linear regression adjusted models selected via backwards elimination holding one of self-efficacy for exercise/ positive outcome expectations for exercise/ negative outcome expectations for exercise within the model. Higher PASE score indicates higher level of physical activity. Higher scores on self-efficacy for exercise and positive outcome expectancies indicate higher self-efficacy and positive outcome expectancies. *=statistically significant β coefficient P<0.05; **=statistically significant β coefficient P<0.01; #=Higher score on the negative outcome expectancy scale indicates less negative outcome expectancies. Potential confounders included in initial multivariable models and excluded during model building include: age, Body Mass Index, comorbidities, depression-Personal Health Questionnaire 8, Gender, anxiety-General Anxiety Disorder 7, pain duration, partner status, socio-economic category, Western Ontario and McMaster Osteoarthritis Index pain and function subscales, widespread pain, work status.

Abbreviations: β=unstandardized coefficient; CI=Confidence Interval; OEE=Outcome Expectations for Exercise (positive and negative subscales); SEE=Self-Efficacy for Exercise.

Table V: Longitudinal associations between baseline attitudes and beliefs about exercise and physical activity level at six months follow-up

	Physical activity level (PASE) at six months follow-up			
	Unadjusted	Adjusted SEE model A	Adjusted POEE model B	Adjusted NOEE model C
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Attitudes & beliefs				
SEE	6.02** (2.30, 9.75)	3.71* (0.26, 7.16)		
Positive OEE	25.74** (11.99, 39.49)		13.93* (1.32, 26.54)	
Negative OEE#	11.72* (1.81, 21.64)			-1.59 (-11.31, 8.13)
Potential confounders				
PASE baseline physical activity	0.53** (0.43, 0.63)	0.49** (0.38, 0.59)	0.49** (0.38, 0.59)	0.49** (0.38, 0.60)
Age	-2.00** (-2.85, -1.15)	-1.07* (-1.88, -0.26)	-0.95* (-1.76, -0.13)	-1.24** (-2.07, -0.42)
Continuous BMI	-1.87* (-3.37, -0.37)			-1.47* (-2.91, -0.03)
Intervention arm (ref usual physical therapy)				
Individually tailored exercise	1.03 (-19.74, 21.79)	3.59 (-14.88, 22.07)	3.13 (-15.31, 21.58)	3.63 (-14.87, 22.14)
Targeted exercise adherence	8.26 (-12.69, 29.21)	9.16 (-9.74, 28.07)	7.52 (-11.38, 26.41)	9.17 (-9.77, 28.11)

Key: Adjusted SEE Model A (Self Efficacy for Exercise)
Adjusted POEE Model B (Positive Outcome Expectations for Exercise)
Adjusted NOEE Model C (Negative Outcome Expectations for Exercise)

Footnotes: Multiple imputed data (combined results from 25 imputed datasets), all independent variables were measured at baseline, multiple linear regression adjusted models selected via backwards elimination holding one of self-efficacy for exercise/ positive outcome expectations for exercise/ negative outcome expectations for exercise within the model. Higher PASE score indicates higher level of physical activity. Higher scores on self-efficacy for exercise and positive outcome expectancies indicate higher self-efficacy and positive outcome expectancies. *=statistically significant β coefficient P<0.05; **=statistically significant β coefficient P<0.01; #=Higher score on the negative outcome expectancy scale indicates less negative outcome expectancies. Potential confounders included in initial multivariable models and excluded during model building include: comorbidities, depression-Personal Health Questionnaire 8, Gender, anxiety-General Anxiety disorder 7, pain duration, partner status, socio-economic category, Western Ontario and McMaster Osteoarthritis Index pain and function subscales, widespread pain, work status.

Abbreviations: β=unstandardized coefficient; BMI=Body Mass Index; CI=Confidence Interval; OEE=Outcome Expectations for Exercise (positive and negative subscales); SEE=Self-Efficacy for Exercise.

Table VI: Associations between attitudes and beliefs about exercise and important physical activity level increase from baseline to six month follow-up

	Important increase in physical activity level (baseline to six months follow-up)			
	Unadjusted	Adjusted SEE model A	Adjusted POEE model B	Adjusted NOEE model C
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Attitudes & beliefs				
SEE	1.07 (0.96, 1.20)	1.10 (0.98, 1.24)		
Positive OEE	1.36 (0.88, 2.10)		1.54 (0.99, 2.40)	
Negative OEE#	0.97 (0.71, 1.32)			1.09 (0.79, 1.51)
Potential confounders				
PASE baseline physical activity	0.99** (0.99,1.00)	0.99** (0.99, 1.00)	0.99** (0.99, 1.00)	0.99** (0.99, 1.00)
Intervention arm (ref usual physical therapy)				
Individually tailored exercise	1.06 (0.55, 2.06)	1.03 (0.52, 2.04)	1.04 (0.53, 2.06)	1.04 (0.53, 2.05)
Targeted exercise adherence	1.15 (0.58, 2.25)	1.17 (0.59, 2.32)	1.15 (0.58, 2.28)	1.19 (0.60, 2.35)

Key: Adjusted SEE Model A (Self Efficacy for Exercise)
Adjusted POEE Model B (Positive Outcome Expectations for Exercise)
Adjusted NOEE Model C (Negative Outcome Expectations for Exercise)

Footnote: Multiple imputed data (combined results from 25 imputed datasets), all independent variables were measured at baseline, multiple logistic regression adjusted models selected via backwards elimination holding treatment arm and one of SEE/ positive OEE/and negative OEE within the model. Higher scores on the SEE and positive outcome OEE indicate higher self-efficacy and positive outcome expectations for exercise. *=statistically significant OR P<0.05; **=statistically significant OR P<0.01; #=Higher score on the negative outcome expectancy scale indicates less negative outcome expectancies. Important increase in physical activity was defined as an increase of 87 PASE points from baseline to six months. Potential confounders included in initial multivariable models and excluded during model building include: age, Body Mass Index, comorbidities, depression-Personal Health Questionnaire 8, Gender, anxiety-General Anxiety disorder 7, pain duration, partner status, socio-economic category, Western Ontario and McMaster Osteoarthritis Index pain and function subscales, widespread pain, work status.

Abbreviations: CI=Confidence Interval; OEE=Outcome Expectations for Exercise (split into positive and negative subscales); OR=Odds Ratio; PASE=Physical Activity Scale for the Elderly; SEE=Self-Efficacy for Exercise.

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Table legends

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Appendix one: Summary of the BEEP trial interventions (18)

Appendix two: Univariable associations with physical activity level at baseline, three, six months and important increase in physical activity from baseline to six months