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ORIGINAL ARTICLE

Relationship Between Attitudes and Beliefs and Physical Activity in Older Adults With Knee Pain: Secondary Analysis of a Randomized Controlled Trial

JONATHAN G. QUICKE, NADINE E. FOSTER, REUBEN O. OGOLLAH, PETER R. CROFT, AND MELANIE A. HOLDEN

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

Methods. **We conducted secondary data analyses of a randomized controlled trial of exercise interventions (ISRCTN: 93634563). Participants were adults ≥45 years old with knee pain attributable to OA (n = 514). Crude and adjusted cross-sectional and longitudinal associations between baseline Self-Efficacy for Exercise (SEE), Positive Outcome Expectations for Exercise (POEE), Negative Outcome Expectations for Exercise scores, and physical activity level, at baseline, 3 months, and 6 months (measured by self-report using the Physical Activity Scale for the Elderly [PASE]), and important increases in physical activity level (from baseline to 6-month followup) were investigated using multiple linear and logistic regression.**

Results. **Cross-sectional associations were found between SEE and PASE scores ($\beta = 4.14$ [95% confidence interval (95% CI) 0.26, 8.03]) and POEE and PASE scores ($\beta = 16.71$ [95% CI 1.87, 31.55]), adjusted for sociodemographic and clinical covariates. Longitudinal associations were found between baseline SEE and PASE scores at 3 months ($\beta = 4.95$ [95% CI 1.02, 8.87]) and 6 months $\beta = 3.71$ (0.26, 7.16), and baseline POEE and PASE at 3 months ($\beta = 34.55$ [95% CI 20.13, 48.97]) and 6 months ($\beta = 25.74$ [95% CI 11.99, 39.49]), adjusted for baseline PASE score and intervention arm. However, no significant associations with important increases in physical activity level were found.**

Conclusion. **Greater 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 physical activity.**

INTRODUCTION

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 the 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

ISRCTN: 93634563.

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Jonathan G. Quicke, BSc Hons(Physio), MSc, PhD, Nadine E. Foster, BSc Hons(Physio), DPhil, PGCE, Reuben O. Ogollah, BSc Hons(Mathematics), MSc, PhD, Peter R. Croft, MD, Melanie A. Holden, BSc Hons(Physio), PhD: Arthritis Research UK Primary Care Centre, Research Institute for Primary Care and Health Sciences, Keele University, Keele, Staffordshire, UK.

Address correspondence to Jonathan G. Quicke, PhD, Arthritis Research UK Primary Care Centre, Research Institute of Primary Care and Health Sciences, Keele University, Keele, Staffordshire, United Kingdom, ST5 5BG. E-mail: j.g.quicke@keele.ac.uk.

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Significance & 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 levels in older adults with knee pain attributable to osteoarthritis (OA).
- These attitudes and beliefs may be modifiable targets for interventions aimed at increasing physical activity in older adults with knee pain attributable to OA.

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 behavior 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 his or her ability and resources to carry out a behavior successfully to reach desired outcomes (9) and is theoretically important in incentivizing individuals to act and persevere in the face of difficulties (14). Outcome expectation beliefs and perceived risks are judgments regarding the consequences of behavior (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 whether or not attitudes and beliefs about exercise are determinants of physical activity level in this population. If this is the case, it 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, first, investigate the cross-sectional associations between self-efficacy for exercise, outcome expectations for exercise, and physical activity levels in older adults with knee pain; second, determine whether these attitudes and beliefs predict future physical activity levels; and third, determine whether attitudes and beliefs about exercise predict an important increase in physical activity level following an exercise intervention.

PATIENTS AND METHODS

Design. This study was a secondary analysis of cross-sectional and longitudinal data from a three-armed randomized controlled trial of physical therapist–led exercise interventions (the Benefits of Effective Exercise for Knee Pain [BEEP] trial [ISRCTN: 93634563]) (18). Full details of the BEEP trial are available elsewhere (18) and are summarized below.

Participants. Participants were adults with knee pain attributable to OA (n = 514). A clinical diagnosis of OA (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 1 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 to the BEEP trial from 65 general practices in the midlands and northwest regions of England after identification by 1 of 3 methods: records of those with knee pain consulting their general practitioners in the last year; those referred to physical therapy; and adults registered at participating general practices who responded to a questionnaire and reported knee pain. Those unable to travel to physical therapy treatment centers, 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 3 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 1:1 physical therapist–led exercise program. In summary, following randomization, UC comprised up to 4 clinic sessions of advice and lower-extremity exercise program over 12 weeks, plus a home exercise program. ITE involved 6–8 clinic sessions over 12 weeks of advice and individually tailored, supervised, and progressive lower-extremity exercises plus a home exercise program. TEA included 8–10 treatment contacts (in the clinic or over the telephone) over 6 months of advice, individually tailored, supervised, and progressive lower-extremity exercises and general physical activity, specifically encouraging patients to adhere to exercise and engage in long-term physical activity (see Supplementary Table 1, available on the *Arthritis Care & Research* web site at http://onlinelibrary.wiley.com/doi/10.1002/acr.23104/abstract).

Outcome: physical activity level. Physical activity level was measured by self-report using the 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 >400, with higher scores indicating higher levels of physical activity. The scale has construct validity in terms of correlation with the 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 (intraclass correlation coefficient 0.75) in older adults (19) and has been used in a number of longitudinal empirical studies of knee pain and OA (21,22).

An important increase in physical activity level between baseline and 6 months was calculated using 2 distribution-based methods, in the absence of a suitable anchor for clinically important physical activity change in older adults with knee pain (23). Method 1 involved the use of 0.5 of an SD of the baseline PASE score (43.5) (24), which is equivalent to a medium effect size (25), whereas method 2 involved the minimum detectable change in score for the PASE (identified as 87) from a similar sample of older adults with lower-extremity OA (26). Clinically important change should ideally be larger than measurement error, so a cutoff score of ≥87 was deemed appropriate as the study's working definition.

Determinants: attitudes and beliefs about exercise. Exercise self-efficacy was measured using the Self-Efficacy for Exercise (SEE) scale, 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 the mental and physical health domain measures of the 12-item Short Form health survey and aerobic exercise activity in the past 3 months (27). It has excellent internal consistency reliability, as indicated by a Cronbach's alpha 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 2 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-reported physical activity measured by the Yale Physical Activity Scale (Pearson's correlations of 0.32 POEE and 0.34 NOEE) and SEE (0.69 POEE and 0.61 NOEE) in older adults (28). The POEE has excellent internal consistency, with a Cronbach's alpha score of 0.93, and the NOEE has very good internal consistency, with a Cronbach's alpha score of 0.80.

Potential confounders. The BEEP trial data set 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, sex, body mass index, individual socioeconomic status (30), employment status, comorbidities (categorized as none, 1, or 2 or more), depression (measured by the Personal Health Questionnaire) (31), anxiety (measured by the Generalized Anxiety Disorder questionnaire) (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).

Descriptive statistics. Analyses were carried out using Stata, version 13.1. Baseline characteristics and longitudinal descriptive statistics of attitudes and beliefs about physical activity (assessed with the SEE, POEE, and NOEE) and physical activity levels (assessed with the PASE) were summarized using frequencies and percentages or means and SDs as appropriate (Table 1 and Table 2).

Cross-sectional association between attitudes and beliefs about exercise and physical activity level. All cross-sectional analyses utilized complete case data due to low levels of missing data at baseline (<10% missing data in key variables). Baseline univariable associations between the SEE, POEE, NOEE, and PASE at baseline were investigated using simple linear regression. Additional associations between potential confounders and the PASE at baseline were also explored (see Supplementary Table 2, available on the *Arthritis Care & Research* web site at http://onlinelibrary.wiley.com/doi/10.1002/acr.23104/abstract). Adjusted associations between each of the individual attitude and belief scales and physical activity were modeled adjusting for potential confounders and the trial intervention arm.

Model building was done in 3 stages. In order to minimize the problem of collinearity within adjusted models (35), model building began with the investigation of Pearson's correlations between pairs of potential confounders followed by the removal of 1 variable from each highly correlated pair (Pearson's correlations >0.7) based on perceived clinical importance and previous evidence of association with physical activity level. Stage 2 of model building involved entering

Table 1. Summary of BEEP trial participant baseline characteristics (n = 514)*

Characteristic	Value
Age (years), no. (%)	
45–49	52 (10)
50–59	153 (30)
60–69	183 (36)
70–79	99 (19)
≥80	27 (5)
Female, no. (%)	262 (51)
BMI, no. (%)†	
Underweight/normal (<25 kg/m^2)	97 (20)
Overweight (25–29 kg/m^2)	208 (42)
Obese (≥30 kg/m^2)	192 (39)
Currently employed, no. (%)†	214 (42)
Socioeconomic category, no. (%)†	
Professional	166 (43)
Intermediate	94 (25)
Routine and manual work	124 (32)
Comorbidities, no. (%)‡	
None	164 (32)
1	180 (35)
≥2	170 (33)
PHQ-8 (range 0–24), mean ± SD†	4.0 ± 4.7
GAD-7 (range 0–21), mean ± SD†	3.3 ± 4.5
WOMAC, mean ± SD†	
Pain (range 0–20)	8.4 ± 3.5
Function (range 0–68)	28.1 ± 12.3
Stiffness (range 0–8)	3.7 ± 1.7
Knee pain duration (years), no. (%)†	
≤1	125 (25)
>1 but <5	198 (39)
>5 but <10	94 (19)
10+	91 (18)
Widespread pain, no. (%)†	79 (15)

* BEEP = Benefits of Effective Exercise for Knee Pain; BMI = body mass index; PHQ-8 = Personal Health Questionnaire; GAD-7 = Generalized Anxiety Disorder questionnaire; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.
† Subject to missing data; values may not add up to total sample.
‡ Included comorbidities (in descending order of frequency): hypertension, asthma, diabetes mellitus, angina, heart attack, and heart failure.

Table 2. Summary statistics from BEEP variables over time*

Variable (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

* Results are from multiple imputed data (combined results from 25 imputed data sets). Values are the mean ± SD. All scores indicate higher levels of the variable, except negative outcome expectations for exercise (OEE), in which higher scores indicate more positive outcome expectations for exercise. BEEP = Benefits of Effective Exercise for Knee Pain; PASE = Physical Activity Scale for the Elderly; SEE = Self-Efficacy for Exercise.

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 nonsignificant potential confounders using backward elimination (36) until all remaining covariates were significant within the model. Stage 3 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).

Ability of attitudes and beliefs about exercise to predict future physical activity level. Multiple imputed data (25 imputations) were utilized for the longitudinal data analyses in order to maximize the sample size and reduce possible bias associated with loss to followup and missing data (38), since there were higher levels of physical activity missing outcome data at 3 months (30%) and 6 months (25%). Assumptions of data missing at random were made (38). Univariable associations between the SEE, POEE, NOEE, and PASE at 3 months and subsequently at 6 months were investigated using simple linear regression. Adjusted associations were investigated using multiple linear regression model building, as described above, but using PASE at the 3- and 6-month followup as the outcome variable and including the intervention arm within models a priori to account for any treatment effect within the trial.

Ability of attitudes and beliefs about exercise to predict an important increase in physical activity level. Univariable associations between the SEE, POEE, NOEE and participants who increased their PASE score by at least 87 points between baseline and 6 months were calculated using logistic regression of multiple imputed data. Adjusted

Table 3. Cross-sectional associations between attitudes and beliefs about exercise and physical activity at baseline*

	Physical activity level (PASE) at baseline			
	Unadjusted β (95% CI)	Adjusted SEE (model A) β (95% CI)	Adjusted POEE (model B) β (95% CI)	Adjusted NOEE (model C) β (95% CI)
Attitudes and beliefs				
SEE	5.50 (2.21, 8.20)†	4.14 (0.26, 8.03)‡		
POEE	19.58 (6.85, 32.30)†		16.71 (1.87, 31.55)‡	
NOEE§	20.16 (11.38, 28.94)†			4.47 (−6.39, 15.33)
Potential confounders				
Socioeconomic (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)†
Paid employment (ref. yes)	−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)‡
PHQ-8 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)†

* All variables were measured at baseline. Multiple linear regression–adjusted models selected via backward elimination, holding one of SEE (model A, n = 338), POEE (model B, n = 339), or NOEE (model C, n = 340) within the model. Higher PASE scores indicate higher levels of physical activity. Higher SEE and POEE scores indicate higher self-efficacy and positive outcome expectancies, respectively. PASE = Physical Activity Scale for the Elderly; 95% CI = 95% confidence interval; SEE = Self-Efficacy for Exercise; POEE = Positive Outcome Expectations for Exercise; NOEE = Negative Outcome Expectations for Exercise; PHQ-8 = Personal Health Questionnaire.
† Statistically significant β coefficient, $P < 0.01$.
‡ Statistically significant β coefficient, $P < 0.05$.
§ Higher scores on the NOEE indicate less negative outcome expectancies. Higher PHQ-8 scores indicate worse depression. Potential confounders included in initial multivariable models and excluded during model building include age, body mass index, sex, anxiety (Generalized Anxiety Disorder 7), pain duration, partner status, Western Ontario and McMaster Universities Osteoarthritis Index pain and function subscale scores, and widespread pain.

Table 4. Longitudinal associations between baseline attitudes and beliefs about exercise and physical activity level at 3-month followup*

	Physical activity level (PASE) at 3-month followup			
	Unadjusted β (95% CI)	Adjusted SEE (model A) β (95% CI)	Adjusted POEE (model B) β (95% CI)	Adjusted NOEE (model C) β (95% CI)
Attitudes and beliefs				
SEE	7.28 (3.33, 11.23)†	4.95 (1.02, 8.87)‡		
POEE	34.55 (20.13, 48.97)†		25.48 (12.33, 38.62)†	
NOEE§	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 PT)				
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)

* Results are from multiple imputed data (combined results from 25 imputed data sets); all independent variables were measured at baseline, and multiple linear regression–adjusted models selected via backward elimination, holding one of SEE (model A), POEE (model B), or NOEE (model C) within the model. Higher PASE scores indicate higher levels of physical activity. Higher SEE and POEE scores indicate higher self-efficacy and positive outcome expectancies, respectively. PASE = Physical Activity Scale for the Elderly; 95% CI = 95% confidence interval; SEE = Self-Efficacy for Exercise; POEE = Positive Outcome Expectations for Exercise; NOEE = Negative Outcome Expectations for Exercise; PT = physical therapy.
† Statistically significant β coefficient, $P < 0.01$.
‡ Statistically significant β coefficient, $P < 0.05$.
§ Higher NOEE scores indicate 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), anxiety (Generalized Anxiety Disorder 7), pain duration, partner status, socioeconomic category, Western Ontario and McMaster Universities Osteoarthritis Index pain and function subscale scores, widespread pain, and work status.

associations were investigated using multiple logistic regression model building, as described above, only without stage 3 and using an important change in PASE as the outcome variable.

RESULTS

The baseline characteristics of the BEEP sample (n = 514) are summarized in Table 1. In total, 51% of participants were female, with a mean ± SD age of 62.8 ± 9.7 years old, and the majority were either overweight (42%) or obese (39%). Participants had, on average, moderate pain and functional disability (mean ± SD WOMAC pain score 8.4 ± 3.5 and WOMAC physical function score 28.1 ± 12.2), low levels of physical activity (mean ± SD PASE score 177 ± 83.3), and they were, on average, moderately positive about exercise (mean ± SD score on the SEE 5.4 ± 2.3, POEE 3.9 ± 0.6, and NOEE 3.5 ± 0.8). Table 2 summarizes 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 3 and Supplementary Table 2, available on the *Arthritis Care & Research* web site at http://onlinelibrary.wiley.com/doi/10.1002/acr.23104/abstract). Every extra point on the SEE was associated with an increase of 5.50 (95% confidence interval [95% CI] 2.21, 8.20) on the PASE. Similarly, for every additional point on the POEE and NOEE scales, there was an associated increase in PASE score of 19.58 (95% CI 6.85, 32.30) and 20.16 (95% CI 11.38, 28.94), respectively (higher NOEE scores indicate more positive outcome expectations).

The adjusted multivariable models are shown in Table 3. Self-efficacy for exercise (β = 4.14 [95% CI 0.26, 8.03]) and positive outcome expectations for exercise (β = 16.71 [95% CI 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 [95% CI −6.39, 15.33]).

Longitudinal associations. All 3 baseline attitude and belief variables predicted physical activity level at the 3- and 6-month followup time points in univariable models (see Table 4 and Table 5). Higher levels of self-efficacy for exercise were associated with higher levels of physical activity at 3 months (β = 7.28 [95% CI 3.33, 11.23]) and 6 months (β = 6.02 [95% CI 2.30, 9.75]). More positive outcome expectations for exercise were associated with higher physical activity levels at 3 and 6 months (β = 34.55 [95% CI 20.13, 48.97] and 25.74 [95% CI 11.99, 39.49], respectively), as were less negative outcome expectations for exercise (3 months β = 16.74 [95% CI 6.51, 26.97] and 6 months β = 11.72 [95% CI 1.81, 21.64]).

Adjusting for baseline physical activity level and the trial intervention arm, higher SEE remained significantly associated with physical activity at 3 months (β = 4.95 [95% CI 1.02, 8.87]) and 6 months (β = 3.71 [95% CI 0.26, 7.16]), as was POEE (3 months β = 25.48 [95% CI 12.33, 38.62] and 6 months β = 13.93 [95% CI 1.32, 26.54]) (Table 4 and Table

Table 5. Longitudinal associations between baseline attitudes and beliefs about exercise and physical activity level at 6-month followup*

	Physical activity level (PASE) at 6-month followup			
	Unadjusted β (95% CI)	Adjusted SEE (model A) β (95% CI)	Adjusted POEE (model B) β (95% CI)	Adjusted NOEE (model C) β (95% CI)
Attitudes and beliefs				
SEE	6.02 (2.30, 9.75)†	3.71 (0.26, 7.16)‡		
POEE	25.74 (11.99, 39.49)†		13.93 (1.32, 26.54)‡	
NOEE§	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 PT)				
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)

* Results are from multiple imputed data (combined results from 25 imputed data sets); all independent variables were measured at baseline, and multiple linear regression–adjusted models selected via backward elimination, holding one of SEE (model A), POEE (model B), or NOEE (model C) within the model. Higher PASE scores indicate higher levels of physical activity. Higher SEE and POEE scores indicate higher self-efficacy and positive outcome expectancies, respectively. PASE = Physical Activity Scale for the Elderly; 95% CI = 95% confidence interval; SEE = Self-Efficacy for Exercise; POEE = Positive Outcome Expectations for Exercise; NOEE = Negative Outcome Expectations for Exercise; BMI = body mass index; PT = physical therapy.
† Statistically significant β coefficient, $P < 0.01$.
‡ Statistically significant β coefficient, $P < 0.05$.
§ Higher NOEE scores indicate less negative outcome expectancies. Potential confounders included in initial multivariable models and excluded during model building include comorbidities, depression (Personal Health Questionnaire 8), sex, anxiety (Generalized Anxiety Disorder 7), pain duration, partner status, socioeconomic category, Western Ontario and McMaster Universities Osteoarthritis Index pain and function subscales scores, widespread pain, and work status.

5). However, NOEE was no longer significantly associated with physical activity level at 3 months ($\beta = 7.40$ [95% CI −2.46, 17.25]) or at 6 months ($\beta = -1.59$ [95% CI −11.31, 8.13]) in adjusted models.

Predicting an important change in physical activity level. Participants with greater baseline SEE and POEE scores were more likely to make important increases in physical activity level (PASE) between baseline and the 6-month

Table 6. Associations between attitudes and beliefs about exercise and important physical activity level increase from baseline to 6-month followup*

	Physical activity level (PASE) at 3-month followup			
	Unadjusted OR (95% CI)	Adjusted SEE (model A) OR (95% CI)	Adjusted POEE (model B) OR (95% CI)	Adjusted NOEE (model C) OR (95% CI)
Attitudes and beliefs				
SEE	1.07 (0.96, 1.20)	1.10 (0.98, 1.24)		
POEE	1.36 (0.88, 2.10)		1.54 (0.99, 2.40)	
NOEE‡	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 PT)				
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)

* Results are from multiple imputed data (combined results from 25 imputed data sets); all independent variables were measured at baseline, and multiple linear regression–adjusted models selected via backward elimination, holding one of SEE (model A), POEE (model B), or NOEE (model C) within the model. Higher PASE scores indicate higher levels of physical activity. Higher SEE and POEE scores indicate higher self-efficacy and positive outcome expectancies, respectively. PASE = Physical Activity Scale for the Elderly; OR = odds ratio; 95% CI = 95% confidence interval; SEE = Self-Efficacy for Exercise; POEE = Positive Outcome Expectations for Exercise; NOEE = Negative Outcome Expectations for Exercise; PT = physical therapy.
† Statistically significant OR, $P < 0.01$.
‡ Higher NOEE scores indicate less negative outcome expectancies. Important increase in physical activity was defined as an increase of 87 PASE points from baseline to 6 months. Potential confounders included in initial multivariable models and excluded during model building include age, body mass index, comorbidities, depression (Personal Health Questionnaire 8), anxiety (Generalized Anxiety Disorder 7), pain duration, partner status, socioeconomic category, Western Ontario and McMaster Universities Osteoarthritis Index pain and function subscale scores, widespread pain, and work status.

followup (odds ratio [OR] 1.07 [95% CI 0.96, 1.20] and OR 1.36 [95% CI 0.88, 2.10], respectively), although these associations did not reach statistical significance (Table 6). Adjusting for baseline PASE and the intervention arm, best estimates suggest that participants with greater SEE scores (OR 1.10 [95% CI 0.98, 1.24]), greater POEE scores (OR 1.54 [95% CI 0.99, 2.40]), and lower NOEE scores (OR 1.09 [95% CI 0.79, 1.51]) were more likely to make important increases in physical activity level (Table 6). 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 behavior 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 a clinically important increase in physical activity from baseline to 6-month followup.

In cross-sectional analyses, 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 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 behavior.

While physical activity behavior in older adults with knee pain is complex and multifactorial (9), our longitudinal data suggest 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 6 months when compared to 3 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.

The null associations between all attitudes and beliefs about exercise and an important increase in physical activity level were similar to those in 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 an increase in physical activity level at 2-year followup. It is possible that limitations in PASE responsiveness have contributed to the null findings (44) or that changes in attitudes and beliefs about exercise may be better predictors of subsequent increases in physical activity (17).

Methodologic strengths of this study 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 our knowledge, no measures of attitudes and beliefs about exercise have specifically been designed for older adults with joint pain attributed to OA. Although the SEE and OEE include items on 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 and be prone to recall bias and misclassification (46), while the scale output magnitude is not easy to interpret. Although guidelines on recommended physical activity levels for adults exist (47,48), which the majority of older adults with knee pain attributed to OA are not meeting (5,6), there is no agreed cutoff 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 an important increase in physical activity level outcome (23). Missing physical activity outcome data were relatively high at 3 and 6 months (30% and 25%, respectively), which may lead to bias in the longitudinal association findings if participants who were lost to followup were systematically different from those remaining under observation (45). Comparing the baseline characteristics of followup responders and nonresponders revealed slightly higher pain, poorer physical functioning, and lower self-efficacy for exercise in nonresponders (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 generalizability, 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 those of other trials conducted in primary care and community settings in the UK and 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 generalizability to other settings where radiographic OA diagnosis is the norm.

In line with National Institute for Health and Care Excellence 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 behavior. Beliefs about normal physical activity behavior, 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 standardized 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 (17) 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.

In conclusion, 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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AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be submitted for publication. Dr. Quicke had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
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