Examining patient activation and other factors associated with changes in pain and function following best evidence osteoarthritis care

Jillian Peta Eyles, PhD, BAAppSc(Physiotherapy)\textsuperscript{a,b,c,*}, Kathryn Mills, PhD, BAAppSc(Physiotherapy)\textsuperscript{f}, Barbara R Lucas, PhD, BAAppSc(Physiotherapy)\textsuperscript{c,d,e}, Sarah R Robbins, PhD\textsuperscript{a,b}, Rachel L O’Connell, PhD\textsuperscript{g}, Matthew Williams, BAAppSc(Physiotherapy)\textsuperscript{i}, Hans Lee, BAAppSc(Physiotherapy)\textsuperscript{h}, Scott Appleton, BSc(Health and Exercise Science)\textsuperscript{j}, David J Hunter, MBBS, PhD, FRACP\textsuperscript{a,b}

\textsuperscript{a} Faculty of Medicine & Health, Kolling Institute of Medical Research, Institute of Bone and Joint Research, The University of Sydney, Australia
\textsuperscript{b} Department of Rheumatology, Royal North Shore Hospital and Northern Clinical School, Faculty of Medicine and Health, The University of Sydney, Australia
\textsuperscript{c} Physiotherapy Department, Royal North Shore Hospital, Sydney, Australia
\textsuperscript{d} Faculty of Medicine and Health Sciences, Macquarie University, Sydney, Australia
\textsuperscript{e} Discipline of Child and Adolescent Health, Sydney Medical School, University of Sydney, Australia
\textsuperscript{f} John Walsh Centre for Rehabilitation Research, Sydney Medical School, The Kolling Institute of Medical Research, University of Sydney, Australia
\textsuperscript{g} National Health and Medical Research Council Clinical Trials Centre, The University of Sydney, Australia
\textsuperscript{h} Rehabilitation Department, Hunters Hill Private Hospital, Sydney, Australia
\textsuperscript{i} Physiotherapy Department, Mount Wilga Private Hospital, Sydney, Australia

ARTICLE INFO
Keywords:
Osteoarthritis
Knee
Rehabilitation
Outcome assessment
Multidisciplinary intervention
Patient activation

ABSTRACT
Objectives: The primary objective was to examine baseline patient activation as a prognostic factor for changes in pain and function following participation in an osteoarthritis management program. The secondary objective was to examine other prognostic factors from existing literature (e.g. employment, functional performance, depression, comorbidities).

Method: One-hundred-and-eleven participants with knee osteoarthritis were assessed at 0-, 12- and 26-weeks in this prospective clinical cohort. Demographic variables, timed-up-and-go (TUG), patient activation measure (PAM-13), Depression Anxiety Stress Scale and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) were collected. Multivariable linear regression examined relationships between prognostic factors and pain and function at 12- and 26-weeks.

Results: Complete 12- and 26-week data were available for 89 and 74 participants respectively, 66 % female, 66.8 (SD 10.0) years, 74 % unemployed, 66 % finished high school or higher, 12 % on joint arthroplasty waitlists. Baseline PAM-13 scores were not associated with changes in pain or function at 12- or 26-weeks. Employment status (β = 9.17 (95 % CI 2.11, 16.24), p = 0.01) and TUG (β = -1.20 (95 % CI -1.91, -0.49), p < 0.01) were associated with changes in pain at week-12. Employment status (β = 11.60 (95 % CI 5.31, 17.90), p < 0.01) and TUG (β = -1.10 (95 % CI -1.78, -0.43), p < 0.01) were associated with 12-week function. Baseline TUG (β = -1.32 (95 % CI -2.40, -0.23), p = 0.02) was associated with week-26 WOMAC function.

Conclusions: Baseline PAM-13 scores were not associated with changes in pain and function at any timepoint. Employment status and TUG were associated with changes in pain and function at 12-weeks, TUG was associated with 26-week function.

* Corresponding author. Kolling Institute of Medical Research, Westbourne St, St Leonards, 2065, NSW Australia.
E-mail addresses: jillian.eyles@sydney.edu.au (J.P. Eyles), kathryn.mills@mq.edu.au (K. Mills), barbara.lucas@sydney.edu.au (B.R. Lucas), sarah.robbins@sydney.edu.au (S.R. Robbins), Rachel.OConnell@ccr.usyd.edu.au (R.L. O’Connell), matt.w@physioinq.com.au (M. Williams), LeeHans@ramsayhealth.com.au (H. Lee), Appletons@ramsayhealth.com.au (S. Appleton), david.hunter@sydney.edu.au (D.J. Hunter).

https://doi.org/10.1016/j.ocarto.2021.100197
Received 27 May 2021; Accepted 26 July 2021
2665-9131/© 2021 The Author(s). Published by Elsevier Ltd on behalf of Osteoarthritis Research Society International (OARSI). This is an open access article under
1. Introduction

Osteoarthritis (OA) is characterised by chronic abnormal remodelling of synovial joint components, which can eventually lead to joint failure [1]. It is a leading cause of global disability [2], recognised by the WHO as a significant threat to healthy ageing [3] and currently incurable. Osteoarthritis is often treated with total joint arthroplasty (TJA) and while this is an effective treatment [4], not all people who have surgery achieve an acceptable result [5]. Further, it is estimated 20–40 % of surgical recipients may not meet the criteria considered appropriate to indicate surgery [6]. International OA management guidelines reserve consideration of TJA for people with severe disease who have exhausted all nonsurgical, best evidence treatments [7,8]. Unfortunately, many people referred for orthopaedic consultation have never before engaged with nonsurgical treatments [9]. This is a well-documented global evidence-practice gap [10].

To address this discrepancy, coordinated, clinical programs known as OA management programs (OAMPs) have been implemented internationally [11]. OAMPs have been defined as packages of best-evidence, person-centred, OA care that include two or more core treatments (i.e. education, exercise, and weight control) with longitudinal reassessment and progression [11,12]. Studies that report outcomes from OAMPs indicate that like TJA, not all participants achieve an acceptable result. Some participants achieve clinically meaningful improvements in their OA symptoms, however, some do not [13,14], and others report worsening [15]. Prognostic factors could be used to identify people who are likely to experience improvements or worsening in their OA symptoms over time, however, these have not been well-established.

The core treatments of OAMPs, namely self-management; exercise and weight control, are lifestyle interventions that require self-management and sustained health behaviour change [11]. Two previous reviews synthesised the determinants of adherence to lifestyle interventions, and both reported that participant knowledge, attitudes and motivation play a critical role in related health behaviour change and self-management behaviours [16,17]. This evidence led us to investigate OA self-management attitudes and capabilities as prognostic factors for pain and function outcomes in people who participate in OAMPs. In the clinic, if we could identify people likely to benefit from OAMPs, we could prioritise these people for entry into such programs. Conversely, if we could identify people who are unlikely to improve their pain and function, we could refer them for supportive interventions, such as health coaching, that may improve their chances of improving these outcomes.

Taking an evidence-informed approach, we conducted a systematic review that aimed to identify the ‘best’ instrument that measured self-management capabilities and attitudes based on measurement property evidence [18]. While the systematic review found little measurement property evidence for the instruments was available, it did identify the Patient Activation Measure (PAM-13), which appeared to have good face validity [18]. The PAM-13 measures confidence, knowledge and skills in the self-management of one’s health [19]. Given the paucity of measurement property evidence available for PAM-13 in people with OA, we conducted a measurement property study in an OA population and found evidence of adequate reliability, unidimensionality and construct validity [20]. Previous studies in other populations have found that higher PAM-13 scores were associated with improved self-management behaviours including: participation in regular exercise and attending to the fat content of foods [21–23]. Given these previously demonstrated associations between PAM-13 scores and self-management behaviours, we hypothesised that higher baseline PAM-13 scores at baseline would be associated with improved OA symptoms following participation in an OAMP.

This study examined the relationships between PAM-13 scores and changes in pain and function following participation in an OAMP. Prognostic models usually perform badly when based on just one factor and the use of multiple prognostic factors combined within a prognostic model is recommended [24]. Previous studies have examined other prognostic factors associated with outcomes (pain and function) following best-evidence OA treatments. These characteristics include: younger age [25], sex [26,27], higher pain intensity [25], lower anxiety and depression scores [27–29], lower level of comorbidity [29] and whether participants were scheduled for TJA [15,30]. We also examined these characteristics to determine whether they were associated with pain and function outcomes in our cohort. The primary aim of this study was to determine whether baseline PAM-scores were associated with changes in pain and function following participation in a program of best-evidence care for knee OA. Our secondary aim was to further investigate other variables that had been identified in previous studies as prognostic factors in people with knee OA.

2. Methods

2.1. Participants and data collection

This study comprised a clinical cohort of consecutive participants with symptomatic and radiographic knee OA recruited for OAMPs at a major teaching hospital and a private metropolitan hospital in New South Wales, Australia. These OAMPs were based on the Osteoarthritis Chronic Care Program (OACCP) model of care [31]. Participants were recruited through referral by rheumatologists, orthopaedic surgeons, general practitioners and TJA waiting lists (at public hospitals). People with a diagnosis of knee OA were eligible if they reported pain in the affected knee on most days of the past month [26], there were no exclusion criteria. Ethical approval for this study, in accordance with the Declaration of Helsinki, was provided by Human Research Ethics Committees (HREC): NSPHEC 2017-LNR-005 and RESP/16/11, HREC reference: LNR16/HAWKE/14. Participants provided consent to take part in this study.

The objectives of the OACCP were to: reduce OA pain, increase functional abilities and quality of life of participants through the provision of tailored interventions delivered by a multidisciplinary team and referral to appropriate community-based services. At initial assessment, a musculoskeletal (MSK) coordinator (experienced physical therapist/exercise physiologist) provided participants with education about their OA and associated comorbidities, set patient-oriented goals, prescribed behavioural change strategies and an individually tailored exercise program. The exercise program comprised of strength and cardiovascular training; and was evaluated and progressed at reassessments (12, 26 weeks). Participants also attended a multidisciplinary clinic for consultations with a rheumatologist, dietitian, occupational therapist, social worker or orthotist according to their individual clinical needs.

2.2. Outcome measures

As per standard practice for the OACCP, demographic data were recorded at baseline including age; educational level (finished/did not finish high school); and employment status (engaged/not engaged in paid employment). Standardised outcomes collected at each OACCP assessment stage included the following:

i) Measures of height and weight using a standardised protocol [32].

ii) Participants rated their average pain on the day of assessment using an 11-point Numerical Rating Scale - NRS (0 no pain, 10 worst pain imaginable) [33].

iii) Participants completed the Knee injury and Osteoarthritis Outcome Score (KOOS) [34] that required them to rate their: Symptoms; Stiffness; Pain; Physical Function; and Recreational Activities; and Quality of Life on 5-point Likert scales. The KOOS subsumes the WOMAC questions enabling calculation of WOMAC pain, stiffness and function subscales [35] which has demonstrated acceptable measurement properties for people living with OA [36]. Higher scores indicate worse symptoms of pain, stiffness or function.
iv) The Depression, Anxiety and Stress Scale 21 item version (DASS-21) requires participants to rate how much 21 separate statements applied to them over the past week using a 4-point Likert scale (0: Did not apply to me at all – never; 3: Applied to me very much, or most of the time - almost always). DASS depression scores were calculated and dichotomised according to thresholds indicating symptoms of moderate depression or worse (scores ≥ 14/42) and no symptoms to mild symptoms of depression (scores < 14) [37].

vi) The Timed Up and Go (TUG) measures the time taken for participants to stand from a chair (with arms), walk in a straight line for 3 m, turn around 180° and walk back to the chair and sit down [38].

vi) A modified version of the Self-Administered Comorbidity Questionnaire estimated a comorbidity score based on participant responses to ‘has your doctor told you that you have any of the following problems?’, 21 commonly reported conditions were listed plus an ‘other’ category [39]. The comorbidity count was categorised into low (0–1), moderate (2–3) and high (≥4) groups.

In addition to the standard OACCP outcomes, participants completed the PAM-13 that required them to rate agreement with 13 statements using a 4-point Likert scale. Responses were added to calculate a raw score and continuous activation score calculated using an empirically derived calibration table by Insignia Health (after January 2014, 0 = no activation to 100 = high activation) [19]. It has been validated in people with OA [20].

2.3. Statistical analyses

Statistical analyses were conducted in SPSS (Version 24.0, Armonk NY: IBM Corp, USA). The distribution of variables was assessed before analysis through visual inspection of histograms and Q-Q plots. To reduce potential problems with multicollinearity, we assessed relationships between prognostic factor variables by constructing a correlation matrix for continuous outcomes, Chi-squared tests for categorical variables, t-tests/ANOVA for categorical vs continuous variables. Descriptive statistics including frequencies (percentage), means and standard deviations summarised participant characteristics.

In addition to PAM-13 scores, other potential prognostic factors were identified a priori through literature review and consensus of the authors. First, the unadjusted analysis was performed using simple linear regression to study relationships between potential factors and WOMAC pain and function change scores. In the second step, models included an adjustment for baseline WOMAC pain/function scores, sex, and age. Variables with a P-value of ≥0.1 were included as candidate variables in multivariable models which were built using a backward selection, forced entry technique. At each step, the least significant variable (p-value > 0.05) was removed from the model and the beta coefficients were checked; if the coefficients changed by ≥ 10 % the variable was retained in the model as a confounder, if not it was removed. The models were checked for issues with multicollinearity using collinearity statistics in SPSS. Variance inflation factor (VIF) estimates were checked (VIF < 10 are considered acceptable), eigenvalues and condition index values for the dimensions were inspected (condition index > 15 indicates a problem). The underlying assumptions of the linear regression model were tested by assessment of residual plots [40].

FIG. 1. Flow diagram of study participants.
Power calculations for this study were based on accommodating six to nine predictors at 10–15 cases per predictor which is a conservative estimate for multivariable linear regression and takes into account the degrees of freedom required for the univariable pre-screening [41]. Therefore we aimed to include approximately 90 participants in the analysis. With knowledge of the expected loss-to-follow-up of participants of this clinical program, we aimed to recruit 112 participants to accommodate a 20 % drop-out rate.

3. Results

Of 117 participants with knee OA recruited to the OACCPs between February–December 2017, 111 consented to take part in the study and completed baseline PAM-13 questionnaires in addition to the standard OACCP outcomes (see Fig. 1). The cohort were predominantly female (76 %), 66.8 (SD 10.0) years of age, overweight with mean BMI 31.7 (SD 6.2) kg/m², not currently employed (74 %) with an education level of finished high school or higher (66 %) (Table 1). Twelve percent of these participants were on TJA waitlists at a public hospital. Baseline mean WOMAC pain and function scores were 45.0 (SD 19.2) and 47.3 (SD 19.1) respectively, and mean PAM-13 was 58.7 (SD 13.0). Of the 111 participants, 22 did not complete their 12-week reassessment (see Fig. 1 for reasons for loss to follow up). The mean change in WOMAC pain and function scores at 12 weeks was −5.5 (95 % CI -8.92, −2.09), p = 0.02 and −7.0 (95%CI -10.06, −3.99 p < 0.01) points respectively (Table 2).

Table 1

| Characteristic                                      | n = 111 |
|----------------------------------------------------|---------|
| Female                                             | 84 (76) |
| Age (years, mean [SD])                             | 66.8 (10.0) |
| Residence: Lives alone                             | 22 (20) |
| Currently employeda                                 | 29 (26) |
| Finished secondary school or higherb                | 73 (66) |
| Did not finish secondary schoolc                    | 32 (28) |
| Missing                                             | 6 (6) |
| On elective joint arthroplasty waitlist             | 13 (12) |
| BMI (kg/m²)                                        | 31.7 (6.2) |
| Pain NRS (mean [SD]), range 0–10                   | 3.9 (2.5) |
| TUG (units, mean [SD])                             | 10.3 (4.2) |
| DASS Depression (mean [SD])                        | 8.8 (10.0) |
| DASS depression ≥14                                | 28 (25.2) |
| Anxiety (mean [SD])                                | 6.7 (9.0) |
| Stress (mean [SD])                                 | 9.9 (9.7) |
| Total comorbidity count                            | 2.5 (1.8) |
| Number of comorbidities Low (0–1)                  | 35 (32) |
| Number of comorbidities Moderate (2–3)             | 45 (41) |
| Number of comorbidities High (≥4)                  | 29 (25) |
| Number of comorbidities Missing                    | 2 (2) |
| Baseline PAM-13 Score (mean [SD])                  | 58.7 (13.0) |
| PAM-13 Activation Level 1                          | 19 (17) |
| PAM-13 Activation Level 2                          | 21 (19) |
| PAM-13 Activation Level 3                          | 56 (51) |
| PAM-13 Activation Level 4                          | 15 (13) |
| KOOS converted to WOMAC Pain mean (mean [SD])      | 45.0 (19.2) |
| KOOS converted to WOMAC Function (mean [SD])       | 47.3 (19.1) |

KOOS: Knee injury and Osteoarthritis Outcome Score; WOMAC: Western Ontario and McMaster Universities Arthritis Index: 0 indicates no problems and 100 indicates extreme problems. Pain NRS: Numerical rating scale (0–10); BMI: body mass index(kg/m²); TUG: Timed Up and Go (seconds); DASS: Depression Anxiety Stress Scale: each subscale 0 best, 42 worst. PAM-13: Patient Activation Measure score 0 worst- 100 best.

a Lives alone reported by participants. Living with others included living with able/non-able bodied person, hostel or aged care residential facility.
b Currently employed includes participants who reported engaging in full/part time paid work.
c Included participants who reported finishing secondary school (final year), or university degree.
d Includes participants who did not finish secondary school, and those who reported no formal schooling.

Seventy-three participants returned for their 26-week assessment, (see Fig. 1 reasons for loss to follow up). The mean change from baseline to 26-weeks WOMAC pain and function scores were −6.3 (95 % CI -10.67, −2.06), p = 0.04 and −4.4 (95 % CI -10.74, −2.97), p = 0.02 respectively. The mean improvement in baseline to 26-week PAM-13 scores was 5.26 (95 % CI 0.81, 9.71) p = 0.02 (Table 2).

3.1. Unadjusted and baseline pain/function, age and sex adjusted linear regression models

Tables 3 and 4 summarise the unadjusted and baseline pain/function adjusted linear regression models for pain and function at 12-weeks. PAM-13 scores were not significantly associated with changes in WOMAC pain and function at 12-weeks. Adjusted and unadjusted employment status and TUG were associated with WOMAC pain and function at 12-weeks. The presence of depressive symptoms was significantly associated with changes in pain when adjusted for baseline pain, sex and age.

The unadjusted and adjusted models for change in week-26 pain and function are presented in Table 5. At the 26-week assessment, baseline PAM-13 were not associated with a change in WOMAC pain and function scores. The baseline TUG scores were significantly associated with changes in function at 26-weeks when adjusted for baseline function, age and sex. No other variables were significantly associated with week-26 pain and function.

3.2. Multivariable linear regression models

Baseline PAM-13 scores were not associated with changes in WOMAC pain or function in the 12- or 26-week multivariable models (Tables 3–5). Employment status (β = 9.17 (95 % CI 2.11, 16.24), p = 0.01) and TUG (β = −1.20 (95 % CI -1.91, −0.49), p < 0.01) were associated with week-12 WOMAC pain change scores when adjusted for baseline pain, PAM-13, depressive symptoms, sex and age (F statistic = 6.685, p < 0.001, adjusted R² = 0.37). Employment status (β = 11.60 (95 % CI 5.31, 17.90), p < 0.01) and TUG (β = −1.10 (95%CI -1.78, −0.43), p < 0.01) were also associated with change in WOMAC function scores at 12-weeks when adjusted for baseline function, PAM-13 scores, depressive symptoms, sex and age (F statistic = 7.117, p < 0.01, adjusted R² = 0.38). There were no significant factors (p ≤ 0.05) in the multivariable model for change in baseline to 26-weeks WOMAC pain (Table 5). Baseline TUG (β = −1.32 (95 % CI -2.40, −0.23), p = 0.02) was associated with week-26 WOMAC function change scores when adjusted for baseline function, PAM-13, sex and age (F statistic = 2.409, p = 0.046, adjusted R² = 0.16).

4. Discussion

The primary aim of this study was to examine the relationships between baseline patient activation and changes in pain and function following 12- and 26-weeks of the OACCP. Baseline PAM-13 scores were not associated with changes in WOMAC pain and function in any of the models. Other variables such as employment status and TUG were independently associated with WOMAC pain and function scores at 12 weeks. Baseline TUG scores were significantly associated with change in WOMAC function at 26-weeks. There were no factors that were significantly associated with change in WOMAC pain at 26-weeks.

Several previous studies have demonstrated that higher patient activation is associated with better longitudinal health outcomes in people living with chronic diseases [21,22,42]. However, most of the outcomes in these studies are measures of general health behaviours such as healthy eating, managing medications or testing glucose levels. Few studies have examined the relationship between PAM-13 and patient-reported or physical outcomes. One study examined the association between baseline PAM-13 and weight-loss following an incentive-based weight-loss intervention for people with obesity [43]. Consistent with our findings, there was no association between PAM-13
Table 2
Absolute value and change in PAM-13, pain and function baseline to 12 and 26- weeks.

| Variable                          | Baseline mean (SD) | 12-week mean (SD) | Difference 12-week - baseline (95 % CI), P | Baseline mean (SD) | 26-week mean (SD) | Difference 26-week - baseline (95 % CI), P |
|----------------------------------|--------------------|-------------------|-------------------------------------------|--------------------|-------------------|-------------------------------------------|
| WOMAC pain                       | 44.4 (19.6)        | 38.9 (20.6)       | -5.5 (-8.92, -2.09), p = 0.02             | 45.6 (20.34)       | 39.2 (22.4)       | -6.3 (-10.67, -2.06), p = 0.04             |
| WOMAC function                   | 47.5 (19.0)        | 40.5 (20.3)       | -7.0 (-10.06, -3.99), p < 0.01            | 47.7 (19.8)        | 40.8 (21.9)       | -4.4 (-10.74, -2.97), p = 0.02             |
| PAM-13                           | 4.67 (3.10, 1.44)  |                   |                                           | 57.9 (13.9)        | 63.1 (17.3)       | 5.26 (0.81, 9.71), p = 0.02                |

KOOS: Knee injury and Osteoarthritis Outcome Score; WOMAC: Western Ontario and McMaster Universities Arthritis Index: 0 indicates no problems and 100 indicates extreme problems. PAM-13: Patient Activation Measure score 0 worst- 100 best. TJA: Total joint arthroplasty; TUG: Timed Up and Go (seconds); DASS: Depression Anxiety Stress Scale: each subscale 0 best, 42 worst. P: P value. Results in bold significant to alpha level 0.05.

Table 3
Linear regression analyses; change in WOMAC pain Wk0 to Wk12 (n = 89).

| Variable                              | β (95 % CI) (crude) | P          | β (95 % CI)* | P          | Final multivariable model* | P          |
|---------------------------------------|---------------------|------------|-------------|------------|---------------------------|------------|
| Baseline PAM-13 score                 | 0.05 (-0.18, 0.28)  | 0.70       | 0.10 (-0.12, 0.32) | 0.38       | 0.08 (-0.12, 0.28)        | 0.43       |
| Male                                  | Reference           |            |             |            |                           |            |
| Female                                | 4.29 (-3.62, 12.21) | 0.28       | -           |            |                           |            |
| Age (per year)                        | -0.40 (-0.76, -0.03) | 0.03       | -           |            |                           |            |
| Didn't finish high school             | Reference           |            |             |            |                           |            |
| High School/higher                   | 4.67 (-3.10, 12.44) | 0.24       | 4.80 (-2.50, 12.08) | 0.19       |                           |            |
| Paid employment                       | 10.46 (17.99, 2.93) | 0.01       | 11.35 (3.85, 18.85) | <0.01      | 9.17 (2.11, 16.24)        | <0.01      |
| DASS Depression score <14            | Reference           |            |             |            |                           |            |
| DASS Depression score ≥14            | -1.28 (-9.24, 6.69) | 0.75       | -9.02 (-17.10, -0.94) | 0.03       | -5.18 (-12.76, 2.40)     | 0.18       |
| Comorbidity count: 0-1               | -1.56 (-9.37, 6.25) | 0.69       | -0.52 (-8.04, 7.00) | 0.89       |                           |            |
| Comorbidity count: ≥4               | -7.10 (-16.12, 1.93) | 0.12      | -6.05 (-14.58, 2.49) | 0.16       |                           |            |
| Not on waitlist                      | Reference           |            |             |            |                           |            |
| On waitlist                          | -7.21 (-18.76, 4.35) | 0.22      | -8.04 (-19.00, 2.91) | 0.15       |                           |            |
| TUG                                   | -0.86 (-1.62, -0.11) | 0.025     | -1.42 (-2.13, -0.71) | <0.01      | -1.20 (-1.91, -0.49)     | <0.01      |
| KOOS WOMAC pain                      | 0.29 (0.12, 0.45)   | 0.01       | 0.46 (0.28, 0.62) | <0.01      |                           |            |

KOOS: Knee injury and Osteoarthritis Outcome Score; WOMAC: Western Ontario and McMaster Universities Arthritis Index: 0 indicates no problems and 100 indicates extreme problems. PAM-13: Patient Activation Measure score 0 worst- 100 best. TJA: Total joint arthroplasty; TUG: Timed Up and Go (seconds); DASS: Depression Anxiety Stress Scale: each subscale 0 best, 42 worst. P = p value. Results in bold significant to alpha level 0.05. *Adjusted for Wk0 WOMAC Pain score, sex, and age.

Table 4
Linear regression analyses; change in WOMAC function Wk0 to Wk12 (n = 89).

| Variable                              | β (95 % CI) (crude) | P          | β (95 % CI)* | P          | Final multivariable model* | P          |
|---------------------------------------|---------------------|------------|-------------|------------|---------------------------|------------|
| Baseline PAM-13 score                 | 0.06 (-0.15, 0.28)  | 0.55       | 0.09 (-0.12, 0.29) | 0.40       | 0.08 (-0.10, 0.26)        | 0.35       |
| Male                                  | Reference           |            |             |            |                           |            |
| Female                                | 5.28 (-1.81, 12.37) | 0.14       | -           |            |                           |            |
| Age                                   | -0.46 (-0.78, -0.14) | 0.01       | -           |            |                           |            |
| Didn’t finish high school             | Reference           |            |             |            |                           |            |
| High School/higher                   | 0.34 (-6.77, 7.45)  | 0.92       | 1.41 (-5.45, 8.27) | 0.68       |                           |            |
| Paid employment                       | 14.24 (7.74, 20.73) | <0.01      | 13.59 (7.01, 20.18) | <0.01      | 11.60 (5.31, 17.90)       | <0.01      |
| DASS Depression score <14            | Reference           |            |             |            |                           |            |
| DASS Depression score ≥14            | -1.59 (-4.26, 6.08) | 0.76       | -7.46 (-15.22, 0.29) | 0.06       | -4.94 (-11.86, 2.07)     | 0.16       |
| Comorbidity count: 0-1               | -0.79 (-7.89, 6.31) | 0.83       | 0.63 (-6.29, 7.55) | 0.86       |                           |            |
| Comorbidity count: ≥4               | -5.62 (-13.81, 2.57) | 0.18      | -4.95 (-12.82, 2.91) | 0.21       |                           |            |
| Not on waitlist                      | Reference           |            |             |            |                           |            |
| On waitlist                          | -5.31 (-15.79, 5.17) | 0.32      | -5.72 (-15.78, 4.34) | 0.26       |                           |            |
| TUG                                   | -0.68 (-1.56, 0.00) | 0.05       | -1.30 (-2.02, -0.58) | <0.01      | -1.10 (-1.78, -0.43)     | <0.01      |
| KOOS WOMAC function                  | 0.18 (0.03, 0.34)   | 0.02       | 0.38 (0.20, 0.56) | <0.01      |                           |            |

KOOS: Knee injury and Osteoarthritis Outcome Score; WOMAC: Western Ontario and McMaster Universities Arthritis Index: 0 indicates no problems and 100 indicates extreme problems. PAM-13: Patient Activation Measure score 0 worst- 100 best. TJA: Total joint arthroplasty; TUG: Timed Up and Go (seconds); DASS: Depression Anxiety Stress Scale: each subscale 0 best, 42 worst. P = p-value. Results in bold significant to alpha level 0.05. *Adjusted for Wk0 WOMAC function score, sex, and age.

and change scores [43]. Conversely, another study reported that higher pre-operative PAM-13 scores predicted greater improvement in KOOS and Hip Disability and Osteoarthritis Outcome Scores (HOOS) following TJA for patients with advanced arthritis [44]. These conflicting findings
Table 5
Linear regression analyses; change in WOMAC pain and function Wk0 to Wk26, n = 73.

| Variable | Wk0 to Wk26 WOMAC Pain | β (95 % CI) (crude), P | β (95 % CI) (adjusted)*, P | Final multivariable modela |
|----------|-------------------------|------------------------|--------------------------|--------------------------|
| Baseline PAM-13 | −0.07 (−0.38, 0.24), 0.64 | 0.02 (−0.28, 0.33), 0.88 | 0.02 (−0.28, 0.31), 0.91 |
| Male | | | |
| Female | −1.85 (−12.32, 8.63), 0.73 | 0.15 (−1.01, 10.52), 0.98 |
| Age | 0.11 (−0.35, 0.57), 0.62 | 0.41 (−0.07, 0.89), 0.09 |
| Comorbidity | | | |
| DASS Depression | | | |
| Paid employment | | | |
| Not paid employment | | | |
| TUG | −0.06 (−1.26, 0.94), 0.77 | 0.18 (0.08, 0.23), 0.12 |
| KOOS WOMAC | 0.31 (0.10, 0.50), <0.01 | 0.41 (0.12, 0.64), <0.01 |
| Not finished high school | | | |
| Employment status | | | |
| On TJA waitlist | | | |
| On TJA waitlist | 1.57 (−13.54, 16.68), 0.84 | −3.94 (−19.13, 11.26), 0.61 |
| TUG | −0.16 (−1.26, 0.94), 0.77 | 0.18 (0.08, 0.23), 0.12 |
| KOOS WOMAC | 0.31 (0.10, 0.50), <0.01 | 0.41 (0.12, 0.64), <0.01 |
| Not finished high school | | | |
| Employment status | | | |
| On TJA waitlist | | | |
| Paid employment | 5.89 (−3.18, 14.95), 0.2 | 7.26 (−2.00, 16.52), 0.12 |
| Not paid employment | | | |
| DASS Depression | | | |
| Greater than 14 | 1.42 (−7.42, 10.26), 0.75 | −2.91 (−12.41, 6.58), 0.54 |
| Comorbidity count: >4 | | | |
| Paid employment | 9.16 (−11.60, 18.93), 0.85 | 8.56 (−0.78, 17.89), 0.08 |

Table 5 (continued)

| Variable | Wk0 to Wk26 WOMAC function | β (95 % CI) (crude), P | β (95 % CI) (adjusted)*, P | Final multivariable modela |
|----------|-----------------------------|------------------------|--------------------------|--------------------------|
| Baseline PAM-13 | −0.03 (−0.31, 0.25), 0.83 | 0.03 (−0.25, 0.30), 0.85 |
| Male | | | |
| Female | 2.33 (−7.03, 11.68), 0.62 | 2.54 (−5.87, 11.66), 0.58 |
| Age | −0.06 (−0.48, 0.35), 0.77 | 0.15 (−0.27, 0.57), 0.48 |
| Comorbidity count: 0–1 | | | |
| DASS Depression | | | |
| Greater than 14 | 1.42 (−7.42, 10.26), 0.75 | −2.91 (−12.41, 6.58), 0.54 |
| Comorbidity count: >4 | | | |
| Not finished high school | | | |
| Employment status | | | |
| On TJA waitlist | | | |

KOOS: Knee injury and Osteoarthritis Outcome Score; WOMAC: Western Ontario and McMaster Universities Arthritis Index.

Results in bold signify p-value < 0.05.
aAdjusted for Wk0 WOMAC pain/function, sex and age.

may be due to the different treatments used in the study, patient activation may be a better predictor of patient reported outcomes from TJA versus nonsurgical care in OAMPs. Our study did not find any evidence to support the use of baseline PAM-13 scores as a prognostic tool to predict pain and function outcomes in people participating in OAMPs.

The mean change in PAM-13 scores following 26 weeks of the OACCP was −0.94 (95% CI: −1.94, −0.94), p = 0.002. This indicates that the intervention was effective in reducing pain, function, and disease impact.

Other factors independently associated with changes in pain and function were identified. Employment status has been associated with age and the severity of OA symptoms in previous studies [47,48]. It could be argued that employment status was acting as a proxy for disease severity and/or age in this analysis, however, we adjusted the models for these variables, so this should not be the case. While employment status was strongly associated with changes in pain and function following the OACCP, these results should be interpreted carefully. The clinical implications of these findings are limited until these findings can be replicated in larger studies, in different OA populations [24]. Hence, the relationship between employment status and improved outcomes following the OACCP warrants further attention in longitudinal cohort studies.

Timed Up and Go was associated with change in WOMAC pain and function scores at 12 weeks and function at 26-weeks. A possible explanation for this finding is that people with higher functional ability may have found it easier to fully engage with their exercise program, and hence were more able to achieve the potential beneficial treatment effects associated with the intervention. Although the TUG is a
recommended functional performance measure for hip and knee OA [38], little has been reported about biomechanical forces at the knee during this test. A study from >30 years ago demonstrated that standing from sitting causes loading across the different joint compartments of the knee [49]. The forces at the patellofemoral joint were approximately 15x bodyweight which were almost twice the magnitude of those at the tibiofemoral joint [49]. By vigorously loading the different compartments of the knee, the TUG may provide a comprehensive outcome that reflects the overall health of the OA knee and hence reflect changes in pain and function following participation in the OACC. In line with the findings related to employment status, these results should be interpreted with caution and the clinical implications are limited until they are replicated in larger studies [24].

There are some limitations of our study. We examined short term outcomes of the OACC at 12- and 26-weeks only. The symptomatic benefits from lifestyle interventions requiring substantial behavioural change may take longer than 12- or 26- weeks to result in improvements that are noticeable and important to patients. The analyses at 12- and 26-weeks may not have allowed adequate time for participants to harness their activation to change behaviour and experience noticeable changes in pain and function.

There was loss to follow up throughout this study consistent with clinical practice (follow-up rates were 80 % and 67 % at 12- and 26-weeks respectively). There were nine participants who did not attend their 12-week follow-up but did attend their 26-week follow up. Reduced follow-up rates at 26 weeks may have contributed to the lack of association between baseline measures and changes in symptoms at the 26-week time point. There is also strength in conducting this study in a clinical cohort. Although randomised trials are the gold standard for establishing efficacy of interventions, participants may differ from patients in clinical practice due to the application of inclusion/exclusion criteria. In contrast, clinical cohort studies include individuals who reflect more accurately the populations that are often excluded in trials (e.g., people who are older, have comorbidities, and earlier or more advanced disease) [50]. We conducted our study in a real-life clinical setting which increases the clinical applicability of our results. It is important to note that the study data were drawn from two OACC in socio-demographically similar regions of NSW, Australia which likely reduces the external validity of our findings. Ideally, our findings would be confirmed in a larger study population with greater heterogeneity.

5. Conclusion

Although improvements in pain and function were achieved following participation in the OACC, these were not associated with PAM-13 baseline scores. Other independent factors including employment status and TUG were associated with changes in pain and function.

Author contributions

All authors should have made substantial contributions to this work, including conception and design (JE, DJH, KM, BL, SR, RO, MW, HL, SA), collection and assembly of data (JE, RO, MW, HL, SA), analysis and interpretation of the data (JE, DJH, KM, BL, SR, RO), drafting of the article (JE, DJH, KM, BL, SR, RO, MW, HL, SA), critical revision of the article for important intellectual content (JE, DJH, KM, BL, SR, RO), final approval of the article, statistical expertise (RO, JE, DJH, KM).

Role of the funding source

This work was not supported by a grant. DJH is supported by a National Health and Medical Research Council (NHMRC) Investigator Grant.

Declaration of competing interest

No conflicts of interest to declare. DH reports consultancies of <$10,000/year with the following: Merck Serono, Pfizer, Lilly, TLCBio.

Acknowledgement

We would like to acknowledge the participants of the OACC programs at Royal North Shore and Mount Wilga Hospitals who graciously completed the PAM-13 along with the other patient-reported outcomes used as part of the program.

References

[1] A. Mohanberi, M. Batt, An update on the pathophysiology of osteoarthritis, Ann Phys Rehabil Med 59 (5-6) (2016) 333–339.
[2] T. Vos, A.D. Flaxman, M. Naghavi, R. Lozano, C. Michaud, M. Ezzati, et al., Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010, Lancet 380 (9895) (2012) 2163–2196.
[3] World Health Organization, World Report on Ageing and Health, World Health Organization, Geneva, 2015.
[4] S.T. Skou, E.M. Roos, S. Laurent, M.S. Rathleff, L. Arendt-Nielsen, O. Simomenn, et al., A randomized, controlled trial of total knee replacement, N. Engl. J. Med. 373 (17) (2015) 1597–1606.
[5] A.D. Beswick, V. Wyldle, R. Goobberman-Hill, A. Blom, P. Dieppe, What proportion of patients report long-term pain after total hip or knee replacement for osteoarthritis? A systematic review of prospective studies in unselected patients, BMJ Open 2 (1) (2012), e000435.
[6] D.L. Riddle, W.A. Jiranek, C.W. Hayes, Use of a validated algorithm to judge the appropriateness of total knee arthroplasty in the United States: a multicenter longitudinal cohort study, Arthritis Rheum. 66 (8) (2014) 2134–2143.
[7] R.R. Bannuru, M.C. Ossai, E.E. Vaysbrot, N.K. Arden, K. Bennell, S.M.A. Birma- Zeitstra, et al., OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis, Osteoarthritis Cartilage 27 (11) (2019) 1578–1589.
[8] S.L. Kolasinski, T. Neogi, M.C. Hochberg, C. Oatis, G. Gayatt, J. Block, et al., 2019 American college of rheumatology/arthritis foundation guideline for the management of osteoarthritis of the hand, hip, and knee, Arthritis Rheum. 72 (2) (2020) 220–233.
[9] S. Bunzli, P. Olbrien, D. Ayton, M. Dowsey, J. Gunn, P. Choong, et al., Misconceptions and the acceptance of evidence-based non-surgical interventions for knee osteoarthritis. A qualitative study. Clin. Orthop. Relat. Res. 477 (9) (2019) 1975–1983.
[10] M. Basedow, A. Esterman, Assessing appropriateness of osteoarthritis care using quality indicators: a systematic review, J. Eval. Clin. Pract. 21 (5) (2015) 782–789.
[11] J.P. Eyles, D.J. Hunter, K.L. Bennett, K.S. Dziedzic, R.S. Hinman, M. van der Esch, et al., Priorities for the effective implementation of osteoarthritis management programs: an OARSI international consensus exercise, Osteoarthritis Cartilage 27 (9) (2019) 1270–1279.
[12] J.L. Bowden, D.J. Hunter, L.A. Deveza, V. Duong, K.S. Dziedzic, K.D. Allen, et al., Core and adjunctive interventions for osteoarthritis: efficacy and models for implementation, Nat. Rev. Rheumatol. 16 (8) (2020) 434–447.
[13] M.V. Harley, N.E. Walsh, H. Mitchell, J. Nicholas, A. Patel, Long-term outcomes and costs of an integrated rehabilitation program for chronic knee pain: a pragmatic, cluster randomized, controlled trial, Arthritis Care Res. 64 (2) (2012) 238–247.
[14] G.P. Snijders, C.H. van den Ende, B.J. van den Bent, P.L. van Riel, F.H. van den Hoogen, A.A. den Broeder, et al., Treatment outcomes of a Numeric Rating Scale (NRS)-guided pharmacological pain management strategy in symptomatic knee and hip osteoarthritis in daily clinical practice, Clin. Exp. Rheumatol. 30 (2) (2012) 164–170.
[15] J.P. Eyles, K. Mills, B.R. Lucas, M.J. Williams, J. Makovey, L. Tech, et al., Can we predict those with osteoarthritis who will women following a chronic disease management program? Arthritis Care Res. 68 (9) (2016) 1268–1277.
[16] F. Dobson, K.L. Bennett, S.D. French, P.J. Nicolson, R.N. Klaasman, M.A. Holden, et al., Barriers and facilitators to exercise participation in people with hip and/or knee osteoarthritis: synthesis of the literature using behavior change theory, Am. J. Phys. Med. Rehabil. 95 (5) (2016) 372–389.
[17] E. Burgess, P. Hasnem, K.L. Pumpa, Determinants of adherence to lifestyle intervention in adults with obesity: a systematic review, Clin Obes 7 (3) (2017) 123–135.
[18] J.P. Eyles, D.J. Hunter, S.R.F. Meneses, N.J. Collins, F. Dobson, B.R. Lucas, et al., Instruments assessing attitudes toward or capability regarding self-management of osteoarthritis: a systematic review of measurement properties, Osteoarthritis Cartilage 25 (8) (2017) 1210–1222.
[19] J.H. Hibbard, E.R. Mahoney, J. Stockard, M. Tuler, Development and testing of a short form of the patient activation measure, Health Serv. Res. 40 (6 Pt 1) (2005) 1918–1930.
[20] J.P. Eyles, M. Ferreira, K. Mills, B.R. Lucas, S.R. Robbins, M. Williams, et al., Is the Patient Activation Measure a valid measure of osteoarthritis self-management attitudes and capabilities? Results of a Rasch analysis, Health Qual. Life Outcome 18 (1) (2020) 121.
