Self-efficacy and risk of persistent shoulder pain: results of a Classification and Regression Tree (CART) analysis

Rachel Chester,1 Mizanur Khondoker,2 Lee Shepstone,2 Jeremy S Lewis,3 Christina Jerosch-Herold1

ABSTRACT
Objectives To (i) identify predictors of outcome for the physiotherapy management of shoulder pain and (ii) enable clinicians to subgroup people into risk groups for persistent shoulder pain and disability.

Methods 1030 people aged ≥18 years, referred to physiotherapy for the management of musculoskeletal shoulder pain were recruited. 810 provided data at 6 months for 4 outcomes: Shoulder Pain and Disability Index (SPADI) (total score, pain subscale, disability subscale) and Quick Disability of the Arm, Shoulder and Hand (QuickDASH). 34 potential prognostic factors were used in this analysis.

Results Four classification trees (prognostic pathways or decision trees) were created, one for each outcome. The most important predictor was baseline pain and/or disability: higher or lower baseline levels were associated with higher or lower levels at follow-up for all outcomes. One additional baseline factor split participants into four subgroups. For the SPADI trees, high pain self-efficacy reduced the likelihood of continued pain and disability. Notably, participants with low baseline pain but concomitant low pain self-efficacy had similar outcomes to patients with high baseline pain and high pain self-efficacy. Cut-off points for defining high and low pain self-efficacy differed according to baseline pain and disability. In the QuickDASH tree, the association between moderate baseline pain and disability with outcome was influenced by patient expectation: participants who expected to recover because of physiotherapy did better than those who expected no benefit.

Conclusions Patient expectation and pain self-efficacy are associated with clinical outcome. These clinical elements should be included at the first assessment and a low pain self-efficacy response considered as a target for treatment intervention.

INTRODUCTION
Persistent musculoskeletal shoulder pain is common and frequently associated with substantial disability. Over a period of 1 month, between 16% and 31% of the general population in the UK will have suffered from musculoskeletal shoulder pain lasting at least 24 hours.1-3 Experiencing shoulder pain concerns many and accounts for up to 3% of visits to general practitioners (GP) annually4 5 and up to 48% of people with shoulder pain visit their GP more than once over a 3-year period due to ongoing symptoms.5 6 The most effective treatment is not yet known; clinical trials comparing surgical and non-surgical management, including exercises prescribed by physiotherapists report equivocal effects.7-9 Between 8% and 11% of patients visiting their GP with shoulder pain are referred to see a physiotherapist at initial consultation,10 11 rising to 18% over a 3-year period.5

Response to physiotherapy is variable. In a multicentre cohort study of 1030 patients with musculoskeletal shoulder pain attending physiotherapy, of mean duration 14 months (SD 28 months), 69% of patients reported complete recovery or being much improved by 6 months follow-up; 17% reported only slight improvement and 14% reported no change or a worsening of symptoms.12 A multivariable general linear model (GLM) was used to identify prognostic factors associated with patient-rated pain and disability.13 Several factors were consistently associated with a better outcome at 6 months. One limitation of the GLM approach is the difficulty of practical use, particularly in a clinical setting. All predictor variables within the model and permissions. Published online only. To view, please visit the journal online.
are used simultaneously requiring lengthy calculations (particularly when there are many predictor variables).

Classification and Regression Tree (CART) analysis is an alternative method of providing prognostic guidance. CART analysis considers the predictive value of prognostic factors sequentially, that is, in a hierarchy of importance. CART typically results in a simple and readily interpretable decision ‘tree’ (or ‘what if’ flow diagram). This can be graphically represented easily and requires no numeric calculations. This can help guide clinicians to prioritise their initial prognostic assessment to those factors which are most influential. When modifiable, prognostic factors may become targets for interventions and inform shared decision making between clinicians and patients. The objective of these analyses was to provide clinicians with a guide to the most influential factors that predict outcome for people undergoing management for non-surgical musculoskeletal shoulder pain.

METHODS
Data were available on 1030 people with shoulder pain recruited from primary and secondary care to a multicentre longitudinal cohort study in the East of England, UK, between November 2011 and October 2013. People aged 18 years or over were eligible to participate if they were referred to physiotherapy for the management of musculoskeletal shoulder pain and complained of shoulder or arm pain reproduced on movement of the shoulder. Those presenting with shoulder fractures, traumatic shoulder dislocations, systemic source of shoulder symptoms, cervical radiculopathy or had undergone shoulder surgery were excluded. Referral and treatment pathways were unaffected by participation in the study. The study protocol has been published.

Outcome variables
Two validated patient-rated outcome measures were collected at baseline and via postal questionnaire at 6-month follow-up: the Shoulder Pain and Disability Index (SPADI), and Quick Disability of the Arm, Shoulder and Hand (QuickDASH). The SPADI is a joint specific questionnaire designed to measure two domains: shoulder pain and disability. Thirteen items, five comprising a pain subscale and eight a disability subscale, are scored from zero to 10, where zero represents no pain or disability and 10 represents the worst pain imaginable or so difficult it requires help. For this analysis, each domain carried equal weighting in the overall score. The QuickDASH is an upper limb region specific questionnaire that includes items related to symptoms, daily activities, sleep, social and work function. Eleven items are scored from one to five where one represents no difficulty and five represents unable. Each item carries equal weighting in the final score. Scores are converted to a scale of zero to 100, where zero represents no pain or disability and 100 represents maximum pain and disability.

Baseline predictor variables
Data for potential prognostic factors were collected prior to and during the participant’s first physiotherapy appointment using bespoke questionnaires and clinical record forms. These variables included demographics, patient expectations and beliefs, lifestyle, general health, work, shoulder history and presentation and clinical examination findings. All factors statistically associated with outcome (p≤0.05) in at least one of the multivariable linear models from our previous analysis were included in the CART analysis. In addition, baseline factors measured, but not found to be statistically significant, were entered if reported as a significant prognostic factor for outcome in reviews of other musculoskeletal studies. A description of the variables included in the CART analysis are detailed in online supplementary file 1.

Patient involvement
Patient and public representatives were involved in the design of the study, in particular, details associated with the timing and procedures for recruiting and follow-up of participants, and the design and layout of questionnaires for data collection. A lay version of results, designed with patient and public representatives, were disseminated to all study participants who at their final data collection replied that they would like a copy. Patients were not involved in the actual recruitment or conduct of the study.

Statistical analysis
We used regression trees algorithms, a subclass of CART, for continuous outcome variables, in our analyses. CART uses a recursive partitioning of the study sample to produce subgroups as homogenous as possible with respect to the outcome of interest. This partitioning is based on a binary split of each predictor variable. It is a more flexible approach for uncovering complex variable relationships than traditional linear modelling as it does not rely on any functional relationship between the outcome and predictor variables, nor does it require any distributional assumption regarding the outcome variable. CART is also less sensitive to outlying data, well suited for a large number of predictor variables and therefore offers a suitable alternative for building prediction models where the relationships among variables are unspecified and existing parametric statistical methods are not suitable to guide the model building. The prediction accuracy of CART is comparable with parametric regression models and it can be more accurate when the relationship between the outcome and predictor variables is non-linear. Furthermore, the partitioning in CART can be represented graphically as an easily interpretable decision tree that may then be used to inform clinical practice.

We constructed four regression trees for each of the four outcome variables, that is, SPADI overall score, SPADI pain subscore, SPADI disability subscore and QuickDASH score, respectively. We used the R (R Core Team, 2015) package rpart. For each of the 6-month outcome variables the respective baseline score was included within the list of predictor variables. Including the respective baseline scores, the number of predictor variables entered in different models ranged between 32 and 34. The pain and disability subscales were not included in the total SPADI tree analysis therefore using only 32 variables (see online supplementary file 1 for a complete list and definitions of variables).

The procedure for building a regression tree in rpart is discussed below.

Building a tree
First, the predictor variable is found which best splits the sample into two subgroups. The ‘best’ is defined as the split that maximises the between groups sum-of-squares (or, equivalently, minimises the within-group error sum-of-squares). This process is applied separately to each subgroup recursively until the subgroups either reach a minimum size (set to seven in our analysis, the default in rpart) or until no improvement can be made in the model fit.
Pruning the tree
The resultant model is typically too complex and likely to overfit the data. The second stage of the procedure consists of using cross-validation to trim back the full tree. We used 10-fold cross-validation to evaluate model fit at a series of model complexities and chose the optimal (pruned) tree by inspecting the plot of the cross-validated error against model complexity. Statistical analyses were completed by a statistician without prior knowledge of the clinical area or results of earlier analyses. Based on the cross-validated predicted residual error sum of squares statistic, these trees provided the best predicting models. Retention of more baseline variables within the trees did not improve their predictive capacity. See online supplementary file 2 for the plot for cross-validated errors versus model complexity for SPADI (total score) at 6 months.

Estimating a model and evaluating prediction accuracy on the same dataset generally overestimates model performance. It is, therefore, recommended to evaluate the model performance on an independent dataset (ie, a dataset that was not used to estimate the model). In the absence of an independent test dataset for model evaluation, cross-validation approach is an alternative way to create independent datasets for model assessment by holding apart a small portion of the sample for model evaluation. More specifically, 10-fold cross-validation involves randomly splitting the data into 10 parts of similar size, holding aside one part (1/10th of the whole sample) for testing and using the rest (9/10th) for model estimation. The process is repeated 10 times, meaning that each of the 10 folds is used as independent test set for model evaluation. Overall model performance is typically assessed by calculating prediction errors on each of the 10 folds and averaging across all of these results.

Cross-validation is a widely used and acceptable way of validating model accuracy/performance and we used this approach to select the optimal CART model, that is, to select the variables that are most predictive of the respective outcome variables (and also to remove those not contributing enough to the prediction model). The results of this validation process ensures that our selected CART models are optimal, despite not having a separate independent validation dataset.

RESULTS
One thousand and fifty-five participants were assessed by physiotherapists and subsequently recruited and consented into the study. One thousand and thirty participants were found to be eligible for the study and provided adequate baseline data. There were no potential prognostic factors at baseline for which >2% of data were missing. Eight hundred and eleven participants (79%) provided outcome data at 6-month follow-up. One participant was excluded due to incomplete outcome data (see flow diagram in figure 1).

All participants providing complete outcome data at 6 months were included in the CART analysis for the SPADI and QuickDASH (n=810). There were differences between those participants who provided complete data at 6 months and those who did not. Completers were older by a mean of 10 years, had greater pain self-efficacy by a mean of almost 4 out of a possible 60 points, were almost twice as likely to exercise and had a twofold lower likelihood to report anxiety or depression. A summary description of baseline characteristics for all participants (n=1030) for each of the 34 variables entered into the CART analysis are provided in online supplementary file 3.

Figures 2–5 represent the resulting pruned regression trees for the total SPADI, SPADI pain subscale, SPADI disability subscale and QuickDASH at 6-month follow-up. Three variables were identified as important predictors of 6-month outcomes: (1) baseline pain or disability levels, (2) pain self-efficacy and (3) patient expectation of ‘change as a result of physiotherapy treatment’. All three variables were collected prior to the participant’s first physiotherapy attendance. Pain self-efficacy is the extent or
Figure 2  Regression tree for total Shoulder Pain and Disability Index (SPADI) score. Cut-off points for the SPADI and pain self-efficacy questionnaire (PSEQ) have been rounded up or down to whole numbers. The four box plots at the bottom of the figure illustrate the distribution of total SPADI scores at 6-month follow-up. The median SPADI score at 6-month follow-up, (represented by the horizontal line dissecting the box), is lowest (better outcome) in the subgroup represented by the box furthest left and highest (poorer outcome) in the subgroup represented by the box furthest right.

strength of the patient’s belief in their ability to complete tasks and reach a desired outcome despite their shoulder pain. Pain self-efficacy was measured using the pain self-efficacy questionnaire (PSEQ), which comprises 10 items rated 0 to 6, zero representing minimum pain self-efficacy and six representing maximum pain self-efficacy. The total score is out of 60, a higher score representing higher pain self-efficacy. Patient expectation of change was collected in response to the following question: ‘How much do you expect your shoulder problem to change as a result of physiotherapy treatment’ and was measured on a 7-point Likert scale ranging from ‘completely recover’ to ‘worse than ever’.

The first ‘node’ (at the top of the trees) represents the sample (ie, all 810 participants). This then divides into two, based on

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Figure 3  Regression tree for Shoulder Pain and Disability Index (SPADI) pain subscale score. Cut-off points for the SPADI pain subscale scores and pain self-efficacy questionnaire (PSEQ) have been rounded up or down to whole numbers. The four box plots at the bottom of the figure illustrate the distribution of total SPADI pain subscale scores at 6-month follow-up. The median SPADI pain subscale score at 6-month follow-up (represented by the horizontal line dissecting the box) is lowest (better outcome) in the subgroup represented by the box furthest left and highest (poorer outcome) in the subgroup represented by the box furthest right.

Clinical interpretation:

Patients who score <75 on the initial SPADI Pain Subscale score and ≥41 on the initial PSEQ are predicted to have the better outcome at 6 months.

Conversely, patients who score <75 on the initial SPADI Pain Subscale score but <41 on the initial PSEQ are predicted to have a worse outcome at 6 months.

Patients who score ≥75 on the initial SPADI Pain Subscale score on the initial but ≥48 on the initial PSEQ are predicted to have the better outcome at 6 months.

Conversely, patients who score ≥75 on the initial SPADI Pain Subscale score but <48 on the initial PSEQ are predicted to have a worse outcome at 6 months.

The combination of the two initial scores is important to predict how a patient will respond to physiotherapy.

High pain self efficacy modifies the poor predicted outcome associated with high baseline pain to a better predicted outcome. Low pain self efficacy modifies the better predicted outcome associated with low baseline pain to a poorer predicted outcome.
Figure 4  Regression tree for Shoulder Pain and Disability Index (SPADI) disability subscale score. Cut-off points for the SPADI disability subscale scores and pain self-efficacy questionnaire (PSEQ) have been rounded up or down to whole numbers. The four box plots at the bottom of the figure illustrate the distribution of total SPADI disability subscale scores at 6-month follow-up. The median SPADI disability subscale score at 6-month follow-up (represented by the horizontal line dissecting the box) is lowest (better outcome) in the subgroup represented by the box furthest left and highest (poorer outcome) in the subgroup represented by the box furthest right.

Clinical interpretation:

Of patients who score <62 on the initial SPADI Disability Subscale, those who score <42 compared to between 42 to 61 are predicted to have better outcome at 6 months.

Of patients who score ≥62 on the initial SPADI Disability Subscale, those who score ≥48 compared to <48 on the initial PSEQ are predicted to have the better outcome at 6 months.

The combination of the two initial scores is important to predict how a patient will respond to physiotherapy.

High pain self-efficacy modifies the poor predicted outcome associated with high baseline disability to a better predicted outcome.
Regression tree for Quick Disability of the Arm, Shoulder and Hand (QuickDASH). Cut-off points for the QuickDASH scores have been rounded up or down to whole numbers. The four box plots at the bottom of the figure illustrate the distribution of QuickDASH scores at 6-month follow-up. The median QuickDASH score at 6-month follow-up (represented by the horizontal line dissecting the box) is lowest (better outcome) in the subgroup represented by the box furthest left and highest (poorer outcome) in the subgroup represented by the box furthest right.
cut-off values for baseline pain or disability (SPADI, SPADI subscale score or QuickDASH). The baseline score was therefore considered the most important variable in predicting the respective 6-month outcome. In addition to baseline pain or disability, each pruned regression tree retained only one other variable of the 34 variables considered: baseline pain self-efficacy or patient expectation. Either pain self-efficacy or patient expectation led to classification of participants into four subgroups. The number of participants in these subgroups ranged from 48 to 487. The cut-off point for baseline SPADI scores (total, pain and disability subscores) at the first node of each tree ranged from 62 to 75. When subdividing patients with lower baseline SPADI or baseline SPADI pain subscores into two groups using baseline pain self-efficacy scores, the cut-off for the PSEQ was 40 and 41, respectively. When subdividing patients with higher baseline SPADI pain or disability subscores into two groups using pain self-efficacy scores, the cut-off point for the PSEQ was consistently 48.

Table 1 and figures 2–4 show that the size of any subgroup with low pain self-efficacy ranged from 16% (n=127) to 20% (n=161) of participants in the cohort. The SPADI pain tree includes two subgroups with low pain self-efficacy and this constitutes as 36% (n=288) of the cohort. The discrimination between median outcome scores associated with different pain self-efficacy scores differs between trees and baseline pain and/or disability. For example, the median difference in subgroups is most marked for participants with high baseline SPADI pain subscores (≥75) and least for participants with lower baseline total SPADI scores (<68). Twenty-three per cent (n=239) of the cohort had a baseline of 41–59 on the QuickDASH, their outcomes were differentiated by their expectation of ‘change as a result of physiotherapy treatment’: the median difference in subgroups at outcome being 23/100 on the QuickDASH.

Validation

External validation of the results was not possible as we were unable to identify an external dataset containing the same or similar variables. We have, however, conducted an informal internal validation of the results by partitioning the QuickDASH outcome data based on the classifications of the SPADI regression trees and comparing the distribution of QuickDASH outcome within each subgroup with that of the SPADI outcomes. Comparison of QuickDASH distributions corresponding to the total SPADI, SPADI pain and SPADI disability trees are displayed in online supplementary files 4, 5 and 6, respectively. The similarity of the pattern distributions of the SPADI outcome on the left and QuickDASH outcome on the right demonstrate the replicability of the SPADI tree.

**DISCUSSION**

The objective of these analyses was to identify important predictors of outcome for patients presenting with non-surgically managed musculoskeletal shoulder pain. We identified that only 3 of 34 baseline variables considered in the classification trees were predictive of outcome. These were i) baseline pain or disability measured by the SPADI or QuickDASH, ii) pain self-efficacy measured by the PSEQ<sup>16</sup> and iii) patient’s expectation of ‘change as a result of physiotherapy treatment’, measured on a 7-point Likert scale. As expected, there was a positive association between pain and disability at baseline and at 6-month follow-up, that is, those with higher scores at baseline tended to have higher scores at follow-up. However, in all three SPADI classification trees higher pain self-efficacy influenced this relationship: for patients with high baseline pain or disability (cut-off points 75 and 62, respectively), higher pain self-efficacy (PSEQ≥48) reduced the likelihood of continued high levels of pain and disability at 6-month follow-up. Between 16% and 19% of participants were at risk of continued high levels of pain and disability (measured by SPADI pain and disability subscores) at 6 months due to (i) high baseline pain and disability and (ii) low pain self-efficacy. For patients with moderate levels of baseline pain and disability measured with the QuickDASH (41–59), the association was influenced by patient expectation: participants who expected to completely recover or much improve as a result of physiotherapy did better than patients who expected to only slightly improve, stay the same or worsen. Participants at risk of continued high levels of pain and disability at 6-month follow-up due to a lower expectation of recovery constituted 7% of our cohort at 6-month follow-up.

Pain self-efficacy also influenced outcome for patients with low levels of baseline pain and disability: for patients with low baseline SPADI and SPADI pain scores (<68 and <75, respectively), low pain self-efficacy (PSEQ <40 and <41, respectively) increased the likelihood of persistent pain. Perhaps surprisingly, patients reporting low baseline pain but low pain self-efficacy (n=161, 20% of cohort) had a similar or worse outcome on the SPADI pain subscale to patients with high baseline pain but high pain self-efficacy (n=48, 6% of cohort).

Our regression tree analyses provide a useful and simple clinical guide, highlighting the influence of patient beliefs and expectations of treatment on outcome, irrespective of baseline pain and disability. While these findings are consistent with those from the GLM analysis, the CART analysis selects variables based on prediction power rather than statistical significance or p values. Variables are included in order of importance; the most predictive variable is included first, the analysis then searches for the second most important variable among the rest and so
on. The prediction error curve estimated using cross-validation gives a clear indication at what point in the selection process the additional predictors are not contributing enough to the prediction model. The prediction-based variable selection combined with cross-validation for assessing model performance ensures that only the relevant and most predictive variables are included in the optimal model.

CART analysis has advantages over traditional regression modelling in that it does not require a specified distribution of outcome data or a large sample size. In terms of predictive power, CART analysis is comparable to traditional modelling. However, CART does have limitations. Defining subgroups based on data-driven cut-off points for continuous measures (ie, the PSEQ) is subject to sampling variability, but the CART methodology does not provide a measure of uncertainty (eg, SEs or CIs) associated with the cut-off points. A different cut-off point may be selected in a different sample, but it was not our intention to provide a ready to deploy clinical tool with definitive cut-off points at this stage. We rather aimed to demonstrate that an easily interpretable prediction tool with potential for clinical applications can be developed which can be further examined in bigger and external cohorts to derive more generalisable cut-offs. However, use of cross-validation approach for model selection should make the derived models sufficiently robust at least for the population represented by the study cohort. Also, being a multicentre study with broad eligibility criteria increases the generalisability of the results to the wide range of patients and presentations of shoulder pain commonly seen by physiotherapists within primary and secondary care. This is further supported by similar patterns of the distributions of the Quick-DASH outcome based on classification of participants using the SPADI trees in our informal internal validation.

With regard to non-surgically managed shoulder pain, this study is one of only two known using a CART analysis to investigate the hierarchy of predictive factors associated with outcome. Vergouw compared the results of CART and logistic linear regression for 587 patients with musculoskeletal shoulder pain attending general practice in the Netherlands; however, they did not include patient expectation of change as a result of physiotherapy and pain self-efficacy. A positive association between patient expectation and outcome has been consistently reported for a range of health conditions. Ours is one of only two studies to investigate self-efficacy in non-surgical management for shoulder pain. A randomised controlled trial of 102 participants did not find an association between baseline pain and disability and concomitant low pain self-efficacy. The association between pain self-efficacy and chronic non-cancer pain has also been consistently reported for a range of health conditions. Although our findings are applicable to people referred to physiotherapy for the management of shoulder pain of any duration and in primary and secondary care, they are likely to be applicable beyond this group.

COnClusIOn

This is the first known study to subgroup people with shoulder pain of musculoskeletal origin attending physiotherapy into risk groups for persistent pain and disability based on a range of baseline personal, clinical, activity and participatory variables. This multicentre study provides evidence that for a given baseline measure of shoulder pain and disability, pain self-efficacy and patient expectation of change as a result of physiotherapy, are the most influential predictors of patient-rated outcome at 6-month follow-up. Additionally, this is the first study to demonstrate that for people with shoulder pain higher pain self-efficacy reduced the likelihood of continued high levels of pain and disability at 6-month follow-up, for those with high baseline pain or disability. The likelihood of persistent pain increased in the subgroup that were categorised as having low levels of baseline pain and disability and concomitant low pain self-efficacy. Of importance those identified as having low baseline pain and low self-efficacy had similar or worse outcome on the SPADI subscale by the patients with high baseline pain and high pain self-efficacy.

Although not previously reported for those experiencing shoulder pain, high self-efficacy has been shown to be significantly associated with greater exercise adherence as well as other health behaviours such as physical activity and taking medications as prescribed. A consistent and statistically significant association between all three factors, changes in self-efficacy, adherence and outcome, has yet to be demonstrated. Further studies are needed to explore if moderating self-efficacy affects outcome.

Further development and testing of educational interventions targeting healthcare practitioners with strategies to increase patients’ pain self-efficacy and expectations of treatment is needed. A number of promising interventions exist for increasing patients’ self-efficacy and include positive feedback on performance, observation of mastery in others, graded activity, identifying realistic goals for which the patient is likely to succeed and selecting tasks and activities relevant to the patient.

Variability in reported effectiveness suggests that the purpose, content and delivery may need to be tailored to each patient, requiring a person-centred approach.

Although patient-clinician dialogues around the potential impact of expectations and beliefs further supports shared decision-making. Our results suggest that cut-off points will vary according to baseline pain and disability and therefore the use of specific cut-off points for stratification is not justified. Further research is also needed to validate our point estimates in an external cohort.

It is plausible that patient expectation and pain self-efficacy are mediating factors. Adherence to non-surgical management is reportedly low. The therapeutic effect of a home exercise and/or self-management programme cannot be realised if not enacted by the patient. One of the suggested mechanisms by which higher patient expectation is associated with outcome is through an increased motivation to engage and adhere to an intervention that participants believe will have a beneficial outcome.

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Variability in reported effectiveness suggests that the purpose, content and delivery may need to be tailored to each patient, requiring a person-centred approach.

CONCLUSION

This is the first known study to subgroup people with shoulder pain of musculoskeletal origin attending physiotherapy into risk groups for persistent pain and disability based on a range of baseline personal, clinical, activity and participatory variables. This multicentre study provides evidence that for a given baseline measure of shoulder pain and disability, pain self-efficacy and patient expectation of change as a result of physiotherapy, are the most influential predictors of patient-rated outcome at 6-month follow-up. Additionally, this is the first study to demonstrate that for people with shoulder pain higher pain self-efficacy reduced the likelihood of continued high levels of pain and disability at 6-month follow-up, for those with high baseline pain or disability. The likelihood of persistent pain increased in the subgroup that were categorised as having low levels of baseline pain and disability and concomitant low pain self-efficacy. Of importance those identified as having low baseline pain and low self-efficacy had similar or worse outcome on the SPADI subscale by those with high baseline pain and high pain self-efficacy.

Although our findings are applicable to people referred to physiotherapy for the management of shoulder pain of any duration and in primary and secondary care, they are likely to be applicable beyond this group.

Based on our findings, we suggest that pain self-efficacy and patient expectation should be formally assessed and
discussed at the first physiotherapy appointment. Further research should investigate whether these factors can be targeted and modified by therapeutic interventions and improve patient outcomes.

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Contributors RC conceived the study. RC, LS, JSL and CJ-H contributed to the design of the study. RC directed the study and managed data acquisition. RC had full access to all of the data in the study and takes responsibility for the integrity of the data. MK undertook and LS provided expert advice on the statistical analysis. RC and MK drafted the manuscript. LS, JSL and CJ-H provided additional important intellectual and substantial scientific input throughout the study and on all redrafts of the report.

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