USASP
US ASSOCIATION FOR THE STUDY OF PAIN

PUBLISHED BY
ELSEVIER

The Journal of Pain, Vol 00, No 00 (), 2021: pp 1–24
Available online at www.jpain.org and www.sciencedirect.com

Review Article

A Systematic Review and Meta-Analysis of the Effects of Biopsychosocial Pain Education upon Health Care Professional Pain Attitudes, Knowledge, Behavior and Patient Outcomes

Jagjit Mankelow,* Cormac Ryan,* Paul Taylor,† Greg Atkinson,* and Denis Martin*

*School of Health and Life Sciences, Teesside University, Middlesbrough, UK
†School of Social Sciences, Humanities and Law, Teesside University, Middlesbrough, UK

Abstract: **Pain is a significant health burden globally and its management frequently fails to comply with evidence based, biopsychosocial guidelines. This may be partly attributable to inadequate biopsychosocial focussed pain education for students and clinicians. We aimed to undertake a systematic review, using Cochrane methodology, of randomized controlled trials with meta-analysis to quantify the effects of biopsychosocial education strategies in changing student/qualified health care professionals (HCPs) pain related attitudes, knowledge, clinical behaviour or patient outcomes. A systematic search of the literature was undertaken using CINAHL, AMED, PEDro, Cochrane Central Library, MEDLINE, ScienceDirect, Rehabdata, SportDiscus, EMBASE, ASSIA, Dentistry and Oral Science, Psycinfo, Education Research Complete and OpenGrey from 1977 to November 2020. Pooled effect sizes were quantified in random effects meta-analyses for attitudes, knowledge, and clinical behaviors. From a sample of 1812 records, 6 were narratively analysed and 15 were included in the meta-analyses. These studies represented 3022 patients and 3163 HCPs and students. Education improved attitudes by 11.3% (95% confidence interval: 2.2–20.4%, *P* = .02), and knowledge by 18.8% (12.4–25.3%, *P* = .01). The effects of education on clinical behavior favoured a clinically relevant improvement (OR = 2.4, 0.9–5.9, *P* = .06). Narrative analysis of the effect of biopsychosocial education for student HCPs/HCPs upon patient outcomes was inconclusive. These findings demonstrate that biopsychosocial focussed pain education strategies can improve student/qualified HCPs' pain related knowledge and attitudes and increase the likelihood that they will behave more in keeping with evidence-based practice. This should result in improved patient outcomes, however, evidence to support or refute this is lacking.**

PROSPERO systematic review record number, CRD42018082251.

Perspective: **We outline the effectiveness of biopsychosocial pain education for health care professionals and students in improving pain knowledge, attitudes, and evidence-based behaviors. These improvements should enhance clinical outcomes in patients with pain but further evidence is needed to confirm this.**

Key words: *Systematic review, meta-analyses, pain education, healthcare.*

Chronic pain is a highly prevalent condition and a major contributor to global disability.[17,29,36,44] Chronic pain can have a significant impact upon the lives of patients, their families, workplaces and health care services.

The general consensus is that chronic pain conditions require a broad biopsychosocial, rather than a narrow biomedical, model of care.[27,56,64] The biopsychosocial

Received April 13, 2021; Revised June 9, 2021; Accepted June 18, 2021.
No funding was received for this study.
There are no conflicts of interest.
Address reprint requests to Jagjit Mankelow, PhD, School of Health and Life Sciences, Teesside University, Middlesbrough, TS1 3BX, UK. E-mail: j.mankelow@tees.ac.uk
1526-5900/$36.00

https://doi.org/10.1016/j.jpain.2021.06.010

approach encompasses biological, psychological, social and environmental factors contributing to pain. It is apparent that sole reliance on the biomedical approach, as well as associated negative attitudes about the functional ability of people with persistent pain have endured in clinical practice[1] and been resistant to change.[32] These negative attitudes towards pain can be observed during the undergraduate training stage of the health care professionals' (HCP) career.[47] Thus, the pre-registration phase is an important point where HCPs' understanding of pain and attitudes towards function in people with pain may be shaped for the future. Buchbinder et al (2018)[6] and Foster et al (2018)[31] identify the global need for enhanced education of students to support best practice for pain management.

In 2011 Briggs, Carr and Whittaker[4] described pain education at pre-registration level for HCPs as 'woefully inadequate'. They identified that the amount of curriculum time dedicated to pain was minimal, averaging 6 hours across a range of health care professions, with few if any, implementing the preregistration pain curricula proposed by IASP.[37] A recent international systematic review found that pain medicine teaching in medical schools was inadequate[66] confirming regional findings from medical schools in Europe[5] and healthcare courses in North America. A recent study by Mankelow (2021)[53] observed the variation in pain education delivery in 5 different countries, at twelve universities, amongst 6 different nursing, midwifery and allied health professional disciplines. Training varied from no specific pain education teaching to up to 40 hours of teaching, with greatest teaching found amongst physiotherapy schools. The majority of courses provided a very low volume of pain education. This is concerning in light of the prevalence of pain, the associated disability and the multi-disciplinary approach that is needed to manage it.

Whilst many researchers have investigated the effectiveness of pain education to improve pain related knowledge and attitudes in people with chronic pain[48,70,73] there have been relatively few studies in which the effectiveness of pain education has been investigated for HCPs. Shipton et al (2018)[66] conducted a systematic review of pain medicine content, teaching and assessment in medical school curricula using narrative analysis. In such studies as Strong et al (2003),[68] Watt-Watson et al (2004)[71] and Tauben and Loeser (2013),[69] the effects of pain education have been examined on students and clinicians. Nevertheless, these studies did not include a comparator group, so no robust claims about causality could be made. Other researchers have investigated the effects of pain education on students using the more robust randomized controlled trial (RCT) design[14,19,50,52] which can be adopted in education research, especially if both RCT groups follow "usual educational practice", but the intervention group is administered as an extra specific educational programme. In 2012, Briggs[3] called for an evaluation of different pain education strategies for different groups. However, to date no systematic review of the effectiveness of such strategies has been published. There is a need to systematically review the existing biopsychosocial pain education approa'ches for HCP students to guide educational practice in this important and rapidly growing field.

The aim of this systematic review was to investigate the effectiveness of biopsychosocial pain education strategies for improving pain related knowledge, attitudes and clinical behaviors of HCPs/HCP students, and the clinical outcomes of their patients with pain.

Methods

This study was guided by Cochrane methodology, and was reported in keeping with PRISMA guidelines. The review protocol was registered on PROSPERO systematic review record number, CRD42018082251.[51]

Inclusion Criteria

Types of Studies

Only RCTs were included to minimise bias and enable a degree of cause-effect analysis.[33] Studies in all languages and modes of delivery (eg, distance learning or in person lecture delivery) were included in this study from 1977 to the 22nd November, 2020. These were initially screened using an online translation tool with the intention to find translators as needed. The term 'biopsychosocial' was first used in a medical context in 1977[23] hence the search start date used.

Types of Participants

Participants in the studies selected were either students or fully qualified HCPs. All disciplines that conceivably could be involved in the care of people with chronic pain were included. Both student and HCP studies have been included because strategies employed for HCPs may be equally valuable to students and vice versa.

Types of Interventions

The studies selected used a variety of different biopsychosocial pain education interventions in keeping with current best practice guidelines. These were either studies which used a recognised biopsychosocial pain education such as pain science education or within their educational intervention they included features of teaching which are broadly aligned with IASP[37] recommended pain education. Authors were contacted when clarity was needed about interventions for the inclusion/decision-making process. Educational interventions centred around the biomedical model, focusing on content such as anatomy and biomechanics were not included. Biomedical education is conceptually very different to biopsychosocial education as it fails to address lifestyle and 'moribdogenic' environmental components which contribute to chronic diseases.[28,40] A biomedical education has the potential to promote maladaptive beliefs which negatively impact patient management.[18]

Studies were eligible for inclusion irrespective of the delivery method of the education programmes, including

but not limited to, face-to-face, online, blended learning, short courses or workshops. The programmes were delivered either to individuals or a group, as a one-off session or over a number of sessions. The intervention had to target changes in 1 or all of the following:

1. Pain physiology knowledge;
2. Individuals' attitudes about pain;
3. Pain management behaviors.
4. Patient outcomes.

Types of Comparison Groups

Studies using usual non-biopsychosocial based education control, placebo/sham education, or no education were included in this study.

Types of Outcome Measures

This systematic review included studies that used outcome measures to assess 1 of 4 key areas:

- Pain physiology knowledge (eg, the revised pain neurophysiology questionnaire[9]
- Students'/HCPs' attitudes and beliefs regarding people with chronic pain such as the Health Care Providers' Pain and Impairment Relationship Scale (HC-PAIRS),[35] and Fear-Avoidance Belief Questionnaire (FABQ).[54]
- Pain management clinical behaviors (eg, management of real patients, patients' notes, patient vignettes).
- Patient outcomes as measured in clinic.

Given the nature of the constructs being assessed (eg, pain management behaviors), non-validated outcome measures were considered on a case-by-case basis.

Measuring Clinical Significance of Outcomes

The outcomes for this systematic review were HCP students'/HCPs' knowledge attitudes, clinical behavior and patient outcomes after student/HCP's exposure to biopsychosocial pain education. The minimal clinically important difference (MCID) reflecting a threshold for meaningful changes in 2 of the outcome measures (knowledge and attitudes) was 7.3% for knowledge outcome and 4.6% for the attitudes outcome based upon thresholds established in Mankelow et al, (2020)[52] for HC-PAIRS and RNPQ. These thresholds were originally tentatively estimated by Mankelow et al (2020)[52] as half the baseline SD presented in previous studies from similar populations.[12,14,20,58] The basis for this decision is that attitudes in 5 out of the 6 selected studies were measured by HC-PAIRS, thus to continue to use this MCID is justifiable. For consistency the same approach was applied to the knowledge outcome measure in the absence of another established MCID for knowledge interventions in clinical or educational literature, and in light of 3 out of 11 of the meta-analysed knowledge studies using RNPQ. Behavior outcomes were judged as having magnitudes of effect sizes derived from Chen, Cohen and Chen's (2010)[11] proposed method wherein odds ratios of 1.68 equate to a small magnitude effect size, 3.47, medium magnitude and 6.71 equates to a large magnitude effect size.

Search Methods for Identification of Studies

Electronic Searches

The following databases were searched: CINAHL, AMED, PEDro, Cochrane Central Library, MEDLINE, ScienceDirect, Rehabdata, SportDiscus, EMBASE, ASSIA, Dentistry and Oral Science, Psycinfo and Education Research Complete. Grey literature was searched via the website OpenGrey. Search filters were used to identify RCTs on MEDLINE, EMBASE and CINAHL. Specialist librarian assistance was engaged to translate filters for other platforms without a recognised filter in keeping with guidance in the Cochrane Handbook for Systematic Reviews for Interventions.[34]

Search Strategy

The Population, Intervention, Comparison, Outcomes and Study design strategy was used to define the scope of this study. The provisional scoping search revealed that there were previous studies featuring biopsychosocial education for physiotherapy, sports therapy and rehabilitation students, medics and nurses and the interventions included pain science education, e-learning interventions and cognitive behavioral pain management.

Guided by the Population, Intervention, Comparison, Outcomes and Study structure, the following search terms for RCTs were used, whilst allowing for variation of medical subject heading descriptors governed by individual databases. All medical subject heading descriptors were exploded to broaden the data set. Boolean operators were also used for this purpose as suggested by the Cochrane Handbook for Systematic Reviews for Interventions.[34] For example:

(('pain' AND ('education' OR 'curriculum' OR 'continuing professional' OR 'training' OR 'teaching' OR 'cognitive functional' OR 'PNE' OR 'e-learning')) AND

('student' OR 'health professionals' OR 'nurs', OR 'doctor* OR 'physiotherap* OR 'therapist* OR 'practitioner' OR 'medic' OR 'midwi* OR 'paramedic*)*

AND

('knowledge' OR 'attitudes' OR 'beliefs' OR 'behavior)

Some databases with more limited interfaces such as PEDro required slightly different approaches to the search terms used. These were recorded as they were applied.

Search Other Resources

Bibliographies of all included RCTs were hand searched for further relevant sources.

Data Collection and Analysis

Selection of Studies

First Screening

Initially, duplicates were removed from the list of studies. Study titles and abstracts extracted from the electronic and hand searches were reviewed independently by 2 review authors (J.M. & D.S.) and assessed for eligibility using Endnote.

Second Screening

Full text articles were then reviewed in their entirety to ensure their eligibility. Any studies that did not qualify for eligibility after a second screening were detailed in the table of excluded studies (see supplementary material) with reasons for their exclusion. Full text reviews were undertaken independently by JM & DS. Disagreements were resolved by consensus. Where consensus could not be reached, a third reviewer was consulted, C.R.

Data Extraction and Management

Stage 1

Data were extracted independently by 2 reviewers (J.M. and G.A.) in keeping with Cochrane guidelines.[34] Extraction techniques were reviewed by both reviewers to ensure uniformity and reproducibility of the methodology and to minimise errors. Excel data extraction forms were modified from the Cochrane extraction form, piloted, and amended to match the data features of this review.[34] Data were extracted on the basis of intervention description (including definition), participants (including the numbers), duration of intervention, mode of intervention, the outcome measures used and pre-and post-intervention scores with standard deviations. In the case of the behavior outcome measure the data extracted related to events and non-events of guideline consistent behavior. Where this information was not available it was sought from authors and if they were either unable to provide the information or did not return contact then the study was removed from the list of studies or just the meta-analyses as appropriate. Where knowledge and attitude questionnaires were combined, they were scrutinized by JM and CR to establish which outcome domain the joint questionnaire primarily assessed.

Stage 2

Assessment of Methodological Quality

Assessment of risk of bias in included studies. Two reviewers (J.M. and P.T.) assessed the included studies for risk of bias (RoB) using the Revised Cochrane RoB 2.0 form.[67] KB and KC reviewed Mankelow et al (2020)[52] so that RoB was not assessed by an author of that work, in keeping with Cochrane guidance, and in order to reduce RoB. Authors were contacted to clarify any outstanding queries that may affect the RoB assessment. Any disagreements in RoB assessment were resolved through discussion and if agreement could not be reached then a third reviewer was consulted. The data were transferred to Revman 5.4 to understand the overall RoB.

Dealing with missing data. Authors of 13 papers were contacted to seek data/information that was not published. Missing data and attrition were reported in the RoB table. Authors and co-authors of 4 studies did not respond to a request for further information thus their studies were excluded as it could not firmly be established if their intervention was biopsychosocial and/or the nature of the control education could not be established. Additionally, 4 authors were unable to furnish missing data and this affected the RoB score for their studies.

Data synthesis. Where possible, reported mean intervention effects were pooled in a random effects meta-analysis using Stata 16 software (Statacorp, 1985). Random effects meta-analyses were selected a priori based on the philosophical presence (fixed effect) or absence (random effects) of a "true effect" across the studies.[2] A random effects model was selected as it was more realistic and appropriate to allow that the true effect could vary from study to study, for example, the effect size might in theory be different if the participants were older, or healthier; or if the study used a slightly more intensive or longer variant of the intervention; or if the effect was measured more reliably; and other such sources of variation.

Double data entry was carried out for all results by JM and GA. Study effect sizes were weighted using the inverse variance approach. The restricted maximum likelihood approach was adopted with the Knapp-Hartung modification applied. 95% confidence intervals (CIs) and prediction intervals (PI) were calculated. The PI is better aligned to the selection of a random effects model than a CI. In keeping with the philosophical absence of a true stable effect size across the studies, the PI represents the likely range in which a new study's effect size will fall into, assuming that this future study is of a similar nature.[38] Pooling of data was only undertaken where there were at least 5 studies to help ensure sufficient statistical power and relatively precise inferences.[39] The results of the meta-analysis can be seen in the forest plots and funnel plots below in Fig. 3–7. Where studies did not lend themselves to statistical pooling due to insufficient studies relating to a specific outcome measure, they were presented as a narrative synthesis.

Quantification of heterogeneity. I-squared and tau statistics were used to quantify between-study heterogeneity in the meta-analyses of continuous level data. Tau is essentially interpreted in the same way as a standard deviation. Tau-squared is the variance of the true effects across studies while tau (T) is the estimated standard deviation of underlying true effects across studies.[2] Sensitivity analyses was carried out where appropriate.

Data that were not amenable to statistical pooling was discussed in narrative format.

Quality of evidence. The Grades of Recommendation, Assessment, Development and Evaluation profiler software was used to assess the quality of evidence for outcomes which were meta-analysed (Table 2). This process was undertaken by JM and CR.

Results

A summary of the search results can be seen in the PRISMA diagram below (Fig 1).

In total, 1812 studies were identified (excluding duplicates). Of those, 44 full texts were obtained and evaluated against the inclusion criteria. A further 24 studies were excluded as they did not meet the inclusion criteria thus 20 studies were included in this study.

Meta-analyses were undertaken for fifteen studies, data sets from some of these studies were used for multiple outcomes as illustrated in Table 1 below. Narrative analysis was undertaken for 6 studies (1 of these studies also had an outcome measure that was meta-analysed) to investigate the change in patient outcome.

Of the 20 studies, 5 involved students alone, 1 included students and clinicians and 14 involved clinicians only.

Methodological Quality

Quality appraisals were completed for all 20 papers. RoB was found to be relatively low overall as shown in Fig 2 below.

Overall, the areas of greatest RoB occurred in the blinding of personnel and or participants delivering the specific intervention. Studies such as Maguire, Chesterton and Ryan (2019)[50] and Colleary et al (2017)[13] clearly state in the study design description that participants were blinded though this was not clearly stated in all studies. However, blinding of the educator does not appear to have occurred in any study. Blinding of the outcome assessment was marked as having a high potential for RoB in most studies however this was in the absence of an explicit statement in most cases. Attempts to uncover this information by contacting authors was largely unsuccessful as the majority did not respond and this was reflected in the RoB assessment. Equally, other missing data contributed to the increased RoB that could not be resolved with enquiries to the authors. It is acknowledged that it is difficult to blind

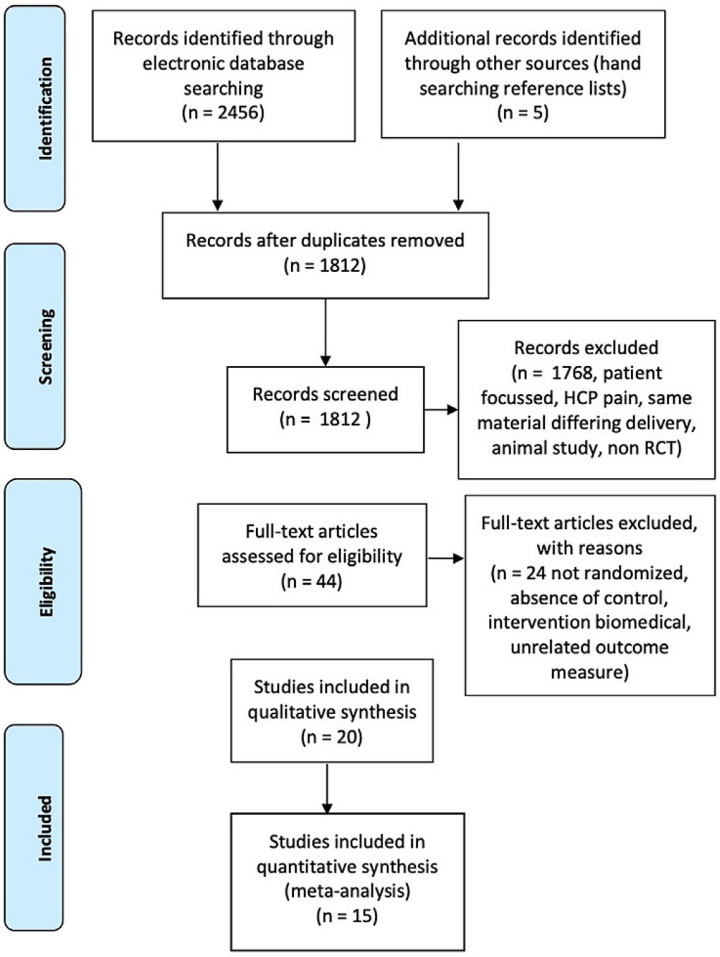

Figure 1. PRISMA flow diagram of the search and study selection process.

Table 1. Studies Used in Meta-Analyses

	Outcome measure		
Study	Knowledge	Attitudes	Behaviors
Colleary et al[13]	x	X	x
Maguire et al[50]	x	X	x
Mankelow et al[52]	x	X	x
Lin et al[45]	x	X	
Domenech et al[18]		X	x
Evans et al[26]		X	x
Corson et al[15]			x
Engers et al[24]			x
Maclaren et al[49]	x		
Zhang et al[76]	x		
Dwyer et al[21]	x		
El-Aqoul et al[22]	x		
Salim et al[63]	x		
Yoo et al[75]	x		
Johnston et al[41]	x		

Legend x – indicating studies from which data was extracted.

study participants and even more so study personnel delivering educational interventions.

The overall findings of the meta-analyses are shown in Table 2. The quality of findings scores were graded as low. This was in part due to a few studies being less robust in RoB findings, but primarily attributable to the asymmetry of the statistical analysis between studies and the imprecision and inconsistency of results.

Knowledge

Data from 1,038 study participants were pooled from 11 studies and the knowledge outcome was dominated by qualified nurses. These were predominantly female participants however not all studies provided this information. In the case of Johnston et al (2007)[41] this information was deliberately not collected to avoid identification of participants. Mean ages were also not provided in every study but in those that do present them they vary from between 22 to 36 years of age. The studies took place in the UK, Canada, USA, Taiwan, China, Jordan, Germany, Dubai and South Korea. The interventions varied between one 70 minute lecture to 7 sessions totalling 15 hours over 2 weeks, 10 1-to-1 coaching sessions. Two studies delivered information online and the others were delivered face-to-face. Outcome measurement took place using a variety of different measures including validated outcome measures such as the RNPQ[9] to specifically devised outcome measures such as the Lin et al's (2008)[45] own 'checklist for knowledge of pain management' outcome measure.

The effect size data from the 11 RCTs assessing the impact of biopsychosocial education on knowledge were established as a percentage to enable pooling with a higher score indicating better knowledge. There was a mean improvement in pain knowledge of 18.8 % (95% CI 12.4–25.3) compared to control (P = .01; low quality evidence). Heterogeneity was high (I^2 = 95%; tau = ±9.19; PI = -2.9 to 40.6). See Fig. 3 and 4 for the associated forest plot and funnel plot which again suggests publication bias.

Attitudes

The majority of the 2,179 participants from the 6 RCTs included in this meta-analysis were female and the attitudes outcome was dominated by physiotherapy students and HCPs. The mean ages varied from 20 to 41 with the older age groups dominated by qualified HCPs. There was considerable variation in the form of the intervention, varying from educational information posted to participants to multiple lectures and workshops. The lectures varied in duration from 70 minutes to 15 hours with the latter providing training for the application of the intervention. Studies were based in the UK, Spain and Taiwan. The majority of the studies used HC-PAIRS for their assessment of attitude. Lin et al (2008)[45] used an outcome in which, unlike HC-PAIRS, a higher score indicated a better result. Thus, the meta-analysis for the data in this study was adjusted so that it scored in the same direction as the HC-PAIRS to enable comparison. Domenech et al (2011)[18] also used the FABQ. This enabled a sensitivity analyses

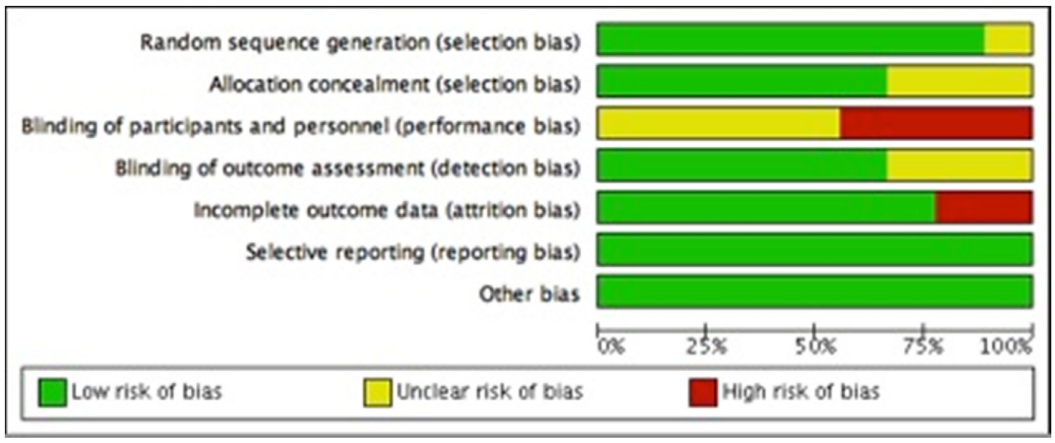

Figure 2. Risk of bias graph: review authors' judgments about each risk of bias item presented as percentages across all included studies.

Table 2. Summary of Findings

Outcome	*Effect size % (95% CI)*	*No. of participants (studies)*	*Certainty*	*Comments*
Pain Knowledge (measured immediately after intervention to 1 mo after intervention)	18.8 (12.4–25.3)	1038 (11 RCTs)	⊕⊕⊖⊖ LOW*,†,‡,¶	A higher score indicates greater knowledge. A change of ≥7.3%‖ was considered clinically important. Biopsychosocially oriented pain education may result in a clinically relevant improvement in pain knowledge.
Pain Attitude (measured immediately after intervention to 6 mo after intervention)	-11.28 (-20.37 to 2.19)	2179 (6 RCTs)	⊕⊕⊖⊖ LOW*,‡,§,¶	A lower score indicates better attitudes. A change of ≥4.6%‖ was considered clinically important. Biopsychosocially oriented pain education may result in a clinically relevant improvement in pain attitudes.
Pain management behaviors	2.39 OR (0.9–5.9)	2181 (7 RCTs)	⊕⊕⊖⊖ LOW	A higher score indicates improved pain management behaviour. Biopsychosocially oriented pain education may result in a small to moderate# improvement in pain management behavior.
Patient outcome	NA	2179 (6 RCTs)	⊕⊕⊖⊖ LOW	Studies in which HCP students/HCPs received biopsychosocial oriented pain education were not conclusive about the effect of this intervention upon patient pain related outcomes.

*The difficulties in blinding personnel was the consistent area of weakness as blind delivery of the intervention difficult to overcome when education is delivered in person and not without potential for bias when delivered remotely.
†There were 2 distinct groups of findings amongst these studies.
‡There was clear asymmetry of evidence suggestive of publication bias.
§There was 1 outlier wherein confidence intervals do not overlap.
¶I-squared was above 50%.
‖Based on MCIDs established by Mankelow et al.[52]
#Derived from OR = 1.68 (small magnitude) and 3.47 (medium magnitude) proposed by Chen, Cohen and Chen.[11]

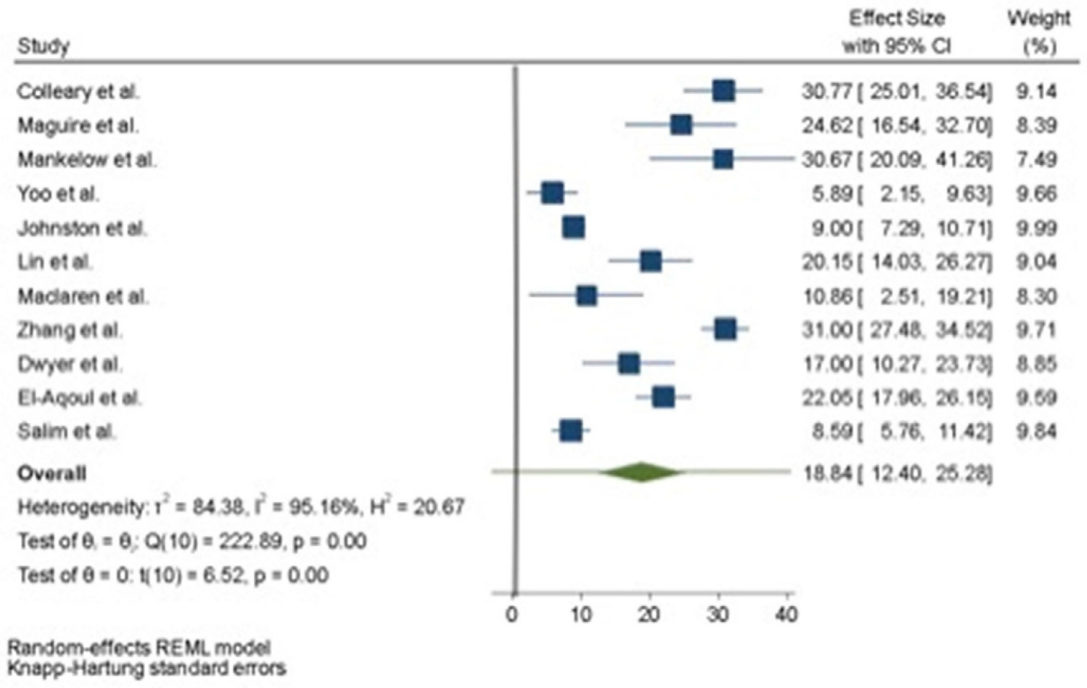

Figure 3. Forest plot of biopsychosocial pain education versus control for the knowledge outcome. Legend: CI is the distance between the 2 sideways "points" of the pooled effect green diamond and the PI is the green line. The pooled effect itself is represented by the vertical points of the diamond.

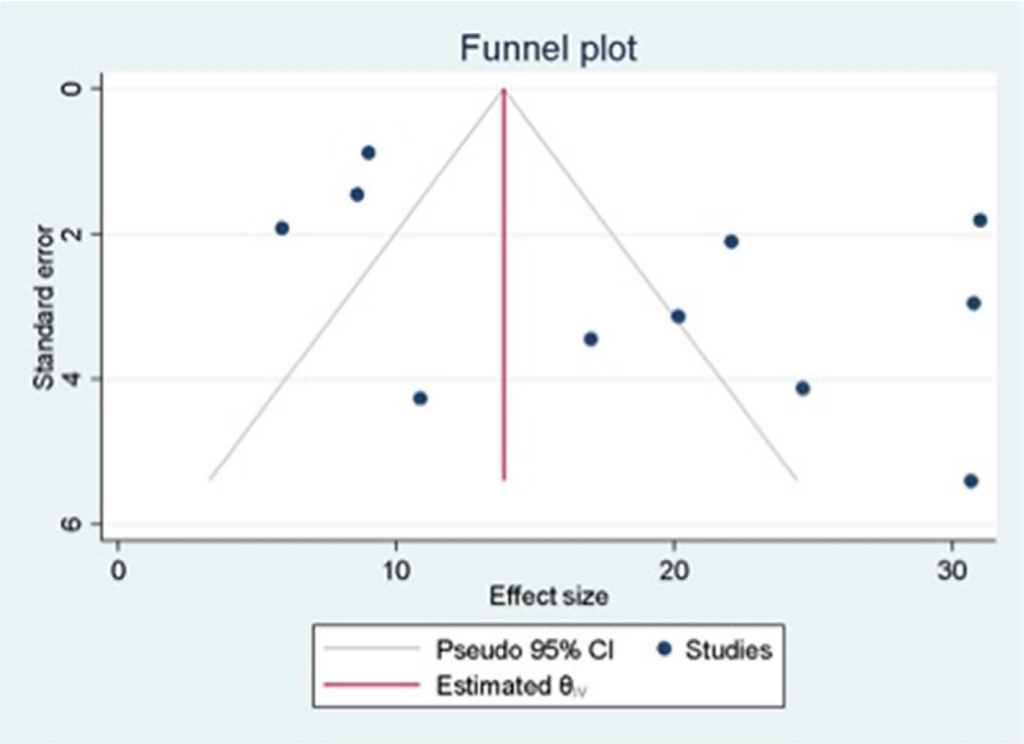

Figure 4. Funnel plot for studies involved in the knowledge outcome indicating considerable publication bias due to asymmetry and a paucity of small studies in which relatively small effect sizes were reported.

between the 2 components of the FABQ reported separately, work and physical activity replacing these for HC-PAIRS. This sensitivity analysis did not alter the findings. As the Domenech et al (2011)[18] study was the only study to use a beliefs outcome, this outcome is henceforth assimilated under the attitudes outcome as the constructs were very closely linked.

The effect size data from the 6 RCTs assessing the impact of biopsychosocial education on attitudes were established as a percentage to enable pooling of the results with a lower score indicating better attitudes to pain. The mean improvement in attitudes towards function in people with chronic pain was -11.3 % (95% -20.4 to -2.2, $P = .02$; low quality evidence) compared to control. Heterogeneity was high ($I^2 = 95.08\%$; tau = ±8.4. The PI was -36.6 to 14.04). See Fig. 5 and 6 for the forest plot and funnel plot for this outcome. The results reflect the small number of published studies, which were relatively small in sample size, in which relatively small effect sizes were reported (in the opposite direction to what was expected).

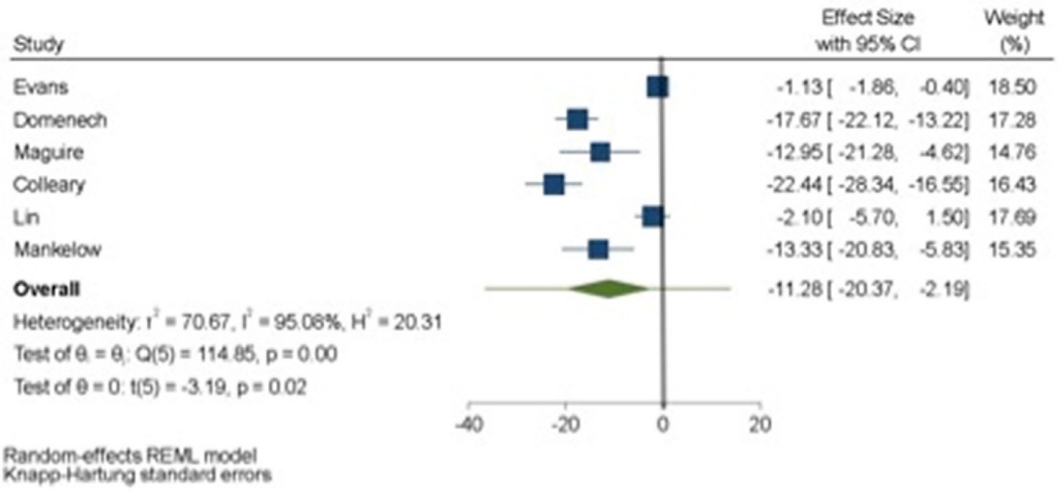

Figure 5. Forest plot of biopsychosocial pain education versus control for the attitudes outcome. Legend: CI is the distance between the 2 sideways "points" of the pooled effect green diamond and the PI is the green line. The pooled effect itself is represented by the vertical points of the diamond.

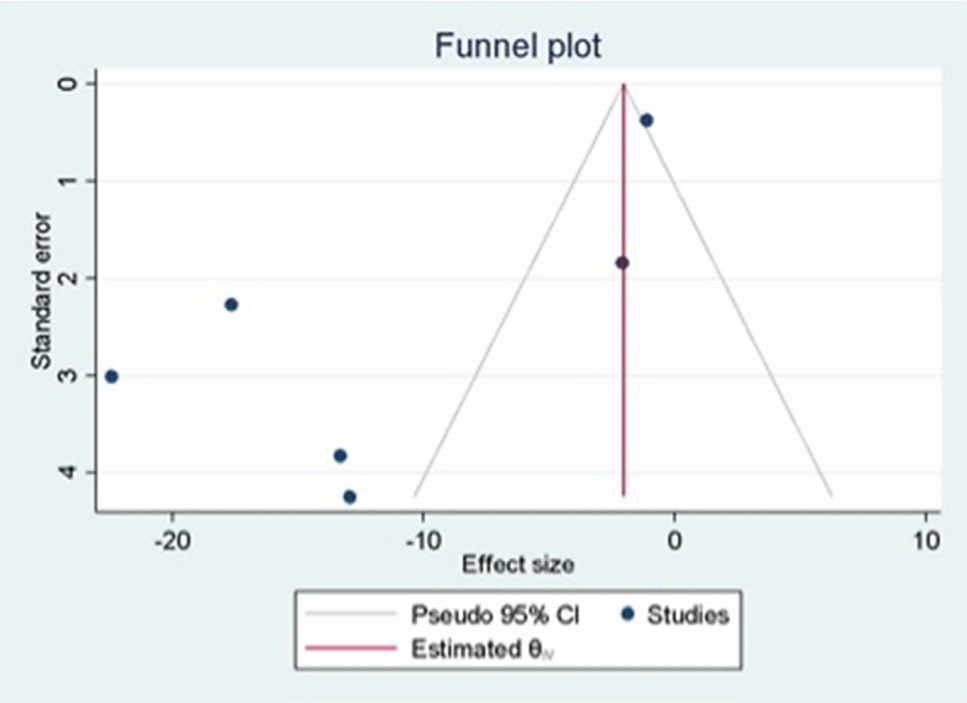

Figure 6. Funnel plot for studies involved in the attitude outcome indicating considerable publication bias due to asymmetry and a paucity of small studies in which low or opposite-to-expected values were reported.

Behavior

The 7 meta-analysed studies featuring 2,181 students and clinicians were not dominated by participants from any 1 clinical discipline. Two studies exclusively featured physiotherapists, 1 exclusively studied sports therapy and rehabilitation students, 1 focussed on a mixed group of chiropractors, osteopaths and physiotherapists, Mankelow et al (2020)[52] featured a mixed group of nursing, midwifery and allied health professional students, and Corson et al (2011)[15] had a mixture of different professional levels of doctors and nurses. One study featured only GPs.[24] Some of these studies did not state mean age of participants nor gender composition of the study groups. Of those that did, though the samples were dominated by female participants there were some studies with more male participants and others with close to 50% male participants. The minimum average age was 19 and the maximum age was 41. The shortest teaching intervention was a 70-minute lecture and the longest was 2 sessions of 3 hours each. These were mainly lecture sessions, some with associated workshops however 1 education programme involved information sent only once in the post. Outcome measures selected for meta-analyses all focussed on the percentage of students or clinicians making recommendations for activity in keeping with guidelines after education. Five of them were vignette/case study which measured hypothetical behaviors.[13,18,26,50,51] These studies examined guideline concordant behavior in a very similar manner. Corson et al (2011)[15] and Engers et al (2005)[24] used patient notes to evaluate change after education. They also had other outcome measures that were not meta-analysed as they were not theoretically aligned with the outcome measures examining recommendations for activities. Both of these studies' other outcomes and associated findings are narratively discussed. The studies also featured varying patient groups from hospital patients to primary care patients to nursing home residents with dementia.

Other studies measuring behavior changes in students or clinicians but that were too theoretically disparate to combine for meta-analysis are narratively described here. These were Dwyer et al (2020),[21] Kalinowski et al (2015),[42] Lin et al (2008),[45] Maclaren et al (2008),[49] Pieper et al (2018),[61] Yoo et al (2019)[75] and Zhang et al (2008).[76] They used very different outcome measures of pain management behavior, including prescription rates, type of analgesic prescribed, specific prescription of nonpharmacological treatment such as relaxation therapies or 1 of 3 types of cognitive behavioral therapies or appropriate use of a pain scale. These behaviors were observed via auditing of notes, clinician self-reporting and role-play scenario responses. Pieper et al (2018)[61] measured nurses' estimation of pain in twelve nursing homes, whilst Kalinowski et al (2015)[42] measured the incidence of nurses or GPs using non-pharmacological treatment. Engers et al (2005)[24] measured the referral rates of GPs to therapy and the prescription of medication.

The pain management behavior changes were very varied in studies that were not meta-analysed, and within 1 study there may be improvements in 1 element but not another. An example would be Pieper et al (2018)[61] who found that estimated pain did not decrease but 'observed' pain and that prescription of

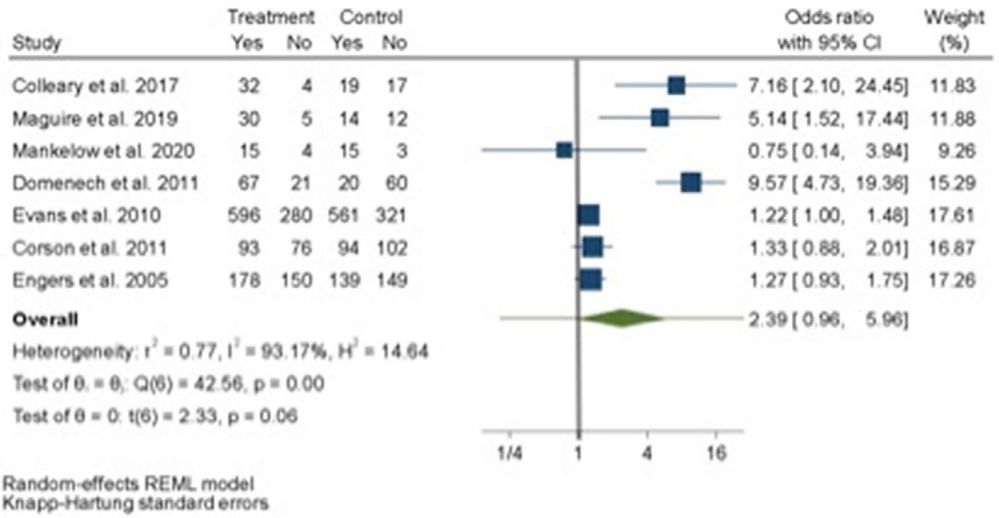

Figure 7. Forest plot of biopsychosocial pain education versus control for the student/clinician pain management behavior change outcome.

opioid medication increased but paracetamol use did not. In Kalinowski et al (2015)[42] non-pharmacological treatment by nurses did not increase significantly but by medical doctors it did. Overall, 6 out of 7 studies showed improvements in clinician behavior. The improvement was statistically significant in the majority of studies.

Behavior outcome measures were measured by the average of appropriate recommendations events data after intervention and the resulting odds ratio calculated. Overall low quality evidence found that clinician behavior improved following biopsychosocial education compared to control (OR of 2.39, 95% CI 0.9 to 5.9, $P = .06$), see Fig 7. The 8 other studies in this systematic review which examined behaviors but were not fit for meta-analysis generally also found statistical and/or clinical improvements in clinician behavior. Three studies concluded nil to variable overall improvement in pain management behavior.[15,42,61] Whilst Corson et al (2011)[15] shows improvement in guideline concordant recommendations in the parameter selected for meta-analysis that was thematically uniform with the other studies, participants had an 8 point list of behaviors to change in order to be considered guideline consistent; overall they were found not to have changed behavior significantly after education. Kalinowski et al (2015)[42] found that positive change in pain management behavior was not consistent; the doctors studied made a significant change in their use of non-pharmacological therapies but the nurses did not.

A summary of the twenty studies included in this study can be found in Table 3.

Patient Outcomes

Six RCTs investigating patient outcomes were deemed suitable for inclusion and they were set in France, Sweden, Bavaria, USA and Netherlands. These RCTs jointly included 2,179 patients, in primary care and nursing homes. The intervention for GPs was short in duration, 4 hours in Chassany et al's (2006)[10] study, and outcome measures used were very varied. They focussed on the extent of pain relief; outcome measures of the severity of osteoarthritis, Lequesne index of severity for osteoarthritis of the hip (LISOH) and the Western Ontario and McMaster Universities Osteoarthritis Index; patient perception of treatment and Acetaminophen use. In Corson et al's (2011)[15] study the intervention consisted of 2 days for GPs and nurses and guidance about patients intermittently over a 12-month period. The main outcome measure in the latter study was the Roland-Morris Disability Questionnaire (RMDQ). Overall there were some clinically relevant improvements in patient outcomes such as increased function and reduced pain. Three studies concluded that there was no improvement in clinical outcomes.[15,43,59]

The studies that examined patient outcomes had a diverse range of outcome measures with Corson et al (2011)[15] primarily using the RMDQ and Chassany et al (2006)[10] using multiple measures including pain relief, osteoarthritis functional indices and use of medication, and number of pain sites, intensity and function. Corson et al (2011)[15] found no statistical difference between RMDQ in the intervention and control groups whilst Chassany et al (2006)[10] found significant changes in patient outcomes in the patients treated by the trained group of GPs with reduced pain ($P < .0001$), increased function ($P < .0001$) and better overall perception of treatment ($P = .002$).

Whilst there was a diverse range of patient outcome measures 5 of the studies examined pain intensity. This should have permitted meta-analyses but it was not possible to contact all authors to gather specific outcome data despite multiple attempts.

Kalinowski et al (2015)[42] whilst defining their primary outcome measure as severity of pain in patients, present data only on the number of participants with pain pre and post intervention. However the same research group present the sample population's pain severity

Table 3. Characteristics of Included Studies

	Study	Outcome measures	Sample size (baseline/gender/mean age in years)	Participants	Interventions	Duration of educational intervention	Control	Authors' conclusions	Setting
1	Chassany et al[10]	-Pain relief -Lequesne -WOMAC -Perception of treatment -Acetaminophen use	180 GPs 842 patients	GPs	Biopsychosocial pain education	4 h meeting	Clinical trial patient -recruitment and obtaining consent	Patients in the trained-GP group had better overall pain relief (316 ± 290 mm•day vs 265 ± 243 mm; $P < .0001$), greater improvement in Lequesne and WOMAC scores ($P < .0001$), and better overall perception of treatment ($P = .002$). Acetaminophen use was slightly higher in the trained group; however, the difference in pain relief remained statistically significant ($P = .0003$) after adjustment for this difference. This is the first study to demonstrate a positive effect of physician training on patients with a painful condition.	France
2	Colleary et al[13]	RNPQ HC-PAIRS Vignettes/case study of clinical guideline compliant behavior	72 44% M 20	BSc Physiotherapy students	1 PNE lecture	70 min	Red flag attention control lecture	Post education, the PNE group had a greater increase in pain neurophysiology knowledge (mean difference 4.0 [95% CI 3.2 to 4.7], $P < .01$) and more improved attitudes (−17.5 [95% CI −22.1 to −12.9], $P < .01$) compared with the control group. Post education, students in the PNE group were more likely to make appropriate recommendations regarding work (94% vs 56%), exercise (92% vs 56%), activity (94% vs 67%) and bed rest (69% vs 33%) compared with those in the control group ($P < .05$).	UK and Irish universities
3	Corson et al[15]	-Patients medical records -Predictors of document guideline-concordant care (PPC-7) -Association with pain-related functioning -Roland Morris Disability Questionnaire (RMDQ)	42 clinicians and 365 patients	Staff physicians, internal medicine fellows, physician assistants (PAs), and nurse practitioners (NPs)	Chronic pain educational programme and on going support for a year on specific patient management	2 session education programme based on shared decision-making, goal setting, pain management guidelines, pain assessment and comorbid mental disorders	Treatment as usual	Rates of documented guideline- concordant care varied widely among PPC items, from 94% of patients having pain addressed to 17% of patients on opioids having side effects addressed. Intervention status was unrelated to item scores, and PPC-7 totals did not differ significantly between intervention and treatment-as-usual patients (61.2%, standard error [SE] = 3.3% vs 55.2%, SE = 2.6%, $P = .15$). In a multivariate model, higher PPC-7 scores were associated with receiving a prescription for opioids (odds ratio [OR] = 1.07, $P = .007$) and lower PPC-7 scores with patient age (10-y difference OR = 0.97, $P = .004$). Finally, intervention patients who received quantitative pain and depression assessments were less likely to respond to treatment (assessed vs not: 18% vs 33%, $P = .008$, and 13% vs 28%, $P = .001$, respectively).	5 primary care clinics in Oregon, USA

(continued on next page)

Table ? 3. Continued

	Study	Outcome measures	Sample size (baseline/gender/ mean age in years)	Participants	Interventions	Duration of educational intervention	Control	Authors' conclusions	Setting
4	Domenech et al[18]	HC-PAIRS FABQ Vignette/Case-studies to assess symptom perception and recommendations for activity	170 43% M 22	Second year physiotherapy students	Biopsychosocial model in LBP and clinical practice guidelines, interactive discussion of case studies	2 × 3 h sessions	Anatomy, biomechanics and pathophysiology of back pain, no advice on back pain management	The participants attending the biopsychosocial session displayed a reduction in fear-avoidance beliefs ($P < .001$) and pain impairment beliefs ($P < .001$), which was strongly correlated with an improvement in clinicians' activity and work recommendations. However, the students assigned to the biomechanics sessions increased their fear-avoidance scores ($P < .01$), and their recommendations for activity levels worsened significantly ($P < .001$).	Spanish University
5	Dwyer et al[21]	Knowledge Attitudes - PABS Judgement speed Judgement accuracy Empathy – Interpersonal Reactivity Index	63 medics 37% M	Medical students and GP trainees	Flags approach biopsychosocial and behavioral approaches	23 min, 17 min online and then 5 min of active learning case study	Nil	Results revealed a significant effect on knowledge ($F [1,38] = 32.28$, $P = .001$, partial $\eta^2 = 0.25$) and pain attitudes ($F [1,38] = 9.26$, $P = .004$, partial $\eta^2 = 0.20$), in which the experimental group scored significantly higher than controls on both, from pre- to post-testing. Short flags approach-based education video interventions to increase knowledge, overcome attitude barriers and develop clinical judgement processes so that they are biopsychosocially oriented	Ireland
6	El-Aqoul et al[22]	Knowledge and Attitudes Survey Regarding Pain (KASRP)	131 53% M	nurses	Pain theory, management, assessment, NPT	10 education sessions over 2 d	Nil	The mean scores of the intervention group and the control group at 2 measurement points regarding knowledge and attitude toward cancer-related pain were 32.7 (SD = 2.8) and 32.8 (SD = 4.3) and 23 (SD = 5.5) and 22.2 (SD = 3.8), respectively. A pain management education programme can improve nurses' knowledge and attitudes toward cancer-related pain.	Jordan
	Engers et al[24]	Self-reported by GPs on a form -number of referrals to a therapist -prescription of pain medication on a time-contingent	41 GPs 531 patients 73 % M Mean Age - NK	GPs	Tailored interventions consisting of the Dutch LBP guide- line for general practitioners, education workshop, 2 scientific	2 h educational and clinical workshop	Nil	The advice and explanation provided by the general practitioners, the prescription of paracetamol or nonsteroidal anti-inflammatory drugs, and prescription of pain medication on a time contingent or a pain contingent basis showed no statistically significant differences between the	The Netherlands

(continued on next page)

Table ? 3. Continued

	Study	Outcome measures	Sample size (baseline/gender/ mean age in years)	Participants	Interventions	Duration of educational intervention	Control	Authors' conclusions	Setting
		basis -prescription of paracetamol versus NSAIDs -adequacy of patient education			articles on LBP, tools for patient management			intervention and control groups. There were also no differences in overall referral rate (20% vs 21%, respectively). However, in follow-up consultations fewer patients were referred to a physical or exercise therapist by the general practitioners in the intervention group than in the control group (36% vs 76%, respectively; odds ratio of 0.2 (95% CI, 0.1–0.6) .	
8	Evans et al[26]	HC-PAIRS Vignette/case study of clinical guideline compliant behavior	N=1758 39% M 41	Chiropractors, osteopaths and physios	Biopsychosocial focused guideline consistent information with recommendations for management	1 off posted information set	Nil	The changes in reported behavior on the quality indicators were as follows: activity, odds ratio (OR) 1.29 (95% CI, 1.03–1.61) and number needed to be treated (NNT), 19 (15–28); work, OR 1.35 (1.07–1.70) and NNT 19 (14–29); and bed-rest, OR 1.31 (0.97–1.76) and NNT 47 (33–103). The composite NNT for a change from guide- line-inconsistent to guideline-consistent behavior on at least 1 of the 3 quality indicators was 10 (9–14). LBP- related beliefs were significantly improved in those who were sent the information package (P 0.002), but only to a small degree (mean difference, 0.884 scale points; 95% CI, 0.319–1.448). Printed educational material can shift LBP-related attitudes of MSK practitioners, towards practice that is more in line with guideline recommendations.	UK
	Johnston et al[41]	Paediatric Nurses' Knowledge and Attitudes Survey Regarding Pain Pain management experience evaluation – notes audit of pain assessment, analgesia	113 Gender – deliberately not reported 35.7 985 chart audits on 306 children	Paediatric Nurses	10 one to one coaching sessions with relation to specific patient, with a trained opinion leader	One on one coaching with an opinion leader (a trained coach)	Nil	Although there was a greater overall gain in nurses' knowledge in the experimental group (8 points of improvement) than in the control group (1 point of worsening), $F(1, 791) = 106.3$, $P < .0001$, the direction was not consistent within the groups and there were significant site differences. The rate of pain assessments, nurses' knowledge, and nonpharmacological interventions increased in the coaching group.	6 Canadian university affiliated paediatric hospitals

(continued on next page)

Table ? 3. Continued

Study	Outcome measures	Sample size (baseline/gender/ mean age in years)	Participants	Interventions	Duration of educational intervention	Control	Authors' conclusions	Setting
	prescription and non pharma treatments						However, there were significant site differences that could not be attributed to the coaching but to factors inherent in the sites. The context in which interventions are implemented will influence the effectiveness of individualized interventions.	
10 Kalinowski et al[42]	-Pain severity of NHRs -Prescription of non-pharmacological therapies (NPT)	239 NHR	GPs and nurses	Pain management interventions (cluster level) included an online course for doctors and 1-d seminar for nurses.	Training based the interdisciplinary clinical practice guideline for pain management in NHRs	Nil	In the IG, there was a significant increase in the number of NHRs prescribing at least 1 therapeutic NPT after the intervention—from 9% at T0 to 22.1% at T1 (within-group difference: $P = .049$). The therapeutic measures prescribed at T1 were almost exclusively physical therapy (general physiotherapy). However, there was a decrease of 6 percentage points in the number of NPTs prescribed at T2—from 22.1% at T1 to 16.4% at T2 (within-group difference: $P = .230$). The intervention did not result in a significant increase in the NPT applied by nurses, but did significantly increase the therapeutic NPT prescribed by physicians. Residents were active in using NPT to self-manage their pain.	Dutch nursing homes
11 Kutschar et al[43]	Patient pain intensity	222 NHR 82	Nursing staff	Pain management, recognising pain, basics of NPT, and patient education. Web-based training on chronic pain.	32 classroom sessions of 45 min each. 4 online videos, between 7-14 min. Interdisciplinary quality classrooms, 2 whole day classroom meetings	Nil	Maximum pain intensity was higher after intervention (B=1.32, $P < .01$), decreased with a better quality of life (B=-0.07, $P < .001$), and was lower when dementia diagnoses were present (B=−1.12, $P < .01$). PAINAD scores before and after intervention did not differ significantly (OR = 0.89, $P = .724$), but chances to exhibit treatment-related pain were higher with decreasing MMSE (OR = 0.94, $P < .05$). No significant positive intervention effect was measured but findings suggest that nurses had raised awareness towards pain management.	Bavaria, Germany
Lin et al[45]	-Checklist for knowledge of pain		Nursing staff	Biopsychosocial focused lectures,	7 session totalling 15 h over 2 wks	Nil	Scores for pain management knowledge differed significantly between the 2 groups	Taipei Medical Centre

(continued on next page)

Table ? 3. Continued

Study	Outcome measures	Sample size (baseline/gender/ mean age in years)	Participants	Interventions	Duration of educational intervention	Control	Authors' conclusions	Setting
	management -Attitudinal check-list -behavior scale of relaxation therapy	81 1.2% M 28.47		discussion and issued reading material and training in relaxation therapy with 2 actual practice sessions			(F = 40.636, *P* = .001). (2) Attitudes towards pain management differed between the 2 groups (F = 8.328, *P* = .005) and remained stable over time (F = 1.603, *P* = .205). (3) Relaxation therapy practice differed significantly between the 2 groups, with the study group better than the control group (F = 4.006, *P* = .049). (4) Relaxation therapy was applied to nearly all (97.5%) of the patients cared for by study group nurses. All of the instructed patients performed this technique 1 to 3 times per day postsurgery. Continuing education can improve nurses' knowledge and behavior significantly, and attitude towards pain management differs between control and intervention group and remains stable over time.	
14 Maclaren et al[49]	-Knowledge and Attitudes of Pain Management Questionnaire -Role play to measure application of behavioral strategies and the quality of these	30 8% M 22	Nursing students	PNE and CBT, distraction and guided imagery training.	1 lecture	Nil	Results indicated a significant main effect for phase, F(1, 47) = 11.05, *P* < .05, and a significant main effect for group, F(1, 47) = 5.86, *P* < .05. A significant group by phase interaction was also evidenced, F(1, 47) = 6.67, *P* < .05. Training participants had more pain knowledge and CBT knowledge than control after training.	West Virginia University, USA
13 Maguire et al[50]	HC-PAIRS RNPQ Vignettes/case study of clinical guideline compliant behavior	61 57% M 21.5	BSc Sports therapy and rehabilitation students	PNE	One 70 min lecture	Red flag attentional control lecture	Posteducation, the PNE group had a greater increase in pain neuroscience knowledge (mean difference 3.2; [95% CI], 2.1–4.3; *P* < .01) and improved attitudes (mean difference −10.1; 95% CI, −16.6 to −3.6; *P* < .01). In addition, students in the PNE group were more likely to make appropriate clinical recommendations (odds ratio [OR]; 95% CI) regarding return-to-work (OR = 6.1;95% CI, 1.1–32.3; *P* = .03), exercise (OR = 10.7;95% CI, 2.6–43.7; *P* ≤ 01), and bedrest (OR = 4.3; 95% CI, 1.5–12.8; *P* = 01).	1 UK university
			NMAPH students	PNE	One 70 min lecture			1 UK university

(continued on next page)

Table ? 3. Continued

	Study	Outcome measures	Sample size (baseline/gender/ mean age in years)	Participants	Interventions	Duration of educational intervention	Control	Authors' conclusions	Setting
	Mankelow et al[52]	HC-PAIRS RNPQ Vignettes/case study of clinical guideline compliant behavior	37 19% M 30				Red flag attentional control lecture	The intervention group increased knowledge compared to the control, post-intervention (mean difference 3.7 [95% CI, 2.4, 5.0], $P < .001$) but not at 6-mo (0.1 [−1.1, 1.3], $P = .860$). Greater improvements in attitudes for the intervention group were seen post-intervention (-10.4 [−16.3, −4.6], $P < .001$) and at 6-mo (-5.8 [−11.5, −0.2], $P < .044$). There was no difference in behaviors between groups. Thematic analysis identi ed increased patient empathy, partial and patchy reconceptualisation of pain and increased con dence in recommending an active management programme following PNE.	
16	Overmeer et al[59]	Patient pain disability, catastrophising and mood.	229 patients 42 physiotherapists Gender – 36% M 46	Physios	8 d lectures and practical exercises with role play, tests.	8 d course to advance knowledge and skills about identification of psychosocial factors in pain with the treatment of these factors	Nil	There were no significant differences in pain (F 0.85; df 1,225; P 0.9) or disability (F 1.1; df 1,222; P 0.3) outcomes between groups of patients (patients of physical therapists who had participated in a course about psychosocial factors and patients of physical therapists who had not participated in such a course) as a whole at a P level of 0.05 Pain and disability outcomes in patients with a low risk of developing long-term disability—and pain outcomes in patients with a high risk of developing long-term disability—were not dependent upon whether the attitudes and beliefs of their physical therapists changed during the course. However, disability outcomes in patients with a high risk of developing long-term disability may have been influenced by whether the attitudes and beliefs of their physical therapists changed.	Several counties in Sweden
	Pieper et al[61]	Observed pain. Estimated pain Analgesic	288 Nursing home residents with dementia	Nursing home nurses, doctors, psychologists and physio	Interdisciplinary, multicomponent approach to improve	5 meetings, 3 h each	General information about challenging behavior, pain and	The multilevel modelling showed an overall effect of the intervention on observed pain but not on estimated pain; Pain Assessment Checklist for Seniors with Limited Ability to	12 Dutch nursing homes

(continued on next page)

Table ? 3. Continued

Study	Outcome measures	Sample size (baseline/gender/ mean age in years)	Participants	Interventions	Duration of educational intervention	Control	Authors' conclusions	Setting
	prescription opioid and paracetamol			assessment and management of pain in addition to challenging behavior		dementia management	Communicate–Dutch version, mean difference: −1.21 points (95% CI: −2.35 to −0.06); Minimum Dataset of the Resident Assessment Instrument pain scale, mean difference: −0.01 points (95% CI: −0.36 to 0.35). Opioid use increased (odds ratio = 3.08; 95% CI: 1.08–8.74); paracetamol use did not (odds ratio = 1.38; 95% CI: 0.71–2.68).	
18 Salim et al[63]	Knowledge and attitudes survey regarding pain (KASRP)	200 10% M 35	Registered nurses	Pain management and trends, assessment and NPT	5 h group discussion and individual instruction as well as interactive education activities such as role play.	Nil	The findings of the experimental group revealed that the mean score on the KASRP increased after the intervention from 61.36 (SD 11.60) to 69.94 (SD 7.74) with a mean difference of 8.58 (t(99) = −5.97, $P < .05$), while in the control group the mean score on the KASRP slightly decreased following the test (mean ± SD, 60.99 ± 11.53%) compared to the pre-test (mean ± SD, 61.00 ± 11.60%) with a mean difference of 0.01 (t(99) = 1.41, $P > .05$).	United Arab Emirates
19 Yoo et al[75]	-Modified Watt-Watson and Donovan questionnaire for knowledge of pain management -Modified Watt-Watson and Donovan questionnaire for attitude toward pain management -self-efficacy in pain management questionnaire	46 Gender - NK 33	Nurses	8 modules, 29 topics in pain management	400 min	Nil	The experimental group showed a significant increase in knowledge and in self-efficacy about pain management compared to the control group (u = 389.0, $P = .006$; u = 360.0, $P = .030$, respectively).	2 university affiliated hospitals in Seoul, South Korea
Zhang et al[76]	Nurses' Knowledge and Attitude Survey Effective use of the	196 1.1% M Age - NK	Nurses	Biopsychosocial pain assessment and management	6 h over 5 wk	Nil	Nurses in the experimental group who received the PEP had a significant improvement in their pain knowledge and attitudes. Their scores on the Nurses' Knowledge and Attitude Survey increased from 15.67 at T1	2 teaching hospitals, Hubei, China

(continued on next page)

Table ? 3. Continued

Study	*Outcome measures*	*Sample size (baseline/gender/ mean age in years)*	*Participants*	*Interventions*	*Duration of educational intervention*	*Control*	*Authors' conclusions*	*Setting*
	Changhai Pain Scale						to 26.13 at T2 and 35.14 at T3. The scores of nurses in the control group were unchanged (from 15.20 at T1 to 14.29 at T2 and 14.93 at T3, $P > .05$). In addition, experimental group nurses had an improvement in pain assessment. The percentage of nurses who correctly used the Changhai Pain Scale to assess patients' pain intensity increased significantly after the PEP, and the increased usage of the assessment tool between experimental and control groups also shows a statistical difference in trend ($x^2 = 93.281$, $P < .001$).	

Abbreviations: CBT, Cognitive behavioral therapy; CG, control group; CI, confidence interval; df, degrees of freedom; GP, general practitioner; HC-PAIRS, Health Care Professionals' Pain and Impairment Relationship Scale; IG, intervention group; KASRP, knowledge and attitudes survey regarding pain; LBP, low back pain; M, male; MMSE, mini-mental state examination; MSK, musculoskeletal; NK, not known; NHR, Nursing home resident; NPT, non-pharmacological treatment; mm, millimetre; PABS, Pain Attitudes & Beliefs Scale; PEP, pain education programme; PNE, pain neuroscience education; RNPQ, Revised Neurophysiology Quiz; SD, standard deviation; STA OP!, STApsgewijs Onbegrepen gedrag en Pijn bij dementie de baas! A stepwise protocol for pain management addressing assessment and treatment and combining pharmacological and non-pharmacological interventions for pain and challenging behavior; PAINAD, pain assessment in advanced dementia; PPC, pain process checklist; T0, measurement time 0 (or pre-intervention); T1, measurement time 1 after intervention; T2, measurement time 2 after intervention; T3, measurement time 3 after intervention; WOMAC, The Western Ontario and McMaster Universities Osteoarthritis Index.

data in a later paper, Dräger et al (2017).[19] They found that baseline pain levels were very low and that although pain intensity was lower in patients after the pain education intervention delivered to clinicians, it did not lower by their predicted objective of 2 points. Nevertheless, they observed a significant difference between patients in the control and intervention group and their pain intensity and walking ability.

Kutschar et al (2020)[43] found that pain intensity increased in patients and that pain and quality of life was significantly associated with lower maximum pain levels. However, they interpreted their results very cautiously citing greater patient and nursing staff awareness of pain. Furthermore, they speculated that their already complex study type could only be successful if individual patient intervention measures were introduced suggesting that they found the intervention too broad and patient outcome measures too broad to adequately measure patient outcome.

Overall existing studies are not conclusive in their findings about the effect of pain education of clinicians upon patient outcomes with 3 studies finding that they do improve outcomes, and 3 studies finding that they do not. In those studies finding improvement in pain symptoms these exceeded the 10% threshold for change cited by NICE (2020)[56] guidelines as indicating a MCID.

Discussion

This systematic review aimed to complete a synthesis of RCTs investigating the effectiveness of biopsychosocial education strategies for students or clinicians compared with a control and its effect upon pain related attitudes, knowledge, management behaviors, and patient outcomes. The findings from 15 meta-analysed RCTs demonstrated that biopsychosocially oriented pain education may result in a clinically relevant improvement in pain knowledge (18.84%, $P = .01$) and attitudes (11.28%, $P = .02$). The improvements were above the pre-specified MCID's however, given the variety of different outcome measures used and the lack of an established MCID for these domains within the literature, the proposed MCIDs should be seen as attempts to helpfully contextualise the data rather than firm evidence based thresholds.

Seven studies were included in the meta-analyses of change in pain management behaviors after biopsychosocial pain education. This revealed a change that was not quite statistically significant ($P = .06$) but of a small to medium magnitude based on the magnitudes discussed by Chen, Cohen and Chen (2010).[11] Eight other studies identified as assessing clinical behaviors used a wide array of outcome measures that were very different conceptually and thus rendered the studies unfit for meta-analysis. However, in general they found that there was positive change in clinician behavior following biopsychosocial education.

The findings for patient outcomes were inconclusive with half of the studies showing improvement and half showing an absence of significant change in patients treated by clinicians or students who had had biopsychosocial education. Liossi et al (2018)[46] also concluded that there was a paucity of studies investigating patient outcomes when investigating online pain education for HCPs. Optimal pain management also requires shared-decision making with patients[57] and there are numerous factors that could influence this, and therefore patient outcomes, beyond healthcare knowledge, attitudes and behaviors. These include patient willingness to self-manage, patient knowledge and attitudes[30] but also HCP/organisational ability to optimise the shared decision making environment for example the provision of time as well as empathy for patients with pain.[55] Capturing all of these variables in a research study is complex and has yet to be successfully carried out.

The overall quality of the level of recommendations was low due to the heterogeneity of the studies, resulting in imprecision or a wide CI and inconsistency based upon the forest plot. Furthermore, whilst authors were contacted for further information it was not always possible to obtain the required data/details. This in turn resulted in studies being rated as having a higher RoB than they may otherwise have had due to insufficient information, rather than confirmed flaws in methodology. Some studies were better quality RCTs than others with a low RoB but flaws or absence of information in other studies reduced the overall quality of all of these studies. Interestingly those studies with more time intensive interventions did not necessarily effect the greatest change in outcomes. A longer teaching intervention may not necessarily apply recognised pedagogical strategies to enhance learning such as problem based learning and engaging service users.[7]

Studies that were not included in this systematic review, non-RCT studies or studies that were identified as RCTs but did not meet our criteria for inclusion in this study generally bore similar resemblance to our findings. Shaheed et al (2015)[65] found significant and favourable changes in knowledge, attitudes and beliefs after biopsychosocial back pain education. Patiraki et al (2006)[60] also found a significant effect of pain education on total pain knowledge scores. Poulsen et al (2019)[62] found that medical students increased their knowledge and felt more confident in their future management of patients with acute pain after biopsychosocial education.

In 2012, Briggs (2012)[3] stated that further research was needed to explore the specific strategies or combination of techniques for effective pain teaching in different groups. This systematic review is the first to investigate the effectiveness of methods of pain education for student HCPs or HCPs. Briggs (2011)[4] concluded that pain education was inadequate as did Shipton et al (2018)[66] and Watt-Watson et al (2009).[72] One of the main areas of criticism was the tendency to evaluate teaching through written examination alone and not clinical assessment, such as objective structured clinical examination (OSCEs). It was interesting to note that the only study in this current systematic review evaluating pain education through pain management behavior

solely was Chassany et al (2006)[10] which involved clinical participants wherein patient records were scrutinized as it is undeniably difficult to gather a complete reflection of pain management behavior from either OSCEs or vignettes. Studies requiring patient record examination are ethically, logistically and financially more exacting than those involving OSCEs or vignettes. Furthermore, the examination of patient records is not without its difficulties for outcome assessors due to the variability of recording between clinicians. Observing clinical records over a period of time however does enable time for changes in clinical practice to develop after teaching. This allows new information to be processed as it can be difficult to execute in practice immediately after teaching, and confidence to practise new information takes time to develop.[8,25,60,74] Clinical records still present a potential issue of responses in keeping with social desirability although this may have less of an impact when records are observed for an extended period.

Exploring the data beyond meta-analyses it is interesting to note in studies such as Domenech et al (2011)[18] that there were potentially negative outcomes in the biomedical education control group, such as exacerbating maladaptive beliefs which then result in non-guideline compliant recommendations for pain management. In curricula where the content is heavily biased towards biomedical training, there may be a greater potential to reaffirm maladaptive beliefs and non-guideline compliant behaviors.

There was considerable heterogeneity between the interventions used in in all of the studies, barring Colleary et al (2017),[13] Mankelow et al (2020)[52] and Maguire, Chesterton and Ryan, (2019),[50] studies which were produced by this same research group but there were still differences in participants and the number of sites of intervention. The asymmetry of the funnel plots for both the knowledge and attitude studies indicate considerable publication bias and the meta-regression tests suggests that a small-study effect was also present in both knowledge and attitudes outcomes although neither were assessed as being significant (P = .20 for knowledge P = .09 for attitudes). This apparent discrepancy is likely due to the regression lacking statistical power due to the small number of studies included. Funnel plots and publication bias in the behaviors outcome were not produced due to their reduced precision in events based data.[16]

There were more studies including clinician participants than student participants. Effect sizes for knowledge were similarly large for both students and clinicians. Students generally showed the greatest mean effect sizes in behaviors and attitudes. Thus students may be more amenable to change and they may be better targets for biopsychosocial pain education.

Limitations

One limitation of this review is the heterogeneity of studies. This heterogeneity applies to types and modes of intervention, types of participants and outcome measures, however in reporting wide PI s this fact is acknowledged.

Other limitations include caution in generalising findings to HCPs outwith those included in the analyses; mainly physiotherapists, sports therapists, nurses and GPs.

For the purpose of meta-analysis some questionnaires jointly assessing knowledge and attitudes were amalgamated into knowledge analysis if the theoretical construct of the questionnaire lent itself to this. This amalgamation could be open to debate theoretically.

The limited number of studies reduced the precision of the estimated effects of the strategies used. Some studies that may have been eligible for inclusion in both meta-analysis and narrative review could not be included because authors were either unable to provide the additional information required or did not respond to the request for more information.

Conclusion

Clinically important increases are seen in HCP students'/clinicians' pain knowledge and attitudes following biopsychosocial pain education compared with control education. Small to moderate changes in pain management behavior were also seen. The findings regarding patient outcomes were less clear and further work is needed before firm conclusions can be drawn. The quality of the evidence was rated low overall due to study heterogeneity, small study effect, the small number of studies available and greater RoB in some studies than others. More high quality RCTs are needed to explore the effectiveness of biopsychosocial pain education for HCPs/HCP students.

Acknowledgments

The contribution of Teesside University librarian Julie Hogg is acknowledged as well as fellow researcher Dominic Simpson who assisted with the initial screening and Ellis Eddy who was involved in the literature update.

Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jpain.2021.06.010.

References 77−101 support the supplemental list of excluded studies.

References

1. Bishop A, Foster NE, Thomas E, Hay EM: How does the self-reported clinical management of patients with low back pain relate to the attitudes and beliefs of health care practitioners? A survey of UK general practitioners and physiotherapists. Pain 135:187-195, 2008

2. Borenstein M, Hedges L, Rothstein H: Meta-analysis - Fixed effect vs random effects. 2007. Available at: https://www.meta-analysis.com/downloads/Meta%20Analysis%20Fixed%20vs%20Random%20effects.pdf. Accessed June 4, 2021

3. Briggs E: Evaluating the impact of pain education: How do we know we have made a difference? Bri J Pain 6:85-91, 2012

4. Briggs E, Carr E, Whittaker M: Survey of undergraduate pain curricula for healthcare professionals in the United Kingdom. Eur J Pain, 2011. Available at: www.britishpainsociety.org Accessed June 2, 2021

5. Briggs EV, Battelli D, Gordon D, Kopf A, Ribeiro S, Puig MM, Kress HG: Current pain education within undergraduate medical studies across Europe: Advancing the Provision of Pain Education and Learning (APPEAL) study. BMJ Open 5:e006984, 2015

6. Buchbinder R, van Tulder M, Oberg B, Costa LM, Woolf A, Schoene M, Croft P: Low back pain: A call for action. Lancet 391:2384-2388, 2018

7. Carr ECJ, Briggs EV, Briggs M, Allcock N, Black P, Jones D: Understanding factors that facilitate the inclusion of pain education in undergraduate curricula: Perspectives from a UK survey. Bri J Pain 10:100-107, 2016

8. Carroll SP, Augeard N, Tennant J, Seenan C: How do the attitudes, confidence, knowledge and understanding differ in pre-registration healthcare students towards treating people with chronic pain: An observational, cross-sectional study. Eur J Physiother, 2020. https://doi.org/10.1080/21679169.2020.1746830. Accessed 2 June, 2021

9. Catley MJ, O'Connell NE, Moseley GL: How good is the neurophysiology of pain questionnaire? A rasch analysis of psychometric properties. J Pain 14:818-827, 2013

10. Chassany O, Boureau F, Liard F, Bertin P, Serrie A, Ferran P, Keddad K, Jolivet-Landreau I, Marchand S: Effects of training on general practitioners' management of pain in osteoarthritis: A randomized multicenter study. J Rheumatol 33:1827-1834, 2006

11. Chen H, Cohen P, Chen S: How big is a big odds ratio ? Interpreting the magnitudes of odds ratios in epidemiological studies. Commun Stat Simulation Comput 39:860-864, 2010

12. Cohen J: Statistical Power Analysis for the Behavioural Sciences, 2nd edn. NJ, Hillsdale, 1988

13. Colleary G, O'Sullivan K, Griffin D, Ryan CG, Martin DJ: Effect of pain neurophysiology education on physiotherapy students' understanding of chronic pain, clinical recommendations and attitudes towards people with chronic pain: a randomised controlled trial. Physiotherapy 103:423-429, 2017

14. Copay AG, Glassman SD, Subach BR, Berven S, Schuler TC, Carreon LY: Minimum clinically important difference in lumbar spine surgery patients: a choice of methods using the Oswestry Disability Index, medical outcomes study questionnaire Short Form 36, and pain scales. Spine J 8:968-974, 2008

15. Corson K, Doak MN, Denneson L, Crutchfield M, Soleck G, Dickinson KC, Gerrity MS, Dobscha SK: Primary care clinician adherence to guidelines for the management of chronic musculoskeletal pain: Results from the study of the effectiveness of a collaborative approach to pain. Pain Med 12:1490-1501, 2011

16. Debray TPA, Moons KGM, Riley RD: Detecting small-study effects and funnel plot asymmetry in meta-analysis of survival data: A comparison of new and existing tests. Res Synth Methods 9:41-50, 2018

17. Deloitte access economics: The cost of pain in Australia: Painaustralia, 2019. Available at: https://www.painaustralia.org.au/static/uploads/files/the-cost-of-pain-in-australia-final-report-12mar-wfxbrfyboams.pdf?fbclid=IwAR0OaQ-TiCWV6XNqTWIM3Yg6uO_w2_q7J6Pzj9rj0M2svmosNtJ-FhuDGqOo. Accessed June 2, 2021

18. Domenech J, Sánchez-Zuriaga D, Segura-Ortí E, Espejo-Tort B, Lisón JF: Impact of biomedical and biopsychosocial training sessions on the attitudes, beliefs, and recommendations of health care providers about low back pain: A randomised clinical trial. Pain 152:2557-2563, 2011

19. Dräger D, Budnick A, Kuhnert R, Kalinowski S, Könner F, Kreutz R: Pain management intervention targeting nursing staff and general practitioners : Pain intensity, consequences and clinical relevance for nursing home residents. Geriatr Gerontol Int 17:1534-1543, 2017

20. Dworkin RH, Turk DC, Wyrwich KW, Beaton D, Cleeland CS, Farrar JT, Haythornthwaite JA, Jensen MP, Kerns RD, Ader DN, Brandenburg N, Burke LB, Cella D, Chandler J, Cowan P, Dimitrova R, Dionne R, Hertz S, Jadad AR, Katz NP, Kehlet H, Kramer LD, Manning DC, McCormick C, McDermott MP, McQuay HJ, Patel S, Porter L, Quessy S, Rappaport BA, Rauschkolb C, Revicki DA, Rothman M, Schmader KE, Stacey BR, Stauffer JW, von Stein T, White RE, Witter J, Zavisic S: Interpreting the clinical importance of treatment outcomes in chronic pain clinical trials: IMMPACT recommendations. J Pain 9:105-121, 2008

21. Dwyer CP, MacNeela P, Durand H, O'Connor LL, Main CJ, McKenna-Plumley PE, Hamm RM, Reynolds B, Conneely S, Slattery BW, Taheny D, NicGabhainn S, Murphy AW, Kropmans T: McGuire: Effects of biopsychosocial education on the clinical judgments of medical students and GP trainees regarding future risk of disability in chronic lower back pain: A randomized control trial. Pain Med 21:939-950, 2020

22. El-Aqoul A, Obaids A, Jarrah I, Al-Rawashdeh K, Al Hroub A: Effectiveness of education program on nursing knowledge and attitude toward pain management. Asia Pac J Oncol Nurs 7:382-388, 2020

23. Engel GL: The need for a new medical model: A challenge for biomedicine. Science 196:129-136, 1977

24. Engers AJ, Wensing M, van Tulder MW, Timmermans A, Oostendorp RAB, Koes BW, Grol R: Implementation of the Dutch low back pain guideline for general practitioners: A cluster randomized controlled trial. Spine 30:595-600, 2005

25. Ericsson KA: Deliberate practice and the acquisition and maintenance of expert performance in medicine and related domains. Acad Med 79:70-81, 2004

26. Evans DW, Breen AC, Pincus T, Sim J, Underwood M, Vogel S, Foster NE: The effectiveness of a posted information package on the beliefs and behavior of musculoskeletal practitioners: The UK chiropractors, osteopaths, and musculoskeletal physiotherapists low back pain managemENT (COMPLeMENT) randomized trial. Spine 35:858-866, 2010

27. Faculty of Pain Medicine of the Royal College of Anaethetists [RCA]. London, RCA, Core standards for pain management services in the UK, 2015

28. Farre A, Rapley T: The new old (and old new) medical model: Four decades navigating the biomedical and psychosocial understandings of health and illness. Healthcare 5:1-9, 2017. https://doi.org/10.3390/healthcare5040088. Accessed June 2, 2021

29. Fayaz A, Croft P, Langford RM, Donaldson LJ, Jones GT: Prevalence of chronic pain in the UK: A systematic review and meta-analysis of population studies. BMJ Open 6:10364, 2016

30. Fisher KA, Tan ASL, Matlock DD, Saver B, Mazor KM, Pieterse AH: Keeping the patient in the center of decision making: common challenges in the practice of shared decision making. Patient Educ Couns 101:2195-2201, 2018

31. Foster NE, Anema JR, Cherkin D, Chou R, Cohen SP, Gross DP, Ferreira PH, Fritz JM, Koes BW, Peul W, Turner JA, Maher CG: Prevention and treatment of low back pain: evidence, challenges, and promising directions. Lancet 391:2368-2383, 2018

32. Gupta D, Boland RJ, Aron DC: The physician's experience of changing clinical practice : A struggle to unlearn. Implement Sci 12:1-11, 2017. https://doi.org/10.1186/s13012-017-0555-2. Accessed June 2, 2021

33. Hariton E, Locascio JJ: Randomised controlled trials – the gold standard for effectiveness research. BJOG 125:1716, 2018

34. Higgins JPT, Green S: Cochrane Handbook for Systematic Reviews of Interventions. Available at: https://handbook-5-1.cochrane.org. Accessed June 2, 2021

35. Houben RMA, Vlaeyen JWS, Peters M, Ostelo RWJG, Wolters PMJC: Stomp-van den Berg SGM: Health care providers' attitudes and beliefs towards common low back pain: factor structure and psychometric properties of the HC-PAIRS. Clin J Pain 20:37-44, 2004

36. Hoy D, March M, Brooks P, Blyth F, Woolf A, Bain C, Williams G, Smith E, Vos T, Barendregt J, Murray C, Burstein R, Buchbinder R: The global burden of low back pain: Estimates from the Global Burden of Disease 2010 study. Ann Rheum Dis 73:968-974, 2014

37. IASP: IASP curricula, 2018. Available at: https://www.iasp-pain.org/Education/CurriculumDetail.aspx?ItemNumber=2057. Accessed on June 2, 2021

38. IntHout J, Ioannidis JPA, Rovers MM, Goeman JJ: Plea for routinely presenting prediction intervals in meta-analysis. BMJ Open 6:e010247, 2016. https://doi.org/10.1136/bmjopen-2015-010247. Accessed June 2, 2021

39. Jackson D, Turner R: Power analysis for random-effects meta-analysis. Res Synth Methods 8:290-302, 2017

40. Jaini PA, Lee JSH: A review of 21st century utility of a biopsychosocial model in United States medical school education. J Lifestyle Med 5:49-59, 2015

41. Johnston CC, Gagnon A, Rennick J, Rosmus C, Patenaude H, Ellis J, Shapiro C, Filion F, Ritchie J, Byron J: One-on-one coaching to improve pain assessment and management practices of pediatric nurses. J Pediatr Nurs 22:467-478, 2007

42. Kalinowski S, Budnick A, Kuhnert R, Könner F, Kissel-Kröll A, Kreutz R, Dräger D: Nonpharmacologic pain management interventions in German nursing homes: A cluster randomized trial. Pain Manage Nurs 16:464-474, 2015

43. Kutschar P, Berger S, Brandauer A, Freywald N, Osterbrink J, Seidenspinner D, Gnass I: Nursing education intervention effects on pain intensity of nursing home residents with different levels of cognitive impairment: A cluster-randomized controlled trial. J Pain Res 13:633-648, 2020

44. Leadley RM: Chronic diseases in the European Union: the prevalence and health cost implications of chronic pain. J Pain Palliat Care pharmacother 26:310-325, 2012

45. Lin PC, Chiang HW, Chiang TT, Chen CS: Pain management: Evaluating the effectiveness of an educational programme for surgical nursing staff. J Clin Nurs 17:2032-2041, 2008

46. Liossi C, Failo A, Schoth DE, Williams G, Howard RF: The effectiveness of online pain resources for health professionals: a systematic review with subset meta-analysis of educational intervention studies. Pain 159:631-643, 2018

47. Loeser JD, Schatman ME: Chronic pain management in medical education: A disastrous omission. Postgrad Med 129:332-335, 2017

48. Louw A, Vogsland R, Marth L, Marshall P, Cox T, Landers M: Interdisciplinary pain neuroscience continuing education in the Veteran's affairs: Live training and live-stream with 1-year follow-up. Clin J Pain 35:901-907, 2019

49. Maclaren JE, Cohen LL, Larkin KT, Shelton EN: Training nursing students in evidence- pediatric pain management. J Nurs Educ 47:351-358, 2008

50. Maguire N, Chesterton P, Ryan C: The effect of pain neuroscience education on sports therapy and rehabilitation students' knowledge, attitudes, and clinical recommendations toward athletes with chronic pain. J Sport Rehabil 28:438-443, 2019

51. Mankelow J, Ryan C, Taylor P, Simpson D, Martin D: Effectiveness of pain education to improve pain related knowledge, attitudes and behaviours in health care students and professionals: A systematic review protocol. Int J Therapy Rehab 26:8., 2019. https://doi.org/10.12968/ijtr.2018.0083. Accessed June 6, 2021

52. Mankelow J, Ryan C, Taylor P, Martin D: The effect of pain neurophysiology education on healthcare students' knowledge, attitudes and behaviours towards pain: A mixed-methods randomised controlled trial. Musculoskelet Sci Pract 50:1-8, 2020. https://doi.org/10.1016/j.msksp.2020.102249. Accessed June 6, 2021

53. Mankelow J: Exploring Healthcare Students' Pain Knowledge and Attitudes Towards Function in People with Pain. Teesside University, 2021. Doctoral thesis. Available at: https://research.tees.ac.uk/ws/portalfiles/portal/26735635/20210312_corrected_thesis.pdf. Accessed June 8, 2021

54. Mintken PE, Cleland JA, Whitman JM, George SZ: Psychometric properties of the Fear-Avoidance Beliefs

Questionnaire and Tampa Scale of Kinesiophobia in patients with shoulder pain. Arch Phys Med Rehabil 91:1128-1136, 2010

55. National Health Service (NHS) England: Making shared decision making happen - the common challenges. Available at: https://www.england.nhs.uk/shared-decision-making/making-shared-decision-making-happen-the-common-challenges/. Accessed June 4, 2021

56. National Institute for Health and Care Excellence (NICE). Low Back Pain and Sciatica in Over 16s: Assessment and Management (NICE Guideline NG59). 2020. Available at: https://www.nice.org.uk/guidance/ng59. Accessed June 2, 2021

57. National Institute for Health and Care Excellence (NICE). Chronic Pain (Primary and Secondary) in over 16s: Assessment of all Chronic pain and Management of Chronic Primary Pain. (NICE Guideline NG193). 2021. Available at: https://www.nice.org.uk/guidance/ng193. Accessed June 6th, 2021

58. Norman GR, Sloan JA, Wyrwich KW: Interpretation of changes in health-related quality of life: The remarkable universality of half a standard deviation. Med Care 41:82-592, 2003

59. Overmeer T, Boersma K, Main CJ, Linton SJ: Do physical therapists change their beliefs, attitudes, knowledge, skills and behaviour after a biopsychosocially orientated university course? J Eval Clin Pract 15:724-732, 2009

60. Pearson ACS, Moman RN, Moeschler SM, Eldrige JS, Hooten WM: Provider confidence in opioid prescribing and chronic pain management: Results of the opioid therapy provider survey. J Pain Res 10:1395-1400, 2017

61. Pieper MJC, van der Steen JT, Francke AL, Scherder EJA, Twisk JWR, Achterberg WP: Effects on pain of a stepwise multidisciplinary intervention (STA OP!) that targets pain and behavior in advanced dementia: A cluster randomized controlled trial. Palliat Med 32:682-692, 2018

62. Poulsen M, Friesgaard KD, Seidenfaden S, Paltved C, Nikolajsen L: Educational interventions to improve medical students' knowledge of acute pain management: A randomized study. Scand J Pain 19:619-622, 2019

63. Salim NA, Joshua R, AbuBaker NA, Chehab F, Jose A: Effect of a nursing in-service education program on nurses' knowledge and attitudes towards pain management in a governmental hospital in the United Arab Emirates: Experimental random assignment study. Dubai Med J 2:146-152, 2019

64. Scottish Intercollegiate Guidelines Network [SIGN]: Management of Chronic Pain. SIGN publication no. 136 Edinburgh

65. Shaheed CA, Maher CG, Mak W, Williams KA, McLachlan AJ: The effects of educational interventions on pharmacists' knowledge, attitudes and beliefs towards low back pain. Int J Clin Pharm 37:616-625, 2015

66. Shipton EE, Bate F, Garrick R, Steketee C, Shipton EA, Visser EJ: Systematic review of pain medicine content, teaching, and assessment in medical school curricula internationally. Pain Ther 7:139-161, 2018

67. Sterne JAC, Savovic J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng HY, Corbett MS, Eldridge SM, Emberson JR, Hernán MA, Hopewell S, Hróbjartsson A, Junqueira DR, Jüni P, Kirkham JJ, Lasserson T, Li T, Stewart LA, Tilling K, White IR, Whiting PF, Higgins JPT: RoB 2: A revised tool for assessing risk of bias in randomised trials. BMJ 366:1-8, 2019. https://doi.org/10.1136/bmj.l4898

68. Strong J, Meredith P, Darnell R, Chong M, Roche P: Does participation in a pain course based on the International Association for the Study of Pain's curricula guidelines change student knowledge about pain? Pain Res Manage 8:137-142, 2003

69. Tauben DJ, Loeser JD: Pain education at the university of Washington school of medicine. J Pain 14:431-437, 2013

70. Watson JA, Ryan CG, Cooper L, Ellington D, Whittle R, Lavender M, Dixon J, Atkinson G, Cooper K, Martin DJ: Pain neuroscience education for adults with chronic musculoskeletal pain: A mixed-methods systematic review and meta-analysis. J Pain 20:1140.e1-1140.e22, 2019

71. Watt-Watson J, Hunter J, Pennefather P, Librach L, Raman-Wilms L, Schreiber M, Lax L, Stinson J, Dao T, Gordon A, Mock D, Salter M: An integrated undergraduate pain curriculum, based on IASP curricula, for six health science faculties. Pain 110:140-148, 2004

72. Watt-Watson JR, McGillion M, Hunter J, Choiniere M, Clark AJ, Dewar A, Johnston C, Lynch M, Morley-Foster P, Moulin D, Thie N, von Baeyer CL, Webber K: A survey of prelicensure pain curricula in health science faculties in Canadian universities. Pain Res Manage 14:439-444, 2009

73. Wood L, Hendrick PA: A systematic review and meta-analysis of pain neuroscience education for chronic low back pain: Short-and long-term outcomes of pain and disability. Eur J Pain 23:234-249, 2019

74. Wrenn J, Wrenn B: Enhancing learning by integrating theory and practice. Int J Teach Learn Higher Educ 21:258-265, 2009

75. Yoo J, De Gagne JC, Kim HJ, Oh J: Development and evaluation of a web-based acute pain management education program for Korean registered nurses: A randomized controlled trial. Nurse Educ Pract 38:7-13, 2019. https://doi.org/10.1016/j.nepr.2019.05.013

76. Zhang CH, Hsu L, Zou BR, Li JF, Wang HY, Huang J: Effects of a pain education program on nurses' pain knowledge, attitudes and pain assessment practices in China. J Pain Symptom Manage 36:616-627, 2008

77. Bareiss SK, Nare L, McBee K: Evaluation of pain knowledge and attitudes and beliefs from a pre-licensure physical therapy curriculum and a stand-alone pain elective. BMC Med Educ 19:1-9, 2019. https://doi.org/10.1186/s12909-019-1820-7

78. Chu TL, Wang J, Lin HL, Lee HF, Lin CT, Chieh LY, Sung YC, Lin YE: Multimedia-assisted instruction on pain assessment learning of new nurses: A quasi-experimental study. BMC Med Educ 19:1-8, 2019. https://doi.org/10.1186/s12909-019-1496-z

79. Dräger D, Budnick A, Kuhnert R, Kalinowski S, Könner F, Kreutz R: Pain management intervention targeting nursing staff and general practitioners: Pain intensity, consequences and clinical relevance for nursing home residents. Geriatr Gerontol Int 17:1534-1543, 2017

80. Everard KM, Schiel KZ: Learning outcomes from lecture and an online module in the family medicine clerkship. Fam Med 52:124-126, 2020

81. Furlan A, Zhao J, Voth J, Hassan S, Dubin R, Stinson JN, Jaglal S, Fabico R, Smith AJ, Taenzer P, Flannery JF: Evaluation of an innovative tele-education intervention in chronic pain management for primary care clinicians practicing in underserved areas. J Telemed Telecare 25:484-492, 2019

82. Gunnarsdottir S, Zoëga S, Serlin RC, Sveinsdottir H, Hafsteinsdottir EJG, Fridriksdottir N, Gretarsdottir ET, Ward SE: The effectiveness of the Pain Resource Nurse Program to improve pain management in the hospital setting: A cluster randomized controlled trial. Int J Nurs Stud 75:83-90, 2017

83. Holliday SM, Hayes C, Dunlop AJ, Morgan S, Tapley A, Henderson KM, van Driel ML, Holliday EG, Ball JI, Davey A, Spike NA, McArthur LA, Parker JM: Does brief chronic pain management education change opioid prescribing rates? A pragmatic trial in Australian early-career general practitioners. Pain 158:278-288, 2017

84. Hush JM, Nicholas M, Dean CM: Embedding the IASP pain curriculum into a 3-year pre-licensure physical therapy program: Redesigning pain education for future clinicians. Pain Rep, 2018

85. Keefe G, Wharrad HJ: Using e-learning to enhance nursing students' pain management education. Nurse Educ Today 32:e66-e72, 2012

86. Lasch KE, Wilkes G, Lee M, Blanchard R: Is hands-on experience more effective than didactic workshops in postgraduate cancer pain education? J Cancer Educ 15:218-222, 2000

87. Leung YW, Wong J, Kiteley C, Ellis J, Esplen MJ: Addressing educational needs in managing complex pain in cancer populations: Evaluation of APAM: An online educational intervention for nurses. Am J Hosp Palliat Care 36:587-597, 2019

88. Liu YM, Lin GL, Chao KY, Jih HJ, Yang BH, Chiang YC: Comparison of the effectiveness of teaching strategies for a pediatric pain management program for undergraduate nursing students: A quantitative evaluation using an objective structured clinical examination. Nurse Educ Pract 43, 2020. https://doi.org/10.1016/j.nepr.2020.102707

89. Louw A, Zimney K, Puentedura EJ, Diener I: The efficacy of pain neuroscience education on musculoskeletal pain: A systematic review of the literature. Physiother Theory Pract 32:332-355, 2016

90. Poulsen M, Friesgaard KD, Seidenfaden S, Paltved C, Nikolajsen L: Educational interventions to improve medical students' knowledge of acute pain management: A randomized study. Scand J Pain 19:619-622, 2019

91. Mamhidir AG, Sjölund BM, Fläckman B, Wimo A, Sköldunger, Engström M: Systematic pain assessment in nursing homes: a cluster-randomized trial using mixed-methods approach. BMC Geriatr 17:61, 2021. https://doi.org/10.1186/s12877-017-0454-z

92. McCracken LM, Boichat C, Eccleston C: Training for general practitioners in opioid prescribing for chronic pain based on practice guidelines: A randomized pilot and feasibility trial. J Pain 13:32-40, 2012

93. McGillion M, Dubrowski A, Stremler R, Watt-Watson J, Campbell F, McCartney Victor JC, Wiseman J, Snell L, Costello J, Robb A, Nelson S, Stinson J, Hunter J, Dao T, Promislow S, McNaughton N, White S, Shobbrook C, Jeffs L, Mauch K, Leegaard M, Beattie WS, Schreiber M, Silver I: The postoperative pain assessment skills pilot trial. Pain Res Manage 16:433-439, 2011

94. Monaghan J, Adams N, Fothergill M: An evaluation of a pain education programme for physiotherapists in clinical practice. Musculoskelet Care 16:103-111, 2018

95. Overmeer T, Boersma K, Denison E, Linton SJ: Does teaching physical therapists to deliver a biopsychosocial treatment program result in better patient outcomes? A randomized controlled trial. Phys Ther 91:804-819, 2011

96. Parvizy S, Tarvirdinsasab S, Raznahan R, Aliakbari M: The effect of pain management training in workshop on the knowledge, attitude and self-ef cacy of pediatric nurses. J Family Med Prim Care 9:2880-2884, 2020

97. Patiraki E I, Papathanassoglou EDE, Tafas C, Akarepi V, Katsaragakis SG, Kampitsi Lemonidou C: A randomized controlled trial of an educational intervention on Hellenic nursing staff's knowledge and attitudes on cancer pain management. Eur J Oncol Nurs 10:337-352, 2006

98. Schreiner U, Haefner A, Gologan R, Obertacke U: Effective teaching modifies medical student attitudes toward pain symptoms. Eur J Trauma Emergency Surg 37:655-659, 2011

99. Stevens DL, King D, Laponis R, Hanley K, Zabar S, Kalet AL, Gillespie C: Medical students retain pain assessment and management skills long after an experiential curriculum: A controlled study. Pain 145:319-324, 2021

100. Trudeau KJ, Hildebrand C, Garg P, Chiauzzi E, Zacharoff KL: A randomized controlled trial of the effects of online pain management education on primary care providers. Pain Med 18:680-692, 2017

101. Wang AP, Fisher G, Hall J: Pain education for clinicians in geriatrics: a study into changes in clinician attitudes and beliefs. Health education in practice. J Res Prof Learn 1:51-68, 2018