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| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

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| For adult patients with chronic low back pain, does pain neuroscience education intervention improve functional outcomes compared to traditional physical therapy education? |

**AUTHOR**

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**CLINICAL SCENARIO**

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| **The patient is a 44-year old male office worker who presents with low back pain that has been intermittently present for about 3 years with varying intensity. The patient feels as though the pain has been interfering with his daily life and stopping him from doing the tasks he wants, or making them much harder to perform. The patient is also worried that moving too much will make it worse, and that he needs to rest and let it heal. The patient works an office job as a software engineer and wants to be able to tolerate work demands, home demands with his two children, and a return to an exercise routine with less pain. To help this patient increase his function, I want to know if pain neuroscience education, as an intervention, will help more than traditional physical therapy education.** |

**SUMMARY OF SEARCH**

[Best evidence appraised and key findings]

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| Eight studies were included that met selection criteria and included 1 quasi-experimental study, 5 randomized control trials, and 2 systematic reviews with meta-analysis.   * Pain Neuroscience Education (PNE) might improve self-perceived disability in the short term and long term.3,5,7,8 * PNE might improve psychological outcomes, such as pain catastrophising, negative beliefs about pain, and kinesiophobia.2,4,6,7,8 * PNE has been shown to improve some patient physical functions, but evidence is weaker than for other outcomes.2,3,8 * PNE might reduced pain ratings in the short term, but this effect appears to be small or non-existent when utilizing PNE as a stand-alone intervention.5,8 * PNE appears to have benefits compared to traditional education, such as reduced disability, but is often utilized with other physical therapy treatments and not directly compared to educational treatments.5,8 |

**CLINICAL BOTTOM LINE**

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| Adults with chronic low back pain likely benefit from pain neuroscience education compared to traditional physical therapy education in reduced perceptions of disability and improvements in attitudes and feelings about pain and its impact on the patient, especially in the short term. The primary benefit of the use of PNE is likely to be seen in improvements in psychological or self-perceived changes, rather than physical outcomes or ratings of pain, so PNE should still be just one component of a broader and thorough physical therapy rehabilitation plan. |

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| ***This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor*** |

*The above information should fit onto the first page of your CAT*

**SEARCH STRATEGY**

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| **Terms used to guide the search strategy** | | | |
| **P**atient/Client Group | **I**ntervention (or Assessment) | **C**omparison | **O**utcome(s) |
| Adults  Low Back Pain  Chronic Pain | Pain Neuroscience Education  PNE | Physical Therapy  Standard Treatment  Conventional | Function  Oswestry  Functional Outcomes |

**Final search strategy (history):**

*Show your final search strategy (full history) from PubMed. Indicate which “line” you chose as the final search strategy.*

1. (((("low back pain" OR back pain) AND (chronic)) AND ("pain neuroscience education" OR PNE)) AND ("physical therapy")) AND (functio\* OR Oswestry)
2. ((("low back pain" OR back pain) AND (chronic)) AND ("pain neuroscience education" OR PNE)) AND (functio\* OR Oswestry)
3. ((("low back pain" OR back pain OR LBP) AND (chronic)) AND ("pain neuroscience education" OR PNE OR TNE OR "therapeutic neuroscience education" OR "pain neurophysiology education")) AND (functio\* OR Oswestry)
4. **((("low back pain" OR back pain OR CLBP OR LBP OR lumbar OR spinal) AND (chronic)) AND ("pain neuroscience education" OR PNE OR TNE OR "therapeutic neuroscience education" OR "pain neurophysiology education")) AND (functio\* OR Oswestry)**

*In the table below, show how many results you got from your search from each database you searched.*

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| **Databases and Sites Searched** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| **PubMed** | **22** | **For search 1: 5 results**  **For final search 3: 18 results** |
| **PEDro** | **9** | **Searched for (pain neurophysiology education) instead of (pain neuroscience education) and got 5 results, all different than the previous 9** |
| **Cochrane Library** | **14** | **All but 2 of the articles were in the PubMed or PEDro results, and neither fit my criteria** |
| **Web of Science** | **10** | **9 of the results were found in previous searches, and the remaining one was a textbook chapter** |

## INCLUSION and EXCLUSION CRITERIA

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| **Inclusion Criteria** |
| * Article in English * Outcomes measured function * Pain Neuroscience Education as a specific intervention is utilized * Conventional education or treatment is described * Subjects are adults with low back pain longer than one month |
| **Exclusion Criteria** |
| * Not published in English * Pain is acute or subjects have no history of low back pain * No functional outcome measures * Study protocols that have not been completed * Narrative reviews * Case studies |

**RESULTS OF SEARCH**

**Summary of articles retrieved that met inclusion and exclusion criteria**

*For each article being considered for inclusion in the CAT, score for methodological quality on an appropriate scale, categorize the level of evidence, indicate whether the relevance of the study PICO to your PICO is high/mod/low, and note the study design (e.g., RCT, systematic review, case study).*

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| --- | --- | --- | --- | --- |
| **Author (Year)** | **Risk of bias (quality score)\*** | **Level of Evidence\*\*** | **Relevance** | **Study design** |
| **Pires (2015)** | **PEDro 9/11** | **Level 1** | **Low** | **Single-Blind RCT** |
| **Clarke (2011)** | **AMSTAR: 9/11** | **Level 1** | **Moderate** | **Systematic Review with Meta-Analysis** |
| **Rufa (2019)** | **ROBANS: Low 3/6, High 3/6** | **Level 2 – no control or randomization** | **Low** | **Quasi-Experimental Study** |
| **Bodes Pardo (2018)** | **PEDro: 8/11** | **Level 1** | **Moderate** | **Single-Blind RCT** |
| **Wood (2019)** | **AMSTAR: 9/11** | **Level 1** | **High** | **Systematic Review with Meta-Analysis** |
| **Malfliet (2018)** | **PEDro: 10/11** | **Level 1** | **Moderate** | **Triple-blind RCT** |
| **Galan Martin (2020)** | **PEDro: 9/11** | **Level 1** | **Moderate** | **Single-blind RCT** |
| **Moseley (2004)** | **PEDro: 10/11** | **Level 1** | **High** | **Triple-blind RCT** |

\*Indicate tool name and score

\*\*Use Portney & Watkins Table 16.1 (2009); if downgraded, indicate reason why

**BEST EVIDENCE**

The following 2 studies were identified as the ‘best’ evidence and selected for critical appraisal. Rationale for selecting these studies were:

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| * Moseley GL, Nicholas MK, Hodges PW. A randomized controlled trial of intensive neurophysiology education in chronic low back pain. Clin J Pain. 2004;20(5):324-330. doi:10.1097/00002508-200409000-00007   + The most relevant of the RCT to my clinical question, as it examined use of PNE as the sole intervention against use of anatomy and physiology education, which would be most similar to typical physical therapy intervention. It also included 3 physical performance tasks, which could help provide important information regarding functional outcomes, especially when compared to patient-reported questionnaires that were the measure for most other studies. Scored high on PEDro quality assessment. * 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. 2019;23(2):234-249. doi:10.1002/ejp.1314   + Examined relevant information regarding my question in disability outcomes, as well as pain, for physical therapy + PNE versus without PNE in both the short and long term. Scored high on AMSTAR risk of bias assessment and provides a meta-analysis of eight separate studies to examine. |

**SUMMARY OF BEST EVIDENCE**

**(1) Description and appraisal of (A randomized controlled trial of intensive neurophysiology education in chronic low back pain) by (Moseley, Nicholas, Hodges, 2004)**

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| **Aim/Objective of the Study/Systematic Review:** |
| The study examined the effects of neurophysiology education on pain, self-perceived disability, or physical outcomes in patients with chronic low back pain. |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| The study was a randomized control trial. Subjects volunteered for the study after advertisements were given to patients at rehabilitation clinics. Subjects were allocated to control or intervention group based on concealed randomization that was performed after the initial assessment. Subjects were blinded to the intervention group as they were informed of that the study was examining education on pain, but were not aware of the other intervention or control group. Therapists that performed treatments were told of the purpose of the study, but each set of therapists were told that the other type of education, the one they were not performing, was the control intervention in the study. Subjects were assessed at initial assessment, randomized into groups, then again at a final evaluation that occurred fifteen weekdays after the first treatment session. |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| Subjects were voluntarily recruited from three separate private rehabilitation clinics in Brisbane, Australia |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| A total of sixty-three subjects volunteered for the study, but five were excluded, leaving a sample of fifty-eight subjects. Inclusion criteria included patients who had low back pain for more than six months. 31 patients were randomized into the experimental group through concealed randomization. The experimental group consisted of 13 males and 18 female patients with a mean age of 42 years old and mean duration of pain of 29 months. The control group consisted of 12 male and 15 female patients with a mean age of 45 and mean duration of pain of 30 months. There were three drop-outs in the experimental group who did not present for final evaluation and one withdrawal in the control group due to surgery, leaving a final sample of 28 patients in the experimental group and 26 patients in the control group. |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| Each subject received one 3-hour educational seminar session with a 20-minute break. This session presented information on the anatomy and physiology of the spine, postural analysis and advice, lifting advice, ergonomical advice, and principles of stretching, strength, endurance, and fitness training. No information was presented on nervous system components outside of the location of the spinal cord and nerve roots. The control information was designed to be similar to educational components of back school or functional rehabilitation programs. The subjects were given a workbook consisting of 10 sections, with the instructions to complete one section each weekday for two weeks. Educational session was provided by physical therapists who had experience in providing this education. |
| *Experimental* |
| Each subject received one 3-hour educational seminar session with a 20-minute break. The session presented information on the nervous system, including anatomy and physiology, components of pain pathways, conceptual break-down of synapses and nervous system messaging, and a conceptual framework of neural sensitivity, inhibition, and adaptations. No information was given about the low back or to behavioural patterns, such as pain catastrophizing or fear avoidance. The patients were given the same 10 section workbook with the same instructions to complete one section each weekday for two weeks. Educational session was provided by physical therapists who had experience in providing this education. |
| **Outcome Measures**  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| Outcome measures were performed by three separate physical therapists. Two categories of outcome measures were performed, self-reported questionnaires and physical performance measures. Self-reported questionnaires included:   * Roland Morris Disability Questionnaire (RMDQ): self-reported 24-item questionnaire that measures perceived disability due to low back pain. Score ranges from 0, indicating no disability, to 24, indicating severe disability. * Survey of Pain Attitudes (revised) (SOPA(R)): self-reported 35-item questionnaire where subjects indicate level of agreement based on 5-point Likert scale to assess attitudes and beliefs towards pain. Higher scores indicate more positive feelings about pain. * Pain Catastrophizing Scale (PCS): self-reported 13-item questionnaire that assesses feelings about pain and coping strategies based on level of agreement with thought statements. Scored from 0 to 52, with higher levels indicating greater levels of catastrophic thinking and inappropriate coping. Can be broken into three subscales to assesses feelings or thoughts of rumination, magnification, and helplessness.   Physical performance measures were assessed by physical therapist to ensure standardized instructions and recording, as well as correct performance by subjects. Measures included:   * Straight Leg Raise (SLR): assesses neurodynamic movement or lower limb flexibility. Degrees of motion assessed using a goniometer. * Forward Bending Range of Motion: assessing trunk mobility with bare-foot standing and full knee extension. Measured using the distance from the longest finger to the floor in cm. * Abdominal “Drawing-in” Task (ADIT): assessment of motor control via voluntary contraction of deep abdominal muscles. Assessed in mmHg in a pressure cuff placed under the low back of the patient. |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. You may summarize results in a table but you must explain the results with some narrative.] |
| Table 1 (modified from Table 2 on page 327)   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Outcome | Effect Size (95% CI) | Experimental Group (Mean + SD) | | Control Group (Mean + SD) | | | Pre | Post | Pre | Post | | SMDQ | 2.0 (0.4-3.6) \* | 15 + 4 | 14 + 3 | 15 + 4 | 16 + 3 | | SOPA(R) Total | 9.0 (6.5-11.5) \* | 6 + 6 | 16 + 7 | 6+ 6 | 7 + 8 | | PCS | 6.0 (3.8-8.2) \* | 19 + 6 | 14 + 5 | 20 + 6 | 21 + 6 | | SLR (°) | 5.0 (4.0-6.0) \* | 37 + 13 | 43 + 13 | 35 + 15 | 34 + 15 | | Bending (cm) | 4 (0.0-8.2) \* | 26 + 13 | 22 + 9 | 31 + 12 | 31 + 12 | | ADIT (mmHg) | \_\_ | 2.2 + 1.8 | 4.2 + 1.9 | 2.5 + 1.7 | 3.8 + 1.8 |   \* denotes significant difference with p<0.05. As shown in Table 1, subjects from the experimental group had greater change in SOPA(R) (p<0.001), PCS (p<0.001), and SMDQ (p=0022) scores for the patient-reported outcomes. In subset analysis of the SOPA(R) scores, subjects in the experimental group in post-treatment analysis were less likely to seek care from others when in pain (p=0.024), more likely to believe they can control their own pain (p=0.002), more likely to believe emotions influence pain (p=0.007), and less likely to believe pain indicates tissue damage (p=0.023). There was no difference between groups on the perception that pain is associated with disability (p=0.31) In physical performance measure outcomes, subjects from the intervention group demonstrated greater improvements in SLR (p<0.01) and forward bending range (p<0.01). The greatest effect size was seen in the SOPA(R) total score at 9.0 points. |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| Following the use of neurophysiology education compared to a more typical educational intervention, patients with chronic low back pain had less catastrophizing, more positive attitudes, and more self-efficacy related to their pain. The greatest effect was seen in improving thoughts and attitudes about pain. Neurophysiology education also resulted in an improvement in physical performance tasks compared to control education, suggesting that changing patient attitudes about pain likely increases patient pain threshold, sensitivity to movement, or willingness to move into painful motions. Since the exact mechanism behind the improved physical performance is not known, it can be hypothesized that changes in cognition and attitudes impact physical response to pain in the body. While there was a statistically significant difference in perceived disability measured via the RMDQ, the effect size was small and likely related to worsening score in the control group than greater improvements in the experimental group; therefore, neurophysiology education likely does not have a clinically significant effect on perceived disability due to low back pain. Lastly, the lack of improvements in the control group utilizing more conventional back education reflects the inadequacy of traditional pain interventions to address thoughts and beliefs about pain. Based on this study, more back pain treatment regimes should adopt a neurophysiology education component. |
| **Critical Appraisal** |
| **Validity**  [Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.] |
| Using the PEDro scale for randomized control trials, this study scored a 10 out of 11 and was judged to have low risk of bias. The only point in the scale that was not received was for blinding of the therapists, which the study organizers did attempt to do by telling each therapist that performed a treatment that their treatment was the control, and not revealing what the other treatment was. While this strategy does potentially provide some level of blinding, the therapists are still aware of the treatment they perform and the purpose of the study, which does still allow for some influence of bias into their treatments. Outside of this, the subjects were randomly assigned, similar at baseline, blinded to the experimental group, and both scoring of the outcomes and treatments were provided by skilled physical therapists who were blinded to the experimental group. There were four total subjects lost to drop-out or withdrawal, but no intention to treat analysis was mentioned in the study. Thus, the internal validity of the study was good based on the study design. In examining the external validity of the study, the participants were volunteer subjects who were recruited from advertisements in private rehabilitation clinics. This can influence the study sample based on those who are likely to volunteer, but it would also be difficult to randomly select a sample of individuals who fit the chronic back pain inclusion criteria. The outcomes measures chosen appropriately measured the ideas of self-reported pain or disability, although the physical performance measures are relatively low-intensity tasks that might not be able to extrapolated to other physical tasks or general physical performance in this population. One weakness of the study is the short duration of follow-up and that each intervention was only performed once, but this also makes sense given the study was designed to compare one educational treatment to another, and the educational treatment should only need to be applied once primarily. Based on this, this study seems to be of overall high quality to be able to apply the results to my clinical scenario. |
| **Interpretation of Results**  [This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| Based on the large, clinically-significant effect size between the educational interventions in SOPA(R) score, it appears that pain neurophysiology education has the greatest impact on patient beliefs and attitudes towards pain. This makes sense and also agrees with the significant difference in between interventions for PCS score, which could reflect reduced catastrophizing or helplessness. These differences appear to be useful in helping patients increase self-efficacy and improve general attitudes about pain, but this study occurred over a short time with one long three-hour single-session educational session. In addition, there are greater improvements in some movements, such as trunk flexion or straight raising, that might be provocative for patients with chronic low back pain, following neurophysiology education. With a chronic pain population, this change in movement might be a reflection of the impact of changing attitudes and beliefs about pain in the short-term. As such, the difference in beliefs and attitudes is demonstrated as a short-term benefit and the long-term impact is not known; however, the positive changes related to pain perception might lead to greater movement capabilities or improved efficacy of other movement or exercise-based interventions, although that is not known from this study. |
| **Applicability of Study Results**  [Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.] |
| The study is highly relevant in comparing a pain neuroscience or neurophysiology education intervention compared to traditional intervention. There are functional outcomes in the physical performance measures, but they do not assess function in multiple methods and might not relate to patient-perceived functional abilities. In addition, the intervention occurred over a 3-hour educational session, which is highly unlikely to be implemented in physical therapy settings; however, the PNE intervention can be applied in a similar manner during a typical physical therapy appointment. It is not clear if the results can be extrapolated to educational methods that occur in reduced time, since most therapy sessions are less than one hour and education would only be a portion of the time spent during evaluation, or if the education is provided over multiple treatment sessions over time. Since the intervention was education alone, this can be applied in any physical therapy treatment, regardless of setting, especially on a population of adults with chronic low back pain. |

**(2) Description and appraisal of (a systematic review and meta-analysis of pain neuroscience education for chronic low back pain: short- and long-term outcomes of pain and disability) by (Wood, Hendrick, 2018)**

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| **Aim/Objective of the Study/Systematic Review:** |
| The purpose of the systematic review was the examine the effect of pain neuroscience education on pain and disability in patients with non-specific chronic low back pain. This study examined the effect of PNE when used in isolation or in combination with other therapy techniques. |
| **Study Design**  [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]  Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| Systematic review with meta-analysis. Outcomes measured included pain and disability measures, and they were included if they were assessed in the short-term (6 weeks or less) or long-term (up to 12 months). The search occurred using CINAHL, Medline, Cochrane, and Web of Science databases from the years 2011 to 2017. They were searched for articles containing variations of low back or spine pain and pain neuroscience education or neurophysiology education. Three key authors in the field of pain neuroscience were also contacted directly to confirm no potential studies had been missed. Other systematic reviews of pain neuroscience were examined to look for potential papers in their sources. All studies from the search results were screened independently by the two authors and any conflicts were resolved through discussion between the authors. Any studies that were selected were reviewed by one of the authors using the Cochrane Risk of Bias tool to examine the validity of each incorporated study. |
| **Setting**  [e.g., locations such as hospital, community; rural; metropolitan; country] |
| Included studies were conducted in a variety of countries, including Belgium, Australia, Portugal, Spain, Switzerland, Norway, and the USA, but typically study interventions were performed in outpatient treatment centers. Study location likely changed based on other interventions that were performed with the pain neuroscience intervention, such as dry needling, aquatic therapy, manual therapy, or exercise therapy. |
| **Participants**  [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]  Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| Adult patients with chronic non-specific low back pain for more than 3-months were included from randomized control trials. 8 studies were included that resulted in 615 total subjects. 6 studies examined short-term outcomes of less than 12 weeks in 428 total subjects. Two studies examined long-term outcomes at a 12-month follow-up in a total of 254 subjects. The mean age of the participants in the samples ranged from 36 years old to 60.14 years old, and mean duration of pain ranged from 6.8 weeks to 9.26 years. Each of the eight included studies had a sample that was more female than male, ranging from 55% female to 67% female. |
| **Intervention Investigated**  [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| The control group in the included studies consisted of typical general practitioner care (one study), typical physical therapy (one study), biomedical or anatomical education (three studies), and the same interventions as the intervention group without the pain neuroscience education (three studies). In seven of the studies the control group received the same number of treatment sessions as the intervention group, while one study utilized usual general practitioner care. |
| *Experimental* |
| The intervention group received pain neuroscience education or pain neurophysiology education, either alone or as a part of a treatment. In two of the eight included studies, pain neuroscience education was performed as a stand-alone treatment. In the remaining studies, PNE was included with other interventions, including manual therapy and Maitland mobilization, typical physical therapy treatment, aquatic therapy, trigger point dry needling, and sensory and movement training. Three studies included only one treatment session, while five studies utilized between three and fourteen treatment sessions. Treatment duration ranged in the included studies from five-minute PNE explanation prior to typical treatment to a three-hour education session; however, five of the studies did not include the length of time of treatments, but it based on the interventions performed, were likely to be typical physical therapy treatment length between thirty and ninety minutes. |
| **Outcome Measures**  [Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| Outcome measures included measures of pain and disability. Five studies examined pain intensity using a numerical rating scale and one study utilized a visual analog scale, with both being converted to a 0-10-point scale for comparison. Disability was measured via a number of scales, including the Roland Morris Disability Questionnaire (five studies), Quebec Back Pain and Disability Scale (one study), Oswestry Disability Index (one study), Patient-Specific Functional Scale (one study), and Pain Disability Index (one study). Secondary outcomes were examined on the short-term effect of PNE on fear of movement using the Tampa Scale of Kinesiophobia (three studies), and pain catastrophizing using the Pain Catastrophizing Scale (two studies). |
| **Main Findings**  [Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. Use a table to summarize results if possible.] |
| Meta-analysis of pain short-term pain outcomes from six studies showed a non-statistically significant (p=0.10) weighted mean difference of 0.73 (95% CI= -0.14, 1.61) on a 10-point scale when comparing PNE to control groups. Pain outcomes were broken into subgroups, and a subgroup of five studies comparing physical therapy interventions used with PNE demonstrated a statistically significant different (p<0.00001) with a weighted mean difference of 1.32 (1.08, 1.56). This subgroup included 212 total subjects and the difference was not clinically significant. Analysis of long-term pain outcomes at 12-month follow-up for the effect of PNE on pain showed a non-statistically significant difference (p=0.56) with a weighted mean difference of 0.44 (-1.03, 1.91) for this sample of 254 subjects. Meta-analysis of short-term disability outcomes from five studies with a total sample of 362 subjects that utilized the Roland Morris Disability Questionnaire demonstrated a weighted mean difference of 2.28 (0.20, 4.25) that was statistically significant (p=0.02) and clinically significant with the MCIC of 2 points. Sub-group analysis was again performed for effect on disability of PNE used in addition to physical therapy interventions for a sample of 88 subjects, which showed a weighted mean difference of 3.94 (3.37, 4.52) that was statistically significant (p<0.00001) and clinically significant. Analysis of long-term disability outcomes using the Roland Morris Disability Questionnaire demonstrated a non-statistically significant (p=0.013) weighted mean difference of 2.18 (-0.67, 5.02) for the use of PNE in a sample of 254 subjects. In outcomes that were utilized by only one study, intervention groups utilizing PNE alone or with other treatments demonstrated non-statistically significant results in favor of PNE for Patient-Specific Functional Scale (0=0.09), Pain Disability Index, Quebec Back Pain and Disability Scale (p=0.32) and Oswestry Disability Index (p=0.15). Secondary outcome analysis using the Tampa Scale of Kinesiophobia demonstrated a statistically significant (p=0.0001) weight mean group difference of 4.72 (2.32, 7.13) in favor of the use of PNE for short-term fear of movement, but the difference was not clinically significant. Secondary outcome analysis using the Pain Catastrophizing Scale demonstrated a non-statistically significant (p=0.46) weighted mean difference of 2.54 (-4.23, 9.31) in favor of the use of PNE for short-term pain catastrophizing attitudes. |
| **Original Authors’ Conclusions**  [Paraphrase as required. If providing a direct quote, add page number] |
| The authors of this study concluded that “the use of PNE probably improves disability in the short term, irrespective of whether it is delivered in conjunction with physiotherapy or not” (p. 11). Meta-analysis demonstrated a clinically significant change in the Roland Morris Disability Questionnaire in the short-term and long-term outcomes up to one year after the use of PNE, showing reductions in perceived disability. When used as a stand-alone treatment or with physical therapy treatments, PNE had little to no effect on pain scores; however, when PNE was used with usual physical therapy treatment, sub-group analysis showed a slight improvement on short-term pain ratings. Greater benefits were seen when PNE was used in addition to physiotherapy treatments compared to when PNE was utilized alone. There were many differences in how the PNE intervention was performed, such as face-to-face, online, through reading, stand-alone, or in a treatment plan, and what control the intervention was compared to, so there are some limitations in applying results to a specific treatment plan or intervention; however, the results support the general use of PNE within physical therapy practices for patients with chronic low back to reduce disability and potentially improve short-term pain ratings. |
| **Critical Appraisal** |
| **Validity**  [Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.] |
| Using the AMSTAR tool, this systematic review was graded at 9 out of 11. This review did not include a search of grey or unpublished literature, and did not assess publication bias. While the authors did not conduct a search of unpublished literature, they did directly contact key authors in the field, including Moseley, Louw, and Nijs, to identify any missed papers that had not been included yet, which is helpful in a field with a few key authors. The authors did assess the risk of bias in their included studies using the GRADE scale, which showed that seven of the included studies were of moderate quality, while one study was of high quality. The authors of the review also stated that three of the studies were conducted by prominent PNE authors who have an interest in promoting the efficacy of PNE for potential personal gain. There were multiple outcome measures used in the studies, which did make it more difficult to apply the results generally, as meta-analysis could only be performed to assess the effect of PNE on specific outcome measures, not a general outcome, such as disability. As such, many of the outcomes are assessed using two or three studies, rather than all eight. The two authors of the study did do all searching, screening, and selection of the articles, as well as the data collection; however, the authors independently reviewed the articles and resolved disagreements with discussion as to whether they met inclusion criteria or not. In examining the external validity, there was some variability in how the intervention was applied, in terms of concurrent interventions, comparison interventions, length of follow-up up, setting, and more. There was high heterogeneity with *I*2 statistics of 95% when examining pain in the short term and 98% when examining disability in the long term, demonstrating high levels of variability in the included studies. Since the intervention is educational, the variability of treatment setting and concurrent intervention is not surprising, as it can be applied in nearly any setting, and it does provide some support that PNE can be utilized regardless of setting; however, it also makes it hard to generalize results to a specific research question. In addition, there was heterogeneity in age, duration of pain, and format of PNE delivery, which are important factors in applying this study to a specific population or clinical question. Overall, the evidence provided is moderate, as the study designed helped to lower risk of bias, but the low number of included studies and variability among these studies does limit the applicability of the results. |
| **Interpretation of Results**  [This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| I believe that this study supports with the use of PNE in addition to physical therapy interventions to reduce disability in both the short and long-term, as this use demonstrated the largest effect size (mean difference of 3.94) and a smaller confidence interval than other uses. The use of PNE in addition to physical therapy on disability outcomes was examined using a sample of 88 patients, which, while fewer than other samples, was a large enough sample to demonstrate clinical significance. While this study does support the use of PNE for improvements in pain ratings or attitudes about pain, those components either demonstrated small differences, some of which were not statistically or clinically significant, or utilized a smaller number of studies and subjects. Specifically, for psychological benefits, such as reduced kinesiophobia or pain catastrophizing, there might be some benefit, but those components demonstrated smaller effect sizes and large confidence intervals, so the benefit is not as convincing. |
| **Applicability of Study Results**  [Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.] |
| This study is relevant to the scenario in examining the different potential benefits of the use of PNE on an individual with chronic low back pain. One of the main outcomes examined was change in disability, which does reveal useful clinical information about change in function, although not directly. The samples in this review consisted of some studies that were directly applicable, such as those comparing PNE interventions to anatomical education interventions, but it also included some studies that were not as directly applicable to the clinical question, such as those comparing PNE to no intervention; however, as the review takes the data from the variety of studies, I feel confident in the applicability of those findings to this clinical scenario. There was also considerable heterogeneity in many of the subgroup outcomes assessed, including analysis of disability, which lends further support that the results can be confidently applied to my scenario and question. |

**SYNTHESIS AND CLINICAL IMPLICATIONS**

[Synthesize the results, quality/validity, and applicability of the two studies reviewed for the CAT. Future implications for research should be addressed briefly. Limit: 1 page.]

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| Based on the results of these two studies, there is support for the use of PNE in adult patients with chronic low back pain to improve disability outcomes. In these studies, the use of PNE instead of traditional physical therapy or anatomical education appears to most benefit patients in improving their attitudes, feelings, perceptions and self-perceived disability. The use of PNE might also have other benefits, such as improvements in pain scores or physical tasks. Both of these studies found statistically significant benefits for the use of PNE on disability, but Moseley found a small effect size and concluded that reduced disability is likely not the primary benefit, while Wood and Hendrick found the largest effect size for change in disability, when used with or without other physical therapy interventions. In addition, Moseley found the largest effect size on SOPA(R) score, demonstrating a change in pain cognitions or attitudes, but Wood and Hendrick found non-significant changes in rating of pain catastrophising. However, both studies found similar limited benefits on pain ratings. The Moseley study was a randomized control trial that directly compared PNE to a different intervention without additional physical therapy interventions, while the Wood and Hendrick review included studies that used a variety of other interventions and comparison groups. As such, there is some difficulty in comparing the results of the two studies and applying them both in the same manor to the specific population and clinical scenario in question. The two studies examined were of moderate to high quality and both had study designs that worked to reduce bias within the study. On the other hand, the Wood review had high heterogeneity in some significant subject characteristics or study design of included studies, which makes it harder to apply to a specific population. Since the Moseley study was more applicable to the clinical question in that it directly compared one educational intervention to another, there is greater confidence in applying the results to the clinical scenario and determining whether to utilize PNE or traditional physical therapy education, which the Wood and Hendrick study related more broad information about the strengths and weaknesses of PNE within a physical therapy treatment plan. Based on this, I would have the most confidence in my clinical scenario that PNE will help this patient improve his negative thoughts and attitudes, and possibly reduce his perceived disability.  Based on this information and conflicting results of the two studies, it appears that benefits from PNE are likely related to changes in cognition, attitudes, or self-perceived disability, but more specific research comparing PNE to specific educational interventions is needed to confidently conclude what the greatest clinical strengths of PNE are. Future specific research will also be needed to compare outcomes and determine the strengths in terms of changes to disability, physical function, or psychological outcomes, as well as comparing the difference in outcomes when PNE is used alone or with other treatment methods. |

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[List all references cited in the CAT]

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