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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

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Abstract

Objective To investigate the effect of pain neurophysiology education (PNE) on student physiotherapists’: (1) knowledge of chronic pain; (2) attitudes towards patients with chronic pain; and (3) clinical recommendations for patients with chronic pain.

Design Multicentre single-blind randomised controlled trial.

Setting One UK and one Irish university.

Participants Seventy-two student physiotherapists.

Intervention Participants received either PNE (intervention) or a control education. Both were delivered in a 70-minute group lecture.

Main outcome measures (1) The Revised Pain Neurophysiology Quiz to assess knowledge; (2) the Health Care Pain Attitudes and Impairment Relationship Scale (HC-PAIRS) to assess attitudes; and (3) a case vignette to assess the appropriateness of clinical recommendations.
**Results** Post education, the PNE group had a greater increase in pain neurophysiology knowledge [mean difference 4.0 (95% confidence interval 3.2 to 4.7), \( P<0.01 \)] and more improved attitudes [-17.5 (95% confidence interval -22.1 to -12.9), \( P<0.01 \)] compared with the control group. Post education, students in the PNE group were more likely to make appropriate recommendations with respect to work (94% vs. 56%), exercise (92% vs. 56%), activity (94% vs 67%) and bedrest (69% vs 33%) compared with those in the control group (\( P<0.05 \)).

**Conclusion** The improvements in knowledge, attitudes and recommendations for pain management show that PNE is a potentially valuable part of the education of physiotherapy students, and could be used on a more widespread basis. There is a need to investigate whether these findings can be replicated in other healthcare professions, and how well these reported changes lead to changes in actual clinical behaviour and the clinical outcomes of patients.

*Keywords:* Pain education; Undergraduate; Physiotherapy; Pain curriculum; Randomised controlled trial

**Introduction**

Pain education is important for undergraduate healthcare professionals (HCPs). The quantity and quality of undergraduate pain education across multiple HCPs has been questioned [1–8]. A UK survey found that undergraduate pain education amounted to just 12 hours, equating to \(<1\%\) of total teaching time [6]. Adherence to the International Association for the Study of Pain (IASP) curriculum guidelines was scant. There is a need to improve undergraduate pain training.

IASP has published a number of pain curricula for undergraduates [9–11]. While uptake appears to be limited [6], reports have been published where the IASP curriculum has been utilised [4,12,13]. Initial results for such curricula are positive with respect to improved student
knowledge and attitudes. However, findings have come from uncontrolled studies, so improvements cannot be attributed to the educational input [4,12,13].

Pain education can be delivered in many different formats. A relatively distinct format is pain neurophysiology education (PNE). Over 15 years, PNE has grown in popularity as an intervention for patients with chronic pain [14]. PNE uses neurophysiological information to teach people that pain can be overprotective and completely real, even in the absence of tissue injury [14]. PNE can improve patients’ knowledge and attitudes towards pain [15–22]. It can also improve pain knowledge in clinicians [15], which suggests that it may be useful for students. PNE’s potential for student education is seen further as it addresses at least some of the learning objectives of the IASP curriculum. A recent US study [23] found that doctoral physical therapy students’ knowledge of pain was improved by PNE. However, as this study was uncontrolled, the improvement cannot be attributed to PNE alone. The aim of this randomised controlled trial (RCT) was to investigate the effect of PNE compared with a control education on students’: (1) knowledge of chronic pain; (2) attitudes towards patients with chronic pain; and (3) clinical recommendations for patients with chronic pain.

Methods

Design

This was a multicentre single-blind RCT of physiotherapy students’ knowledge, attitudes and behaviours towards patients with chronic pain. Students received either PNE or a control education. Three outcome measures were analysed before and after both education interventions: (1) the revised Pain Neurophysiology Quiz [24]; (2) the Health Care Pain Attitudes and Impairment Relationship Scale (HC-PAIRS) [25]; and (3) a case vignette to measure clinical behaviour indirectly [26,27]. There were no protocol violations. This trial has been reported in accordance with the CONSORT guidelines [28].
Participants

Students were eligible to participate if they were undergraduate physiotherapists enrolled at either Teesside University, UK or the University of Limerick, Ireland. Individuals were excluded if they had previously received in-depth teaching on pain neurophysiology or red flags. At Teesside University, individuals in Years 2 and 3 were excluded as they receive an in-depth session on PNE as part of their usual education. Therefore, only Year 1 students were eligible for this study. For the same reason, only students in Years 1 and 2 were eligible for inclusion at the University of Limerick. Participants were recruited via all-student e-mail invitations. All participants provided written informed consent. This study received ethical approval from the research and ethics boards at both universities, and was conducted in accordance with the Declaration of Helsinki. Data collection occurred between October 2014 and February 2015. An a-priori sample size calculation was not undertaken.

Interventions

Both the PNE and control education sessions were delivered by XX at Teesside University and XX at the University of Limerick. Both have been qualified physiotherapists for ≥5 years, with experience of teaching pain neurophysiology at university level. Both have received training on PNE from Neuro Orthopaedic Institute educational courses. Both education sessions were 70 minutes in duration and delivered in a didactic group-lecture style. The same PowerPoint slides (Microsoft Corp., Redmond, WA, USA) were used at both universities. Each education session had a brief case study towards the end of the lecture. The opportunity was given to ask questions, but group discussion was minimal due to time constraints.

The control group received an education session on red flags. Red flags are questions used in clinical practice to screen patients for serious or sinister pathology [29]. The control
session discussed Waddell’s triage for classifying patients with back pain into one of three categories: serious or sinister pathology; nerve root compression; or non-specific low back pain [30]. Serious and sinister physical spinal pathology were then discussed in detail. Psychosocial issues were not discussed beyond the importance of not unduly worrying the patient when discussing red flags. The red flags session did not discuss pain neurophysiology; instead, it dealt exclusively with tissue pathology and the detection of this pathology. The control education focused on red flags because it provided an attention control whereby students were engaged in learning about a topic, which in this case had clear face validity for pain education, but was clearly different from the content of the intervention.

The intervention group received a PNE session. The material was based on the first four chapters of the Explain Pain manual [31]. Free-hand drawings, stories and metaphors were used to convey messages about pain physiology and theory. The session explained that the nervous system can become overprotective, and that nociceptive transmission can be influenced by the sensitivity of the central nervous system as well as an individual’s thoughts, beliefs and contextual environment.

Outcomes

Immediately before and after the education session, participants completed three questionnaires: the revised Pain Neurophysiology Quiz; the HC-PAIRS; and a case study vignette. Participants were also asked to identify their age, sex and year of study. A written quiz related to knowledge of red flags was also given to all participants before and after the education sessions. This has not been validated and was not used as an outcome measure, but rather to facilitate participant blinding by ensuring that there were questions relevant to the education session delivered for both groups. Details of the red flag quiz are presented in Appendix A (see online supplementary material).
Revised Pain Neurophysiology Quiz

The revised Pain Neurophysiology Quiz was used to assess students’ knowledge of pain neurophysiology. Each item has a true, false or undecided response. Correct responses were awarded 1 point, and incorrect (or undecided) responses were awarded 0 points. Thus, scores can range from 0 to 13, with higher scores indicating greater pain neurophysiology knowledge. The Pain Neurophysiology Quiz is a valid and reliable tool for assessing pain physiology knowledge [15,24].

The modified 13-item Health Care Pain Attitudes and Impairment Relationship Scale

The HC-PAIRS [25] was used to assess students’ attitudes towards patients with chronic pain and their ability to function despite pain. Each item has a seven-point Likert scale response ranging from strongly disagree (scored as 1) to strongly agree (scored as 7). Thus, scores can range from 13 to 91, with lower scores indicating more positive attitudes towards chronic pain patients. Items 1, 6 and 12 were reverse scored as recommended. The HC-PAIRS is a valid and reliable measure of attitudes towards patients with chronic pain [25].

Case study vignette

A case study vignette was given to each patient before and after the education to assess their clinical behaviour with a chronic pain patient. The vignettes were adapted from previously published vignettes [26,27]. The participants were asked to indicate, via four multiple-choice questions (adapted from [26]), their recommendations about usual daily activities, work, exercise and bed rest. The number and percentage of appropriate recommendations (i.e. in line with clinical guidelines [32]) were recorded. The vignette questions and classification of responses are shown in Table 1. Participants were directed to answer specifically about the vignette, rather than about patients in general. Vignettes have been used previously to assess
the effect of clinicians’ attitudes on their management of patients with low back pain [33], and
are seen as a more accurate and valid measure of clinical behaviour than data extracted from
case notes [34].

Blinding and randomisation
Upon volunteering, participants were randomised into either the PNE or control group using
the random number generator function in Excel (Microsoft Corp, Redmond, WA, USA).
Randomisation was completed in a concealed manner prior to meeting the participants.
Participants were informed that the purpose of the study was to compare two different types of
education for chronic pain; as such, they were blind to PNE being the education of primary
interest. The statistical analysis was not undertaken blindly.

Statistical analysis
Descriptive statistics, pooled for both sites, were presented for all outcome measures before
and after the intervention. Having established appropriate normal distribution of data,
continuous data were presented as mean (standard deviation) and categorical data were
presented as percentages. Between-group comparisons for the change in these measures,
controlling for baseline values, were performed using analysis of covariance.

With respect to the vignette, contingency tables were constructed for each of the
recommendations, using the appropriateness of the recommendations as the dependent variable
and educational group as the independent variable. The Mantel-Haenszel test was used to
quantify the odds ratio and 95% confidence interval. Between-group comparisons were made
for the pre-education scores to assess baseline clinical recommendations, and for the post-
education scores to assess clinical recommendations after receiving the respective education.
All analyses were by original assigned groups.
Results

Eighty students (80/106, 75%) volunteered (n=31 at Teesside University and n=49 at the University of Limerick) and were randomised. Prior to study commencement, four participants dropped out from each group. Reasons for drop-out included illness, work commitments and family commitments. The characteristics of the 72 study completers are presented in Table 2. The groups were similar at baseline.

The PNE group had a greater increase in pain knowledge as measured by the revised Pain Neurophysiology Quiz compared with the control (red flag) group (Table 3). The PNE group also demonstrated a greater postintervention shift in positive attitudes towards patients with chronic pain, as indicated by the reduction in HC-PAIRS scores (Table 3). Finally, the PNE group were more likely to provide appropriate recommendations regarding daily activities, exercise, work and bed rest that were in line with clinical guidelines for patients with chronic pain following education, as measured by the case study vignette (Table 4). The non-validated Red Flags Quiz was used to ensure adequacy of blinding, rather than as an outcome measure. For complete reporting, the before and after Red Flags Quiz scores have also been reported in Table 3, showing greater improvement in the control group compared with the PNE group. There were no adverse effects reported by any participants.

Discussion

This study found that a single 70-minute PNE session can increase physiotherapy students’ knowledge of pain neurophysiology, improve students’ attitudes towards patients with chronic pain, and shift students’ recommendations for pain management to be more in line with clinical guidelines, compared with a control education session.

In this study, pain neurophysiology knowledge improved in the PNE group by 34% (from 45% to 79%). This is comparable to the 32% change (from 29% to 61%) observed in patients and 23% change (from 55% to 78%) observed in HCPs in a study by Moseley [15],
and the 43% change (from 41% to 84%) observed in first-year US doctoral physical therapy students under uncontrolled conditions [23]. The current findings demonstrate that UK and Irish undergraduates are able to learn the complex information provided within PNE to a similar level as fully qualified HCPs.

This study found an 18-point improvement in the HC-PAIRS score following PNE. Previous studies investigating other educational formats have reported a nine-point improvement between first- and final-year students’ HC-PAIRS scores on UK physiotherapy [35] and medical degree programmes [36]. Latimer et al. [37] reported an eight-point improvement following a 14.5-hour programme over 4 weeks. While comparison between studies is difficult as the exact volume and content of education within the different studies is not provided, the magnitude of change with the brief input in this study (70 minutes of PNE) is double that previously reported with much longer educational interventions for healthcare students. Interestingly, the present findings contrast with a recent US uncontrolled study which found that HC-PAIRS scores were unchanged (<1 point) following PNE [23]. Reasons for this are unclear and may be linked with methodological differences (e.g. samples and settings).

Following the education sessions, compared with the control group, the PNE group were more likely to make clinical recommendations in line with clinical guidelines. There was a clear and consistent improvement in recommendations across all four domains in the PNE group, while the control group remained similar to their baseline recommendations. Following PNE, appropriate recommendations for daily activities, work and bedrest were 94%, 94% and 69%, respectively. This can be compared with data from a UK nationwide survey of qualified physiotherapists and general practitioners, where appropriate recommendations for daily activities, work and bedrest were 72%, 93% and 99%, respectively [26]. This comparison indicates that clinical behaviour can be shifted in line with that of qualified HCPs following a single session of PNE.
An exploratory analysis found a significant negative correlation between change in revised Pain Neurophysiology Quiz scores and HC-PAIRS scores \((r=-0.48, P<0.001)\). This suggested an association between improved pain neurophysiology knowledge and positive attitudes to patients. Also, there were significant correlations between the post-education Pain Neurophysiology Quiz scores and each of the post-education vignette scales of activity, bedrest, exercise and return to work \((r=0.25 \text{ to } 0.42, P<0.031)\). This suggests that those with more neurophysiological knowledge were more likely to make recommendations in line with current guidelines. Interestingly, for the Red Flags Quiz scores, the associations with HC-PAIRS scores and the vignette scales were in the opposite direction \((\text{HC-PAIRS}: r=0.52, P<0.001; \text{vignette scales}: r=-0.09 \text{ to } -0.27, P=0.024 \text{ to } 0.441)\). As the Red Flags Quiz has not undergone validity testing, it is not advisable to make any significant interpretation on this observation, beyond the possibility that the medical focus in the red flags education delivered in isolation may have influenced a cautious approach to back pain management.

**Clinical implications**

These findings support the use of PNE for student physiotherapists. Furthermore, 70 minutes of PNE resulted in a large (relative to other educational interventions) positive change in attitudes towards patients, which have previously taken considerably longer periods to achieve [35–37]. This strengthens the case for the potential inclusion of PNE as a feasible and cost-effective education for a time-limited curriculum. The apparent enhancement of pain education via PNE within the undergraduate curriculum could have far-reaching implications for patients with chronic pain, potentially increasing the likelihood that they will receive evidence-based pain management.
Strengths and limitations

One limitation of this work is the lack of a follow-up period to assess retention of knowledge, attitudes and behaviour change. Further work needs to investigate if these improvements are sustained and/or if top-up sessions are required. Another limitation is that direct clinical behaviour was not investigated. While vignettes are a good proxy measure of clinical behaviour [34], they are not without limitations [38]. Changing the beliefs of clinicians via a pain-based educational programme does not necessarily result in different clinical behaviour or patient outcome [39,40]. It would have been interesting to follow the participants into clinical practice to investigate if PNE had any effect on actual clinical behaviour and/or clinical outcomes.

A key methodological limitation was that the educators were not blinded. This could have been overcome by employing two independent educators blinded to the study aims to deliver the educational sessions independently. However, the authors did not have the resources to implement this. Additionally, a blind statistical analysis would have been more methodologically robust. As stated above, caution is advised in interpreting the results of the Red Flags Quiz. It was designed and used as a facilitator of blinding, and has not been subjected to any validity or reliability testing. That said, the Red Flags Quiz scores did increase following the control education and did not change in the PNE group, implying a degree of validity. Formal validity testing would be useful future work. Finally, although identical slides were used at both universities, there was no set script. Thus, there may have been minor differences during the education sessions between sites. To investigate this, test sites were compared to identify if findings were consistent between universities. No statistical differences were found between sites, with the exception of change in the HC-PAIRS score in the control groups [mean -4.8 (SD 8.7) vs 2.2 (SD 7.2); \( P=0.02 \)] and change in the revised Pain Neurophysiology Quiz in the intervention groups [mean 5.6 (SD 1.5) vs 4.0 (SD 2.2); \( P=0.04 \)]. However, the magnitude of the differences between sites are smaller than the differences between groups,
and the pattern of the PNE intervention group producing superior results in all outcomes was consistent across sites.

This study was restricted to a relatively small sample of physiotherapy students, early in their studies, in the UK and Ireland. Thus, the findings may not generalise to students in the later years of their programme or other professions or other countries. There is a particular need to repeat this study with students from other professional groups given the importance of multidisciplinary management of chronic pain. In addition, more longitudinal work is warranted to identify if these changes can be identified from the first to the final year of an undergraduate programme, and if any changes observed translate into clinical practice.

Conclusions

This single-blind RCT found that a single 70-minute PNE session can, in the short-term, increase physiotherapy students’ knowledge of pain neurophysiology, improve their attitudes towards patients with chronic pain, and increase the likelihood that they will make recommendations in line with clinical guidelines. The current findings suggest that PNE would be a useful component of the standard undergraduate curriculum, although further studies are required to confirm this. There is a need to investigate if these findings can be replicated in other healthcare professions, and how well these reported changes reflect changes in actual clinical behaviour and outcomes.

Ethical approval: This study received ethical approval from the research and ethics boards at Teesside University and the University of Limerick.

Conflict of interest: None declared.
References


Table 2
Baseline participant characteristics

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PNE</td>
</tr>
<tr>
<td>Age (years)</td>
<td>20 (2)</td>
</tr>
<tr>
<td>Sex</td>
<td>20♂ 16♀</td>
</tr>
<tr>
<td>Year of study (Year 1/Year 2)</td>
<td>25/11</td>
</tr>
<tr>
<td>Pain Neurophysiology Quiz (0 to 13)</td>
<td>5.8 (2.0)</td>
</tr>
<tr>
<td>Red Flags Quiz (0 to 10)</td>
<td>6.3 (1.5)</td>
</tr>
<tr>
<td>HC-PAIRS (13 to 91)</td>
<td>57.9 (6.1)</td>
</tr>
<tr>
<td>Appropriate clinical recommendations</td>
<td></td>
</tr>
<tr>
<td>Daily activities (n, %)</td>
<td>26 (72)</td>
</tr>
<tr>
<td>Exercise (n, %)</td>
<td>24 (67)</td>
</tr>
<tr>
<td>Work (n, %)</td>
<td>19 (53)</td>
</tr>
<tr>
<td>Bed rest (n, %)</td>
<td>10 (26)</td>
</tr>
</tbody>
</table>

HC-PAIRS, Health Care Pain Attitudes and Impairment Relationship Scale; PNE, pain neurophysiology education.
Data are presented as mean (standard deviation) except for sex and appropriate clinical recommendations. The data with respect to appropriate clinical recommendations indicate the number of participants who made appropriate recommendations in line with clinical guidelines regarding daily activities, exercise, work and bed rest.

Table 3
Change in knowledge and attitudes between groups

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>Mean difference (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PNE</td>
<td>Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td></td>
</tr>
<tr>
<td>Pain Neurophysiology Quiz (0 to 13)</td>
<td>4.4 (2.1)</td>
<td>0.1 (1.9)</td>
<td>4.0 (3.2 to 4.7)</td>
</tr>
<tr>
<td>HC-PAIRS (13 to 91)</td>
<td>-18.6 (11.9)</td>
<td>0.3 (8.4)</td>
<td>-17.5 (-22.1 to -12.9)</td>
</tr>
<tr>
<td>Red Flags Quiz (0 to 10)</td>
<td>-0.8 (2.2)</td>
<td>1.2 (1.4)</td>
<td>2.2 (1.5 to 2.9)</td>
</tr>
</tbody>
</table>

HC-PAIRS, Health Care Pain Attitudes and Impairment Relationship Scale; PNE, pain neurophysiology education; CI, confidence interval; SD, standard deviation.
The change in pain knowledge and attitudes from before to after the education sessions. The mean difference is the estimated mean difference from the analysis of covariance adjusted for baseline values.
<table>
<thead>
<tr>
<th>Appropriate recommendations, n (%)</th>
<th>PNE</th>
<th>Control</th>
<th>OR (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily activities</td>
<td>34 (94%)</td>
<td>24 (67%)</td>
<td>8.5 (1.7 to 41.5)</td>
<td>0.01</td>
</tr>
<tr>
<td>Exercise</td>
<td>33 (92%)</td>
<td>20 (56%)</td>
<td>8.8 (2.3 to 34.0)</td>
<td>0.01</td>
</tr>
<tr>
<td>Work</td>
<td>34 (94%)</td>
<td>20 (56%)</td>
<td>13.6 (2.8 to 65.4)</td>
<td>0.01</td>
</tr>
<tr>
<td>Bed rest</td>
<td>25 (69%)</td>
<td>12 (33%)</td>
<td>4.5 (1.7 to 12.3)</td>
<td>0.01</td>
</tr>
</tbody>
</table>

OR, odds ratio; CI, confidence interval; PNE, pain neurophysiology education.