

A RANDOMIZED CONTROLLED TRIAL OF DIFFERENT SINGLE PAIN EDUCATION SESSIONS IN MIDDLE SCHOOL STUDENTS: IMMEDIATE EFFECTS.

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Abstract

Objectives: To compare if a single session of pain neuroscience education (PNE) delivered to middle school students result in improved outcomes for pain knowledge, beliefs regarding pain and fear of physical activity, compared to traditional education (TE) focusing on biomedical information.

Design: Multi-school randomized controlled trial.

Setting: 16 private and public educational 7th grade classrooms.

Participants: Four hundred and nineteen 7th grade students (average age 12.3 years, equivalent to Year 8 UK and S1 Scotland) received PNE (8 schools; 221 students) or TE (8 schools; 198 students),

Intervention: PNE or TE was delivered in a 30-minute verbal in person lecture by a physical or occupational therapist.

Main Outcome Measure: Prior to and immediately following the lectures, students completed a knowledge of pain questionnaire (Neurophysiology of Pain Questionnaire – NPQ), fear of physical activity (Fear-Avoidance Beliefs Questionnaire Physical Activity subscale – FABQ-PA) and beliefs regarding pain questionnaire.

Results: In comparison to TE, post-education PNE resulted in a significant increase in knowledge of pain ($p < 0.001$; $r = 0.46$), decreased fear of physical activity ($p < 0.001$; $r = 0.30$) and improved various beliefs regarding pain ($p < 0.001$). In terms of high FABQ-PA ratings, the PNE group's number of students with a high FABQ-PA score dropped by 5.49% (96 before; 91 after) after the intervention, while the TE group's increased from 94 students to 117 students (an increase of 24.46%). In terms of changing beliefs surrounding pain, a large effect in improvement post education favoring the PNE group was seen for students' understanding: "Your brain decides if you will feel pain."

Conclusion: A PNE lecture to middle school students, compared to TE focusing on biomedical education results in significant immediate differences in regards to pain knowledge, fear of physical activity in the presence of pain and various beliefs regarding pain.

Contribution of the Paper

- An educational session directed at the neuroscience of pain and injury had an effect on the participants beliefs and fears regarding pain compared to a traditional educational session directed at injury.

- Providing adolescents neuroscience information about pain and injury may be a strategy to improve health literacy around pain and reduce chronic pain.

Keywords: Pain neuroscience education, pain knowledge, fear, students

INTRODUCTION

Pain is a normal human experience and the inability to experience pain poses a significant threat to survival⁽¹⁾. If pain is normal, then it is argued that interventions aimed at “preventing pain” are not only futile, but biologically incongruent⁽²⁾. In contrast, chronic pain and disability can potentially be prevented and attempts to do so are warranted^(3,4).

In recent years, a lot of attention has been placed on the various issues that drive acute and sub-acute pain experiences into chronic phases, which constitute the bulk of healthcare expenditures in the United States and other countries^(4,5). Research has shown that the presence of factors such as fear-avoidance and pain catastrophization often drive patients towards chronic pain^(4,6). The updated fear-avoidance model postulates that following a pain experience, when patients encounter a priority to pain control, a negative affect and harm representation of their situation ensues (higher level of pain catastrophization)⁽⁷⁾. With high threat appraisal, fear ensues, which in turn leads to avoidance, interference and ultimately increased negative affect and more pain, thus a vicious cycle. One documented factor that fuels this vicious cycle is the use of biomedical educational models to explain pain to patients⁽⁸⁾. In the biomedical model, the health of a person’s tissues is tied solely to their pain experience⁽⁸⁾. Furthermore, this model focuses on various descriptive labels of tissue pathologies (i.e., bulging discs, torn ligaments, etc.), which is not only unhelpful to patients, but actually increases fear and fear-avoidance and ultimately more pain^(7,9).

The fear-avoidance model and increased awareness of the various factors driving people towards chronicity and disability has highlighted educational strategies to mediate risk factors such as fear-avoidance and pain catastrophization. In physical therapy, one area to help with reduction of these factors is the use of pain neuroscience education (PNE)^(10,11). PNE is an educational strategy that focuses on teaching people more about the neurobiological and neurophysiological processes involved in their pain experience^(12,13). Current best evidence regarding musculoskeletal pain provides strong support for PNE to positively influence patient’s pain ratings, dysfunction, fear-avoidance, and pain catastrophization, limitations in movement, pain knowledge and healthcare utilization⁽¹³⁾. PNE specifically has shown to positively impact pain catastrophization positively influences affect, optimism and

goals, which has been associated with a positive recovery⁽¹³⁾. Most of this past research has looked at patients with chronic pain and not into possible prevention of progression into chronic pain.

Based on the Fear Avoidance model,^(3,7) these shifts toward reduced fear and catastrophization and moving a patient toward confrontation and recovery, as seen in previous PNE research, may be due to PNE reconceptualizing the pain experience. An often overlooked strategy is the application of an intervention, i.e., education, prior to the pain experience⁽¹⁴⁾. Can preemptive education help prime individuals to be directed toward the recovery side of the fear avoidance model when they do experience pain⁽¹⁴⁾? PNE has been explored as a preoperative education intervention for lumbar surgery and knee replacements, showing significant positive shifts in healthcare utilization and surgical experiences, compared to the biomedical model^(15,16). In addition, there has been recent research looking into possible prevention for patient with acute low back patients progressing into a chronic pain state. Traeger, et al.,⁽¹⁷⁾ did not find that the use of PNE reduced progression into chronic pain states with the use of PNE over basic active listening approach. These studies, albeit prior to a surgical pain experience or with an acute pain state, were not truly preemptive studies, since the patients already experienced levels of pain and disability prior to surgery or after injury^(15,16).

Recently, however, a true preemptive study was published where researchers provided PNE to middle school students teaching them the neurobiology and neurophysiology of pain⁽¹⁴⁾. The study showed that middle school students can increase their pain knowledge after the PNE lecture similar to results found in patient populations^(12,18,19) and healthcare providers⁽²⁰⁾. Additionally, this study also showed a shift in beliefs related to pain: most notably, students post-PNE believed they could control the amount of pain they experienced. The original middle school study, however, did not show if the PNE was superior to current biomedical curriculums taught in middle school.

The purpose of this study was to replicate the use of a PNE curriculum in groups of middle school students and compare them to a matched group of middle school students receiving a current biomedical educational curriculum. Comparisons were made in terms of immediate differences in pain knowledge, fear of physical activity, and beliefs about pain between the groups. Secondary aim is to see if initial changes in knowledge and pain beliefs after PNE with middle school students can be replicated with a larger and more diverse sample size.

METHOD

Participants and Recruitment

The individuals that provided the education were similar to previous PNE studies that recruited clinicians to deliver PNE^(15, 21). They had to have professional qualifications of a licensed Occupational Therapist or Physical Therapist, scored $\geq 90\%$ on the revised Neurophysiology of Pain Questionnaire, and be trained through an on-line program from investigators to become familiarized with the content⁽¹⁵⁾. Investigators from a private seminar group specializing in the postgraduate delivery of PNE were asked to identify qualified and willing clinicians to participate as lecturers in the study. Clinicians who responded identified willing participant schools and obtained written consent from the middle schools involved. Based on the previous middle school PNE study, biology curriculums, student availability and children's ability to take on more complex concepts from 6th grade onward,⁽²²⁾ the study recruited 7th graders (equivalent to Year 8 UK and S1 Scotland) in public and private schools in multiple states (South Dakota, Minnesota, Wisconsin, Kentucky, Virginia, and Missouri) across the United States (US). Eight clinicians met the criteria for delivering the PNE, and obtained consent from the schools. Internal Review Board (IRB) approval was obtained for the University of South Dakota. Each school was provided with the goals of the study, layout, IRB documentation and necessary examples of the proposed lecture and outcome measures. Since each school had a different approval process (private, public, different states, etc.), it was left up to each school to determine its own internal procedure for approval, varying between school board approvals, superintendent approvals and individualized parental consent. All students in the studies had the option to opt out of the study. No personal identifiable data was collected. Upon consent, teachers were instructed and familiarized with the intended study and the one-time 45-minute session was slotted into class schedules to allow for 30-minute education and time for pre-post questionnaire data collection. Classes were randomly assigned per envelope system to either receive PNE or traditional education (TE). Some clinicians were only able to secure one class/location, while others delivered education at multiple sites. The exclusions set for the study were students not wanting to attend the class, parents objecting or students not proficient in writing and reading English.

Intervention

Pain Neuroscience Education

The content of PNE is well documented and in line with other studies^(18, 23, 24). An abbreviated 30-minute, 32-slide PowerPoint™ presentation was developed, allowing time for survey completion prior to and following the lecture. The PowerPoint™ presentation's main themes included a

discussion of peripheral sensitization, central sensitization, and biopsychosocial factors associated with pain, threat appraisal of the brain, nociception, stress and endocrine responses in pain as well as various therapeutic endogenous strategies to ease pain^(18, 23, 24). Various images, metaphors and examples were used to convey the PNE to the students⁽²⁵⁾. Following the presentation and completion of the post-PNE surveys, students were encouraged to ask questions. The presentation did not specifically address or target any questions contained in the outcome measures.

Traditional Education

For the TE curriculum, the researchers reached out to middle schools, did online searches and consulted middle school textbooks pertaining to current curriculums being taught pertaining to biology, pain and injuries. The content of the various searches were merged, removing duplicates and packaged into a similar visual format as the PNE presentation. The TE contained descriptions of acute and chronic pain, chronic injuries, acute injuries, soft (muscle, tendon) injuries and hard injuries (bones, fractures), cuts, sprains and strains, fractures, concussions as well as dehydration and hypothermia. In essence, the TE constituted a biomedical sports medicine presentation. The TE presentation was 34 color slides, with images from the current curriculums that lasted 30 minutes with time at the conclusion of the education session for questions that students might have from the presentation. (*See Figure 1 on page 16*)

Outcome Measures

First, students completed a demographic section capturing their age, gender, grade and participation in sports. Additionally, the demographic survey also enquired about various personal aspects pertaining to pain including: currently experiencing pain, pain rating on a 0-10 scale (Numeric Rating Scale, [NRS])(26), past experiences about pain and family experiencing persistent pain. No personally identifiable information was captured and pages were numerically coded to allow matching pre- and post-education surveys. Three outcome measures were used for the student to examine their knowledge of pain, fear of physical activity in the presence and attitudes and beliefs about pain:

- **Pain Knowledge:** Pain knowledge was measured using the neurophysiology of pain questionnaire (NPQ). The NPQ is based on a current pain science text⁽²⁷⁾ and was used in a previous study measuring the neurophysiology knowledge of patients and healthcare providers⁽¹⁸⁾. Following the development of the original 19-question NPQ, a statistical analysis led to the development of a revised NPQ (rNPQ) with 13 questions. The revised version removed ambiguous

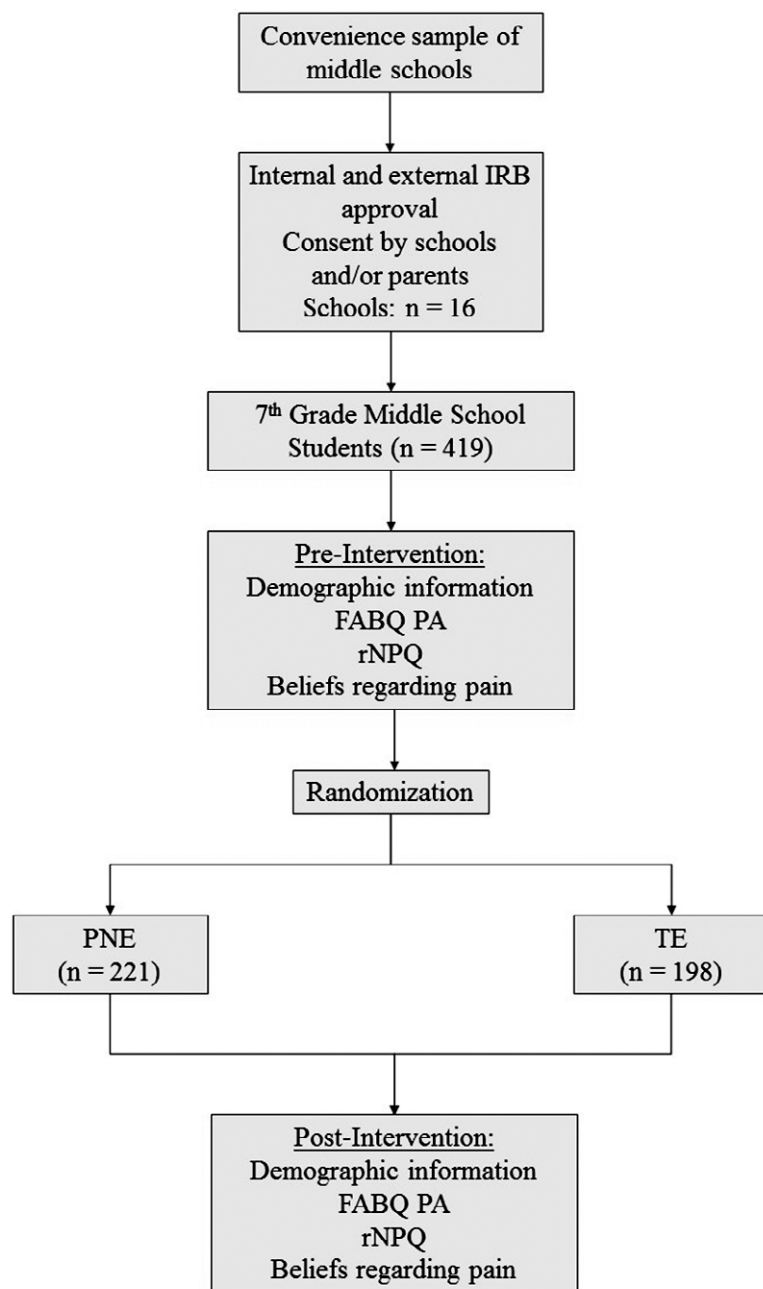


Figure 1: Study Layout

questions⁽²⁸⁾. The 13-question rNPQ was used in this study, but was adapted slightly, similarly to a previous study⁽¹⁴⁾ to make it easier for students to understand the question language. For example, “nociception” was replaced with “danger messages”⁽¹⁸⁾. The authors acknowledge that the 13-question rNPQ has since been replaced by a 12-question rNPQ⁽²⁸⁾. No information is currently available on what constitutes a meaningful shift in NPQ or rNPQ score. Published studies using the NPQ/rNPQ have shown positive changes for patients, healthcare providers and PT students^(12, 18-20, 29). The previous middle school PNE study resulted in NPQ scores improving from 29.5% to 60.8% (31.3% increase)⁽¹⁴⁾. The Flesch-Kincaid grade level index, which bases the reading level assessment on the average number of syllables per word and sentence length for the text was used to ensure the modified rNPQ was at or

near the student grade level⁽³⁰⁾. The reading level for the questions scored at a 7.0 level on the Flesch-Kincaid index demonstrating to be appropriate for 7th grade students.

- **Fear Avoidance of Physical Activity:** To assess the children’s fear of physical activity the physical activity sub-scale of the Fear-Avoidance Beliefs Questionnaire (FABQ) was used. The FABQ is a 16-item questionnaire that was designed to quantify fear and avoidance beliefs in individuals with low back pain. The FABQ has two subscales: 1) a 4-item scale to measure fear avoidance beliefs about physical activity and 2) a 7-item scale to measure fear-avoidance beliefs about work. Given that this study was administered to school students, only the FABQ-PA was used. Each item is scored from 0 to 6 with possible scores ranging between 0 and 24 for the physical activity subscale, with higher scores representing an increase in fear-avoidance beliefs. The FABQ has demonstrated acceptable levels of reliability and validity in previous studies^(6, 31). Presence of avoidance behavior is associated with increased risk of prolonged disability and work loss. It is proposed that FABQ-PA >14 is associated with a higher likelihood of not returning to work^(32, 33) and a high score >15/24 classified as a “high score”⁽³⁴⁾. Given that the FABQ was developed for people in pain, the wording was altered to reflect their agreement to physical activity in the event they were to experience pain, versus actually currently experiencing pain. Flesch-Kincaid reading grade level was 6.1.

- **Pain Beliefs:** Healthcare provider’s attitudes and beliefs regarding chronic low back pain are often measured with the Health Care Provider’s Pain and Impairment Relationship Scale (HC-PAIRS)⁽²¹⁾. This scale is not typically used for non-medically trained people, but was recently adapted for the PNE middle school study⁽¹⁴⁾. Upon review of the HC-PAIRS and the aims of the study, a series of numeric rating scale questions pertaining to beliefs about pain were established by the authors for this study. The numeric rating scale was anchored between 0 (strongly disagree) and 10 (strongly agree). Five questions were generated by the research team based on the HC-PAIRS language to measure pain beliefs prior to and following the PNE session in the allotted time. The questions had a Flesch-Kincaid grade level of 2.0:

- **Pain is normal; without being able to feel pain you will not survive**
- **Pain means something is wrong with your tissues**

- *Pain always means you have to stop what you are doing*
- *You can control how much pain you feel*
- *Your brain decides if you feel pain, not your tissues*

The rNPQ, FABQ-PA and the pain beliefs numeric scale were administered before and after the PNE and TE lectures. Upon completion of the surveys, the surveys were placed into envelopes, sealed and sent to an independent research assistant who entered the data into Microsoft Excel™ (2016) for analysis.

Statistical Analysis

All statistics were performed utilizing IBM SPSS Statistics version 24 (SPSS, Chicago, IL, USA). Data were analyzed for outliers and missing data points prior to initiation of statistical analysis. Descriptive statistics were calculated for means, standard deviation and frequencies of the sample participants. To measure differences between the dependent variables of the two groups at the pre and post test points a Kruskal-Wallis test was used. Effect size was calculated utilizing the Jonckheere-Terpstra test values to calculate the r utilizing standardized test statistic divided by the square root of the observations ($r =$

$z/\sqrt{N1+N2}$). Magnitude of effect size are valued as small (0.1) medium (0.3), and large (0.5)(35). Within group analysis of changes of scores from pre to post education for both groups was assessed with Wilcoxon signed-rank test. Significance was set at $p < .05$ for all tests.

RESULTS

Middle School Students

During the school year of 2017-18 7th grade students were provided with a PNE program or TE program. The PNE program occurred at 8 schools for 221 students and the TE program occurred at 8 schools with 198 students with the average class size being 34 students/class (range 15-70) (Figure 1). Table 1 provides demographic information of the students in each group. The only statistical difference between groups was the PNE group had more individuals currently experiencing pain and higher pre education pain levels than the TE group, $H(417) = 2.34, p = .02$ and $H(417) = 3.18, p = .002$ respectively. A difference in pain reports with the NPRS between groups was not found at post testing.

Table 1 Participant Demographics

	Pain Neuroscience Education (n=221)	Traditional Education (n=198)
Age, mean (SD), years	12.3 (.48)	12.3 (.48)
Female, n (%)	106 (48.0)	96 (48.5)
Currently experiencing pain pre-test, n (% yes)	84 (38.0)	54 (27.3)
Pre-test NRS, mean (SD)	1.5(2.3)	0.8 (1.7)
Pre-test NRS of those experiencing pain, mean (SD)	3.8 (2.1)	3.1 (1.9)
Post-test NRS, mean (SD)	1.6 (2.3)	1.2 (2.2)
Know someone with chronic pain, n (%yes)	150 (67.9)	146 (73.7)
Length of current pain, n (%)		
1 week	102 (46.2)	107 (54.0)
1 month	40 (18.1)	41 (20.7)
Greater than 3 months	39 (17.6)	17 (8.6)
SD=standard deviation, NRS=numeric rating scale		

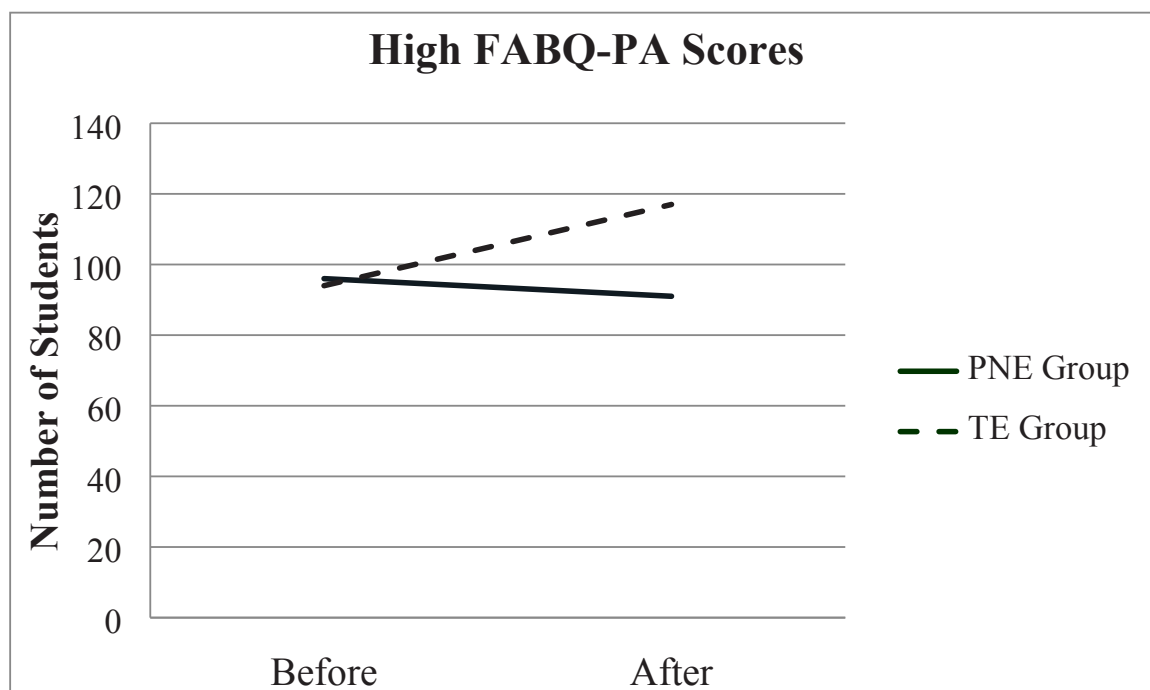
Table 2

Differences between the Pain Neuroscience Education Group and the Traditional Education Group at Pre and Post Education Time Periods

	PNE Group Mean (SD)	TE Group Mean (SD)	PNE vs. TE Mean Difference	p-value	Effect size (r)
FABQ					
Pre-education	13.7 (5.2)	14.3 (4.9)	-0.6	0.397	
Post-education	13.6 (5.7)	16.9 (4.3)	-3.3	<0.001	0.30
NPQ					
Pre-education	3.3 (2.2)	3.2 (2.2)	0.1	0.863	
Post-education	6.4 (2.1)	4.2 (2.1)	2.2	<0.001	0.46
Beliefs Q1					
Pre-education	4.8 (3.2)	5.4 (3.4)	-0.6	0.107	
Post-education	5.8 (3.7)	5.3 (3.5)	0.5	0.333	0.05
Beliefs Q2					
Pre-education	4.7 (2.7)	4.0 (2.6)	0.7	0.009	
Post-education	4.9 (3.2)	5.6 (2.9)	-0.7	0.051	0.10
Beliefs Q3					
Pre-education	2.7 (2.8)	2.8 (2.9)	-0.1	0.839	
Post-education	2.8 (3.0)	3.9 (3.0)	-1.1	<0.001	0.19
Beliefs Q4					
Pre-education	3.2 (3.3)	3.1 (3.2)	0.1	0.665	
Post-education	4.9 (3.7)	3.3 (3.3)	1.6	<0.001	0.21
Beliefs Q5					
Pre-education	4.4 (3.2)	5.0 (3.1)	-0.6	0.057	
Post-education	7.7 (3.2)	4.4 (3.4)	3.3	<0.001	0.48

PNE=Pain Neuroscience Education, TE=Traditional Education, SD=Standard Deviation, FABQ=Fear Avoidance Belief Questionnaire, NPQ=Neurophysiology of Pain Questionnaire, Beliefs Q1=pain is normal, Beliefs Q2=Pain means something is wrong, Beliefs Q3=Pain always means you have to stop what you're doing, Beliefs Q4=You can control how much pain you feel, Beliefs Q5=Your brain decides if you feel pain

Fig. 2. Comparison of students scoring "high" on the FABQ-PA sub-scale before and after PNE and TE.



Post-Education differences

Details of changes in the outcomes variables post testing between the PNE group and TE group are found in Table 2. There was a large effect on increased pain knowledge as measured with the rNPQ for the PNE group immediately post education that did not occur with the TE group. In regard to pain beliefs questions, there was no significant differences between the groups with question 1 (“Pain is normal.”). For question 2 (“Pain means something is wrong.”) the PNE group started out significantly higher than the TE group, but this difference was not found post education. There were a few small effects found post education with question 3 (“Pain always means you have to stop what you’re doing.”) and question 4 (“You can control how much pain you feel.”). The PNE group scored higher on question 4, while the TE group scored higher on question 3 post education. Beliefs question 5 (“Your brain decides if you feel pain.”) showed a large effect in improvement post education with the PNE group scoring significantly higher than the TE group. With FABQ-PA there was a medium effect size in with increased scores post education for the TE group that was not found in the PNE group. In terms of cut-off/high FABQ-PA ratings, the PNE group’s number of students with a

high FABQ-PA score dropped by 5.49% (96 before; 91 after) after the intervention, while the TE group increased from 94 students to 117 students (an increase of 24.46%) (Figure 2).

Assessment within Group Changes

The assessment of within group changes for both the PNE and TE groups over time from pre to post education are detailed in Table 3. The TE showed a moderately increased score in their FABQ-PA from pre to post testing that was not found in the PNE group. Pain knowledge showed significant increase for both groups from pre to post testing, but the PNE group showed a larger effect size compared to the TE group. The PNE group education had a small effect on their responses to beliefs question 1 and 4 following the educational training session, and the TE group had no change to these two questions. In questions 2 and 3 the TE group showed a moderate effect on increased score response to more strongly agreeing to those questions post education and no change in the PNE group. Beliefs question 5 had significant changes for both PNE and TE group, but the PNE group had the larger effect size post education for this question.

Table 3
Pre to Post Education differences for Pain Neuroscience Education and Traditional Education Groups

		T _{JT}	p-value	Effect size (r)
FABQ	PNE	9561.0	0.550	0.03
	TE	13147.0	<0.001	0.36
NPQ	PNE	19997.5	<0.001	0.53
	TE	102656.0	<0.001	0.33
Beliefs Q1	PNE	8812.5	<0.001	0.21
	TE	3065.0	0.970	0.00
Beliefs Q2	PNE	7166.5	0.508	0.03
	TE	8687.5	<0.001	0.30
Beliefs Q3	PNE	4867.0	0.997	0.00
	TE	6204.0	<0.001	0.26
Beliefs Q4	PNE	9082.0	<0.001	0.24
	TE	3488.5	0.549	0.03
Beliefs Q5	PNE	15320.0	<0.001	0.47
	TE	3381.0	0.021	0.12

PNE=Pain Neuroscience Education, TE=Traditional Education, FABQ=Fear Avoidance Belief Questionnaire, NPQ=Neurophysiology of Pain Questionnaire, Beliefs Q1=pain is normal, Beliefs Q2=Pain means something is wrong, Beliefs Q3=Pain always means you have to stop what you’re doing, Beliefs Q4=You can control how much pain you feel, Beliefs Q5=Your brain decides if you feel pain

DISCUSSION

PNE for middle school students resulted in significant positive shifts in pain knowledge, various beliefs regarding pain and fear of physical activity in the presence of pain, compared to TE. These groups, though randomized, presented slightly different in relation to pain ratings and number of students experiencing pain prior to education. The PNE group had more students (38% compared to 27%) with pain and overall a higher pain rating score of 0.7 higher on the NRS for pain rating. Interestingly, the pain rating difference was not present during post testing between the groups. The immediate post-PNE results from this study concur with previous middle school study showcasing increased knowledge of pain, as well as some positive shifts in beliefs regarding pain⁽¹⁴⁾ This study, however, expands on the initial research by showing PNE to be superior to TE in regards to pain knowledge and various beliefs regarding pain. In three questions ([Q3] "*Pain always means you have to stop what you are doing*", [Q4] "*You can control how much pain you feel*" and [Q5] "*Your brain decides if you feel pain, not your tissues.*" the PNE group scored significantly better than the TE group. Question 3 showed that PNE was able to encourage kids to not necessarily stop activity and movement when experiencing pain, while the TE group, tying the health of tissue to pain, believed stopping activity would be the correct choice. Current pacing and graded exposure literature, along with fear-avoidance models, encourage people in pain to move and continue with activity, albeit less^(7, 36, 37). In this study, the PNE group responded positively and in keeping with evidence based practice this is underscored by the significant difference in the FABQ-PA scores after the two lectures. Question 4 pertains to self-efficacy and locus of control. Various practice guidelines and current best-evidence for pain, especially chronic pain, strongly recommend treatment approaches aimed at having patients take control of their pain, their treatment and recovery, shifting to more active treatments versus becoming dependent on healthcare providers via passive treatments⁽³⁸⁻⁴⁰⁾. The PNE group indicated that they had the ability (internal locus of control) to control and manage their pain, while the TE group did not, potentially reverting to an external locus of control ("fix me." mindset). It is well established that cognitions and beliefs regarding pain contribute to the development and maintenance of a pain experience^(1, 2, 18, 41) and the ability of PNE to produce healthier beliefs, especially towards movement, is a potential key finding in this study. If the goal of a school pain program is to foster healthy beliefs and ultimately behaviors regarding pain, this study shows PNE to be superior to current school curriculums.

The initial pain knowledge and beliefs of this cohort did show some difference compared to the initial study on middle

school children along with shifts after education were also different⁽¹⁴⁾. There was an improved average rNPQ score of 4.07 in the initial study, compared to the increase pain knowledge of 3.1 in this study with a smaller effect size noted in this current study. As stated previously, what constitutes a significant shift in pain knowledge is unknown. The difference could be due to the education being delivered by different providers at different geographical locations with the current study compared to a sole presenter at one geographic location in the initial study. The beliefs questions also showed different starting points and changes compared to the initial study. Further study is warranted to explore population differences at different geographical areas along with differences in outcomes based on different presenters.

Fear of physical activity in the presence of pain has been shown to be a powerful driver of a pain experience^(32, 34). A score > 14 on the FABQ-PA for patients with low back pain is a strong predictor of not going back to work, thus driving chronic pain and disability⁽³²⁾. Current low back pain implies that patients who present with acute and sub-acute low back pain present with varying levels of risk for progressing onto chronic pain^(3, 34, 42). New low back pain guidelines call for the screening of patients with acute and sub-acute low back pain into categories of low, medium and high risk for the development of persistent pain and disability^(24, 42). It is proposed that patients who score higher on a variety of psychometric tests including FABQ-PA constitute the high risk group⁽⁴³⁾. In this study, the PNE resulted in a significant difference in FABQ-PA compared to TE. Additionally, PNE lowered high-risk FABQ-PA scores, while the TE increased the scores in the high risk group, resulting in a post-education difference of 30%. The fact that PNE reduced FABQ-PA scores and relative risk is in line with current PNE research with patients with chronic pain⁽¹³⁾. The fact that TE increased high risk FABQ-PA is also not surprising. There is growing evidence that biomedical models, utilizing graphic anatomical and pathoanatomical images along with threatening and provocative language, are simply not helpful for people in pain, but may drive increased fear, fear-avoidance and chronic pain and disability^(8, 9, 44). The FABQ-PA and question 3 results would imply that PNE may indeed be a potential powerful driver in middle school students away from potential chronicity and disability if an injury and painful experience occurs^(3, 7).

The long-term effects of providing PNE pre-emptively prior to a medical encounter and becoming a patient with pain are unknown at this time. This study provides some initial plausibility that at minimum some components of fear may be reduced through the educational model change toward using PNE approach. Future research tracking the long-term effects of the PNE versus TE programs are recommended.

Specifically, do PNE-informed students behave differently in response to pain than those receiving TE?

Limitations

The study contains various limitations. First, the fact that this study only provides immediate post-intervention results tells us nothing about the long-term effects of the PNE and TE programs. So future study is needed to explore long-term effects. Even though the aim of this study was to deliver a preemptive educational model to pain-free people, approximately one in three kids were experiencing some level of pain at the time of the lecture, albeit low levels of pain (less than 3/10). There was no effort to remove those in pain or with history of painful experiences from the data analysis, so being completely preemptive was hindered to some degree. The authors acknowledge that past injury and pain experiences will shape current beliefs, thereby causing an inherent limitation to try to fully determine this information on every subject⁽⁴⁵⁾. The study called for patients fluent in English and applied in the US school system, so the results cannot be readily transferred to non-English speaking students and different cultures and school settings in other states or countries, until such programs are developed, tested and validated. While the curriculum for the specific one-time lecture of PNE or TE was controlled at each of the schools, researchers were unable to control for all of the curriculum the students had received prior to these individual classes which will inevitable have shaped their knowledge and beliefs. The various outcomes measurements have not all been validated and nor have they been validated for use with this student age group. Each of the measurements used were within appropriate reading levels for the population tested per the Flesch-Kincaid grade level and future study needs to be done to verify validity of the tests on different age groups. Thus, caution should be used comparing the raw scores of each to other age ranges.

CONCLUSION:

A PNE lecture to middle school students, compared to TE focusing on biomedical education result in significant immediate differences in regards to pain knowledge, fear of physical activity in the presence of pain and various beliefs regarding pain. If prevention of chronic pain and disability from chronic pain is indeed possible, implementing PNE during the formative years of society's attitudes and beliefs may warrant further exploration and implementation into the public education system.

Ethical Approval: University of South Dakota (protocol number 18-10)

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Conflict of Interest: Dr. Louw and Dr. Zimney have authored books on pain neuroscience education. The remaining authors have no conflicts to declare.

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