ORIGINAL

Pain Neuroscience Education for Elementary School Students in Belize: An Exploratory Study

Educación en neurociencia del dolor para estudiantes de primaria en Belice: un estudio exploratorio

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ABSTRACT

Introduction: Increasing school students' knowledge and beliefs regarding pain yield positive behavior changes including decreased medication use and school absenteeism, as well as increased participation in physical activity. **Objectives**: To determine if a brief, one-time pain neuroscience education (PNE) lecture developed in the United States (US) to school students in Belize can yield similar positive shifts in pain knowledge and beliefs. **Methods**: One hundred and fourteen Belize elementary school students attended a 30-minute PNE lecture. Prior to and immediately following the lecture measurements regarding pain knowledge and pain beliefs were completed. Pain knowledge was measured using the revised Neurophysiology of Pain Questionnaire (rNPQ) and pain beliefs were measured using the adapted Health Care Provider's Pain and Impairment Relationship Scale (HC-PAIRS). **Results**: Immediately following the lecture, overall pain knowledge improved significantly ($p < 0.001$) from 28.6% to 35.4%. Eight of the statements in the rNPQ shifted significantly following PNE. All pain beliefs shifted positive, with two reaching significance - "You can control how much pain you feel" ($p = 0.02$) and "Your brain decides if you feel pain, not your tissues" ($p = 0.003$). **Conclusions**: A one-time PNE lecture to elementary school students in Belize positively shifts pain knowledge and beliefs. The shift in pain knowledge, albeit significant, was less compared to previously US studies and with similar pre-PNE baseline scores indicate a need to further investigate and explore a PNE program specific to students in Belize to better match their ethnic and cultural needs.

Keywords: Pain Neuroscience Education; Chronic Pain; Global Health; School Students; Belize

RESUMEN

Introducción: El aumento del conocimiento y las creencias de los escolares sobre el dolor, produce cambios positivos en su comportamiento. **Objetivo**: Determinar si una conferencia breve y única sobre educación en neurociencia del dolor (PNE) desarrollada en los Estados Unidos para estudiantes de una escuela en Belice, puede producir cambios positivos similares en el conocimiento y las creencias sobre el dolor. **Métodos**: Ciento catorce estudiantes de escuelas primarias de Belice asistieron a una conferencia de PNE de 30 minutos. Antes e inmediatamente después de la conferencia, se determinó el nivel de conocimiento sobre el dolor (mediante el Cuestionario de Neurofisiología del Dolor (rNPQ) revisado) y las creencias sobre el dolor (mediante la Escala de Relaciones entre el Dolor y el Deterioro del Proveedor de Atención Médica (HC-PAIRS) adaptada). **Resultados**: Inmediatamente después de la conferencia, el conocimiento general del dolor mejoró significativamente del 28,6 al 35,4 %. Ocho de los aspectos en el rNPQ cambiaron significativamente después de PNE. Todas las creencias sobre el dolor cambiaron positivamente. **Conclusiones**: Una conferencia única de PNE a estudiantes de primaria en Belice cambió positivamente el conocimiento y las creencias sobre el dolor. El cambio en el conocimiento sobre el dolor, aunque significativo, fue menor en comparación con los estudios anteriores de Estados Unidos, y con puntajes de referencia similares antes de la PNE. Esto indica la necesidad de investigar más y explorar un programa de PNE específico para estudiantes en Belice para satisfacer mejor sus necesidades étnicas y culturales.

Palabras clave: Educación en Neurociencia del Dolor; Dolor Crónico; Salud Global; Estudiantes de la escuela; Belice

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INTRODUCTION

The global pain, especially chronic pain, epidemic has been well-documented in the last four to five decades.[1-3] It is now well reported that chronic pain affects approximately one in five people in the world on a regular basis, resulting in increased disability, decreased quality of life and suffering.[1-3] Epidemiological data strongly suggest the epidemic is growing, which apart from the impact on the individual, increase demand on healthcare services and add an economic burden to individual countries and the world.[4,5] The chronic pain epidemic has also been accelerated and magnified with the well-documented opioid epidemic in the United States (US), the increasing rates of mental and behavioral health issues in the world and the recent COVID-19 pandemic.[6,7]

Large-scale, cost-effective strategies, on a global level will be needed to curb the current global pain epidemic. Traditionally, whenever the world, governments and healthcare organizations encountered global, large scale health issues, it turned to mass-education, i.e., smoke cessation.[8-10] With the growing awareness of the detrimental effects of nicotine, large scale campaigns were implemented to educate the public on the negative effects of smoking.[8-10] Various systematic reviews and meta-analyses have shown these campaigns to play a major role in curbing global rates of tobacco-use.[11,12] Other large-scale epidemics resulting in global educational campaigns include AIDS, the SARS epidemic, COVID-19 and many more.[13,14] In lieu of the size, breath and impact of these issues, education as an intervention seem logical. Education can be done at large scale, in various forms, and as a healthcare or public health strategy is relatively inexpensive. These campaigns included advertising via television advertisements, newspapers, radio, pamphlets, booklets, placards and many more.[15,16] Additionally, education targets specific populations, including healthcare providers, healthcare institutions, local governments and schools. In schools, education on healthcare-related issues, i.e., smoking, was seen as early, upstream initiatives to influence future adults about their healthcare choices, especially in early adolescence. Regarding chronic pain, no global, far-reaching campaign has been deployed. Prior to the COVID-19 pandemic the US opioid epidemic received increasing coverage, and with associated legal action against pharmaceutical companies, led to some decrease prescription and use of opioids, only to accelerate during and after the global COVID-19 pandemic.[6]

If a mass educational strategy was to be developed and employed related to the chronic pain epidemic, it could be argued that targeting future adults, or children, may be advantageous.[17] It's been shown that most children develop powerful healthcare and lifestyle choices in their early adolescence, i.e., exercise habits, use of risky substances, etc.[18,19] Given the significant effect of chronic pain, especially on adults, a newly designed pain neuroscience education (PNE) program has been developed, tested and validated for middle school children in the US.[17] In this program, middle school children, approximately age 12 to 13, receive a 30-minute group lecture on the latest neuroscience of pain. To date, the research associated with the program has shown children, after the lecture, improve their knowledge of pain, decrease their fear and fear-avoidance associated with pain and develop healthier beliefs about pain.[17,20-22] More impressive, it has been shown that children who learn more about PNE, compared to no such education, increase school attendance, participation in recess, sports and physical education and use 30% less pain medication during the school year.[23] Other projects, in line with the PNE studies, have shown similar results, including expanding the studies to younger school children.[21,24] To date, however, these studies have been conducted in the US. Given that there is a global pain epidemic, it is essential that programs such as this be adapted for other countries, cultures and ethnic groups. The aim of this study was to determine if the school program developed in the US, could yield similar results for school children in Belize.

METHODS

Participants and Recruitment

Physical therapy (PT) students at the University of Wisconsin in the US, accompanied with two instructors were scheduled to travel to Belize for a student global health experience over the summer – the first since COVID-19. One of the instructors was aware of the PNE in US school projects and thought it may be an opportunity for the students to use the US program in Belize. The primary researcher of the US school PNE program was contacted, gained approval for the use of the program, and collaborated with the intended project. The annual PT student global health experiences are approved by the Belize Ministry of Health and Wellness's 'Licensing and Accreditation Unit' and partially coordinated by the US Embassy in Belize. For this project, the Embassy was approached with a description of the project, samples of the questionnaires and needs associated with the presentations, i.e., a projector, time, locations, permissions, etc. The Embassy reached out and obtained interest from three elementary school principals in Belize to participate in the study. In line with the objectives of the study, participants had to represent elementary school students in Belize, with English as primary language. The authors communicated directly with schools in Belize, providing an invitation and explanation of the program, as well as a copy of the questionnaires that would be used before and after the PNE lecture. An offer to provide feedback and recommendations as they saw necessary was extended. The US Embassy was able to secure ethical and administrative approval from the local school authorities of all three schools and they consented to participate in the PNE lecture and data collection as part of the PT student global health experience. The three schools were listed as elementary

schools, since Belize offer elementary and secondary schools, versus US middles schools, but ensured the students met the age range (11-13 years).[17,20-22] With approval obtained, dates and times were set for the lectures. US Ethics and institutional review board approval was obtained from Southwest Baptist University in the US.

Intervention

The content of PNE is documented and in line with other studies and used in the previous school studies.[17,20-22] The PNE presentation lasted 30-minute using a 32-slide PowerPoint™ presentation. Small cultural changes were made to the US PNE presentation to better align with school children in Belize, i.e., changing yellow school bus in the US to a non-yellow, locally recognizable bus, images of the children depicted in the slides to resemble children in Belize, versus US, etc. The allotted class time (60 minutes) allowed ample time for questions and answers, as well as time to complete the pre- and post-PNE surveys. The presentation's main themes included a discussion of peripheral sensitization, central sensitization, 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.[17,20-22] Various images, metaphors, and examples were used to convey the PNE to participants. The presentations were delivered by the PT students. Prior to the trip, the PT students were given the PowerPoint™ presentation and met via online teleconferencing with the original author, to review and familiarize themselves with the program. Additionally, PT students were provided with animated videos of the same talk, which has been used in previous PNE school studies.[22] Following the formal presentation by the PT students (and completion of the post-PNE surveys), participants were encouraged to ask questions. The presentation did not specifically address or target any questions contained in the outcome measures.

Outcome Measures

Prior to outcome measures, participants completed a demographic section capturing their gender, age, grade, pain experience and pain rating (Wong-Baker Face Pain Rating Scale) and family history of pain.[25] No personally identifiable information was captured. Two outcome measures were used for the participants to examine their knowledge of pain, and attitudes and beliefs about persistent pain:

- Pain knowledge: Pain knowledge was measured using the revised Neurophysiology of Pain Questionnaire (rNPQ).[26] The rNPQ is based on a current pain science text and was used in a previous study measuring the neurophysiology knowledge of patients and health care personnel. The original Neurophysiology of Pain Questionnaire was a 19-item test requesting "true," "false," or "not sure" answers to statements, with higher scores indicating more correct answers. Since the development of the original questionnaire, a statistical analysis of the questions led to the development of an abbreviated rNPQ with 12 questions, which removed ambiguous questions.[27] The revised 12-question rNPQ was used in this study. The questionnaire was adapted similar to a previous study to make it easier for students to understand (i.e, "nociception" was replaced with "danger messages"). No data is available in patients or healthy controls as to what constitutes a meaningful shift in rNPQ scores. In the previous school PNE studies, the mean increase in the rNPQ was 28%.[17,20-22] The rNPQ has not been assessed for reliability or validity in this age group but has been used in previous populations.

- Pain beliefs: Health care providers' attitudes and beliefs regarding persistent low back pain are often measured with the Health Care Provider's Pain and Impairment Relationship Scale (HC-PAIRS).[28] 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 established to allow surveys to be completed prior to and following the PNE session in the allotted time. This series of beliefs questions has been used in previous school PNE studies.[17,20-22] Beliefs statements were:

    - "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 must stop what you are doing."
    - "You can control how much pain you feel."
    - "Your brain decides if you feel pain, not your tissues."

Both the rNPQ and the beliefs numeric scale were administered before and after the PNE lecture. To avoid influencing answers to the outcome measures, questions that arose during the completion of these forms were addressed by the attending teachers and not the presenters of the PNE. Upon completion of the surveys, the surveys were placed into envelopes, sealed and sent to an independent research assistant who entered the data into an Excel document for analysis.

Statistical analysis

The results of the study were evaluated using SPSS (version 22.0, IBM Corporation). Descriptive statistics of means, standard deviations, and percentages were reported on student group characteristics. Within-group repeated measures for rNPQ and pain beliefs were done using a two-way mixed ANOVA on complete-case analysis. The level of significance was set at $p<.05$.

RESULTS

Participants

Prior to the PNE lecture, 114 students completed the intake forms and following the PNE lecture, 112 completed the post-PNE forms (98.2% retention rate) (Table 1).

Table 1. Demographics of the school students attending the PNE lecture.

Characteristic	n = 114
Gender	
Girls (%)	57 (50%)
Boys (%)	54 (47.4%)
Declined to answer (%)	3 (2.6%)
Age: Mean (range)	11.9 (11–14)
Grade	
5th Grade	15 (13.2%)
6th Grade	46 (40.4%)
7th Grade	20 (17.5%)
8th Grade	15 (13.1%)
Did not complete	18 (15.8%)
Currently experiencing pain (%)	37 (32.5%)
Mean pain rating (range)	2.32 (1–5)
Family member with chronic pain (%)	63 (55.3%)

Pain knowledge

Following the PNE lecture, rNPQ scores increased from 3.43 (28.6%) to 4.25 (35.4%) ($p < 0.001$). Table 2 shows the changes in rNPQ scores before and after the PNE lecture for each individual rNPQ question.

Pain beliefs

Table 2 showcases the various pain beliefs prior to and following the PNE lecture. Only two beliefs reached significant change following PNE - "You can control the amount of pain you feel" ($p = 0.02$) and "Your brain decides if you feel pain, not your tissues" ($p = 0.003$).

Table 3. Pain beliefs before and after PNE lecture.

#	Pain belief	Mean score before	Mean score after	Difference	p-value
1	Pain is normal; without being able to feel pain you will not survive.	4.42	5.03	0.61	0.22
2	Pain means something is wrong with your tissues	4.35	5.04	0.69	0.12
3	Pain always means you must stop what you are doing	5.39	4.73	0.66	0.17
4	You can control how much pain you feel	3.05	4.27	1.22	0.02*
5	Your brain decides if you feel pain, not your tissues	4.58	6.04	1.46	0.003*

* Statistically significant

Table 2. rNPQ changes per statement before and after the PNE lecture.

#	NPQ Statement	Mean score before	Mean score after	Difference	p-value
1	It is possible to have pain and not know about it.	0.27	0.12	0.15	<0.001*
2	When part of your body is injured, special pain receptors convey the pain message to your brain.	0.19	0.05	0.14	0.06
3	Pain only occurs when you are injured or at risk of being injured.	0.47	0.32	0.15	0.02*
4	When you are injured, special receptors convey the danger message to your spinal cord.	0.43	0.79	0.36	<0.001*
5	Special nerves in your spinal cord convey 'danger' messages to your brain.	0.58	0.8	0.32	<0.001*
6	Nerves adapt by increasing their resting level of excitement.	0.51	0.66	0.15	0.03*
7	Chronic pain means that an injury hasn't healed properly.	0.15	0.28	0.13	0.02*
8	Worse injuries always result in worse pain.	0.11	0.18	0.07	0.16
9	Descending neurons are always inhibitory.	0.2	0.18	0.02	0.77
10	Pain occurs whenever you are injured.	0.23	0.36	0.13	0.04*
11	When you injure yourself, the environment that you are in will not affect the amount of pain you experience, as long as the injury is the same.	0.2	0.19	0.01	0.81
12	The brain decides when you will experience pain.	0.32	0.53	0.21	0.002*

* Statistically significant

DISCUSSION

A brief, one-time PNE lecture to elementary school students in Belize is able to significantly improve pain knowledge and shift some beliefs regarding pain. To our knowledge, this is the first study adapting a PNE lecture to students in Belize.

The primary result shows that the brief, one-time PNE lecture is able to significantly increase pain knowledge in elementary school students in Belize. In this study, the mean shift in knowledge was 6.8%, which is a lot lower than the various US studies, showing a mean shift of 28%.[17,20-22] Further analysis shows that the initial, pre-PNE pain knowledge score of 28.6% in the Belizean students were in line with the US studies, typically ranging between 23.6% to 32.8%.[21] The post-PNE knowledge, even though statistically significant, did not increase as much as seen in US studies. This would imply that the PNE lecture was not as effective in the Belizean students, which at minimum indicate the need to further adapt a program such as this to meet student needs. It is well documented that pain experiences are heavily influenced by various ethnic and cultural issues, including those in children.[29,30] Pain content must be culturally and ethnically appropriate to allow participants to connect with the messages to ensure a deeper learning experience.[29,30] In this presentation some superficial changes were made but may not have been adequate to allow for a larger shift in pain knowledge. Learning theorists often point to Piaget's Constructivist Theory when it comes to understanding how children learn, which is described as a dynamic interplay between the individual and their environment, albeit often younger children than the current elementary school students.[31,32] In this theory, children start learning by taking in new information and then adjusting existing knowledge structures to fit that information.[31,32] The PNE lecture provided new information to the students, but also had to merge the new information with existing knowledge, culture, ethnic background, personal beliefs, etc., to ultimately "make sense."[29,30] The small shift in pain knowledge, even with a comparable baseline to the US students, indicates a need to further adapt the program to meet local students, cultural and ethnic needs. The individual rNPQ changes before and after PNE showcase which questions/statements shifted significantly, and which did not, which may be helpful in the design of a new PNE program. Even with the call to update the program it was encouraging to see a significant shift in pain knowledge, which has been tied to various positive behavior changes in school children when it comes to pain experiences, including decreased absenteeism and increased participation in sports and physical activity.[23]

In this study, two pain beliefs shifted significantly following the PNE lecture. Coincidently, the same two pain beliefs that shifted in the Belizean students have also been shown to be the main ones shifting in the US students.[17,20,21] First, students agreed more with the statement that they do control the amount of pain they experience, which powerfully drives self-efficacy. Self-efficacy has been shown to powerfully predict human pain experiences, including recovery from surgery, as well as decreased utilization of medical services.[33,34] Self-efficacy fosters independence, which is much needed in chronic pain experiences.[35] Self-efficacy is also at the heart of coping skills or knowing what to do when one is experiencing pain, and has been tied to optimism, especially in healthcare, which additionally has been shown to be analgesic.[36] By strengthening this belief of self-care, the PNE lecture allows students to develop some control over a potential pain experience, which yields various positive effects. The second significant change in beliefs shifted students towards a more neuroscience, wholistic view of pain, by agreeing more that the brain is key in a pain experience, versus the tissues.[37] One of the biggest drivers of the pain and opioid epidemic is a biomedical model whereby society ties the health of their tissues to a pain experience.[38] In this model, unhealthy or damaged tissues is tied to pain, and similarly if someone is experiencing pain, there must be some underlying unhealthy or damaged tissues.[38] This model has been shown to drive increased medical utilization of imaging, surgery and pharmaceutical and injection interventions. Modern pain science has shown that pain is far more complex than just the underlying health of tissues, with numerous studies showing abnormal scans in pain-free people, and many patients experiencing pain, yet their scans and medical tests show no anomaly.[39] Shifting tomorrow's adults, today's school students, to a less biomedical view of pain would be a powerful part of pain literacy training to help decrease healthcare utilization in chronic pain.[17]

The study contains various limitations. First, this is a simple pre- and post-PNE study with no control groups and no long-term follow-up. Second, as stated, the cultural and ethnic adaptations may not have been adequate to ensure a more powerful intervention. It can be stated, however, that this is also a strength, since it showcases the need to ensure content is not just superficially altered, but time spent on developing a deeper understanding of each study population's needs.

CONCLUSIONS

A one-time PNE lecture to elementary school students in Belize positively shifts pain knowledge and beliefs regarding pain. The shift in pain knowledge, albeit significant, was much less compared to previously published US studies and with similar pre-PNE baseline scores indicate a need to further investigate and explore a PNE program specific to students in Belize to better match their ethnic and cultural needs.

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