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Pain Neuroscience Education as an Intervention for Chronic Pain

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Abstract

PURPOSE:

The purpose of this project was to evaluate the ability of Pain Neuroscience Education (PNE) to increase knowledge of pain as a biopsychosocial process and influence more health-promoting interpretations of pain among low-income adults as a preventative health education approach.

BACKGROUND:

PNE is a promising treatment approach for addressing chronic pain. However more data is needed to understand how to most effectively utilize this intervention.

DESIGN:

A program evaluation was conducted using a pre- and post- test design to elicit quantitative and qualitative data. Nine Seattle Housing Authority (SHA) buildings were invited to participate in two online pain neuroscience modules. Quantitative survey data were collected before the start and after the completion of the modules. Qualitative data was collected at the culmination of the program.

RESULTS:

Analysis used a paired t-test to evaluate changes in the revised Neurophysiology of Pain Questionnaire (rNPQ) item scores and total scores. Content analysis of themes was applied to qualitative responses.

IMPLICATIONS:

Pain neuroscience education delivered in an online module format was an effective strategy for increasing knowledge and positively impacting interpretations of pain in low-income older adults living in subsidized housing.

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Chronic pain is defined as pain that persists beyond expected tissue healing times, or as pain that is present without evidence of tissue damage. Typically pain that persists for three months or longer is considered to be chronic. According to data collected in 2019 by the National Health Interview Survey (NHIS), chronic pain affects 20.4% of U.S. adults. Among people who suffer from chronic pain, 36.4% report high-impact chronic pain (Zelaya et al., 2020). The Centers for Disease Control and Prevention define high-impact chronic pain as chronic pain that occurs most days or daily and limits patients' ability to complete life or work activities (Dahlhamer, 2016). It follows that chronic pain represents a significant economic burden in the United States (U.S.). Researchers from Johns Hopkin's University estimated that the national cost of chronic pain in 2012 ranged from $560 to $635 billion, making it significantly more expensive than heart disease ($309 billion), diabetes ($188 billion) or cancer ($243 billion) (Gaskin, 2012). Amid an opioid crisis, in which Americans consume 80% of the global opioid supply, despite making up just 5% of the world population (Rose, 2017), novel approaches for addressing chronic pain are desperately needed.

Sociodemographic Distribution

The burden of chronic pain is not distributed equally amongst the population. Research suggests that various sociodemographic groups suffer disproportionately from chronic pain and high-impact chronic pain. One of the most potent predictive demographic characteristics for chronic pain is older age *[See Figure 1, page 36]* (Zelaya et al., 2020). As people age, the prevalence of chronic pain correspondingly increases. For adults ages 18-24, chronic pain is relatively rare at just 7% of the population. However, the prevalence of chronic pain positively correlates with the age of the cohort, reaching a peak prevalence of 33.6% in adults ages 85 and

older. For high-impact chronic pain, the correlation with age is even greater. Of the 33.6 % of adults over age 85 who suffer from chronic pain, nearly half (47%) meet criteria for high-impact chronic pain, compared to just 21% of adults ages 18-24 and 39% of adults ages 65-84 who suffer from chronic pain (Zelaya et al., 2020).

Another important demographic factor that correlates with chronic pain and high-impact chronic pain is poverty status. The age-adjusted prevalence of chronic pain for those who earn less than the federal poverty level is 29.6%. In comparison, the wealthiest Americans (those earning greater than 400% of the federal poverty level) have an age-adjusted chronic pain prevalence of just 14.6%, less than half of that of their low-income counterparts. As might be expected, high-impact chronic pain is significantly more prevalent for low-income Americans. The lowest earners, people earning less than 100% of the federal poverty, are 4.4 times more likely to suffer from high-impact chronic pain than the wealthiest Americans making more than 400% of the federal poverty level (Zelaya et al., 2020). High-impact chronic pain which, by definition, interferes with work and life activities, likely further exacerbates economic inequality. Chronic pain is not just a public health problem: it is also a social justice problem.

A Scarcity of Treatment Options

Pain is among the most common reasons patients access medical care, with low back pain and arthritis pain representing the 4th and 6th most common reasons for primary care visits in developed countries, respectively (Fineley et al., 2018). Despite the frequency of these medical encounters, primary care providers are often frustrated by the lack of treatment options for these patients. Since the mid 1990's, following an aggressive opioid marketing campaign by pharmaceutical giant Purdue, providers have relied heavily on opioid pain medications to address chronic pain. Between the years 1996 and 2000, when Purdue Pharma first introduced and

actively promoted the use of OxyContin for non-malignant chronic pain to both providers and patients, sales of the drug increased from $48 million annually to $1.1 billion (Van Zee, 2009). The sequela of this approach is a major public health problem today, with nearly 128 Americans dying every day from opioid overdose (CDC, 2018). What's more, opioid medications are not an effective treatment for chronic pain, and may actually increase pain over time due to their hyperalgesia effects (Rosenblum, 2008). Providers are currently faced with the challenge of not exacerbating the current opioid crisis while still effectively addressing chronic pain for patients. Given the dearth of effective treatment strategies, providers are often left providing reassurance, recommending simple interventions like over-the-counter pain medications or massage, or referring to physical therapy or orthopedics. More effective treatment strategies that can be deployed in primary care are needed.

Modern Theories of Chronic Pain

Scientific knowledge related to the neurobiology of chronic pain has advanced rapidly in recent decades (Martucci et al., 2014). Within the field of neuroscience, it is well established that the brain plays a central role in the pain process, marking a shift from earlier theories that assigned the brain a mere gate-keeping role, modulating pain signals (Mendell, 2014). The brain performs a wide range of functions, which do not appear to be isolated from pain processing. On the contrary, emotional states, beliefs, motivation and other brain outputs affect the amplitude of pain signals (Moseley, 2007). A major component in any chronic pain syndrome is the process of *central sensitization*. It is widely accepted today among neuroscientists that the majority of chronic musculoskeletal pain is characterized by alterations in central nervous system processing (Nijs et al., 2011). Central sensitization occurs when the central neural processing systems of the brain amplify pain signaling relative to the nociceptive inputs from peripheral nerves. A

biopsychosocial framework can be applied to the concepts of chronic pain and central sensitization to better understand the multifaceted sources of chronic pain. Research findings suggest that biopsychosocial factors such as emotional, cognitive, behavioral and biological conditions are complexly intertwined with the pain experience (Moseley, 2007).

Although the understanding of pain neuroscience has become more complex in recent decades, many patients, and even many providers continue to rely upon outdated frameworks for understanding chronic pain. Despite our burgeoning understanding of the role that brain functions have in creating and complicating the pain experience, many Americans are stuck thinking about a tissue-damage model of pain. In response to this knowledge lag, Pain Neuroscience Education (PNE) was developed to update the broader culture on what is known about pain neuroscience and the principal role of the brain. PNE has been increasingly utilized as an intervention for people experiencing unexplained chronic pain, and early research suggests that patients who have a better understanding of pain neuroscience have less pain and less pain-related disability (Louw & Zimney et al., 2016). The goal of PNE is to help patients recognize that pain (particularly when chronic) is not a reliable indicator of tissue damage. PNE involves educating individuals about pain neurophysiology, including the concepts of central sensitization and biopsychosocial factors that contribute to pain. The content communicated during PNE sessions will be expanded upon later in this article. Research examining the effectiveness PNE as an intervention for chronic pain has been ongoing since the early 2000s. And while the studies available in this new field of research are relatively sparse, the research that does currently exist supports the utility of PNE in clinical practice (Louw & Zimney et al., 2016).

Project Purpose and Aims

This project evaluated if a pain neuroscience education program conducted in an online video module format could increase knowledge of pain as a biopsychosocial process and influence health-promoting interpretations of pain among low-income adults in the Seattle, low-income, senior housing population. The specific project aims were to: 1) Implement high quality evidenced-based pain neuroscience education online modules at nine Seattle Housing Authority (SHA) locations. 2) Measure changes in knowledge of pain using the revised Neurophysiology of Pain Questionnaire (rNPQ) before and after PNE. 3) Assess changes in participants' understanding and interpretations of pain using a qualitative, open-ended question about the influence of the PNE program on their own pain stories.

Background and Significance

It is a difficult task to identify one's own cultural framework for understanding the world, particularly when that framework is the dominant cultural narrative. Toward this effort, a historical lens can be usefully deployed to aid in the recognition of the various ways in which culture informs the interpretation of pain in Western cultural contexts. In this brief summary of the history of pain science, a few historical events that influenced the development of the dominant pain narrative in biomedicine will be highlighted. Because biomedicine stems from a Western cultural tradition, the focus of this review will be on the history of Western thought regarding pain. However, it is recognized that many cultures throughout the world and throughout history have developed valuable theories regarding pain. For example, as far back as (circa) 200 BCE the Syriac Empire generated *The Book of Medicines* which suggested that pain originates in the brain (Moayedi et al., 2013), a concept that modern scientists have only returned to in recent years.

A Historical Perspective

French philosopher, René Descartes was an influential figure to the current biomedical conceptions of pain. Descartes pioneered what is today known as the *Specificity Theory of Pain*, which holds that pain signals travel along dedicated nerve fibers to the brain. In 1641, Descartes published '*Meditations on First Philosophy*' which supported the concept of pain as a mechanical process indicating tissue damage. In this work, Descartes states "I have a body which is adversely affected when I feel pain" (Descartes, 1641). In 1964, Descartes described the "path of burning pain" using an image of a body and a depiction of sensory transduction from the site of injury to the brain *[See Figure 2, page 37]* (Bourke, 2012). The concept of pain beginning with an injury may seem obvious today because it is a foundational concept in Western culture, and therefore difficult to recognize as profound. However, prior to Descartes' model of pain, the dominating theories were based in the Judeo-Christian philosophy in which pain originates from a divine source outside of the body (Dedeli, 2013). Descartes pain theories maintained scientific and cultural dominance for the next 300 years, and continue to have profound influence over cultural conceptions of pain. While Descartes theories shed light on the role of the peripheral nerve fibers, they completely neglected the role of neurons in the central nervous system (Moayedi et al., 2013).

Another revolutionary shift in pain science occurred in 1965, when Ronald Melzack and Charles Patrick Wall published an article in Science titled "*Pain Mechanisms: A New Theory*", introducing the *Gate Control Theory of Pain* (Melzack and Wall, 1965). This research was innovative because it proposed a central processing component to pain. The theory describes a gating mechanism located in the spinal dorsal horn which regulates transmission of nerve impulses from peripheral fibers to spinal transmission cells (Moayedi et al., 2013). According to

this theory, perceptions of pain are influenced by the context, including psychological states (Bourke, 2012). Although many of its proposed neurologic mechanisms were overly-simplistic and have since been disproven, the *Gate Control Theory* inspired subsequent research on the role of social context, which has altered our understanding of pain (Moayedi et al., 2013).

The Modern Neuroscience Perspective

Modern theories recognize that pain is complex and multidimensional, and involves brain processes. Acute pain originates from nociceptive signals from the peripheral nervous system (injury, for example) which are interpreted as pain by the brain as a protection mechanism. However, this is often not the case with chronic pain. Pain can occur without nociceptive inputs, and the opposite is also true: nociceptive signals are not always felt as pain. The majority of chronic musculoskeletal pain is characterized by changes in central processing which lead to a hypersensitive state (Meyer, 1995). Normally, the brain generates anti-nociceptive signals in response to pain which leads to a decrease in pain perception. However, in cases of central sensitization, inhibitory mechanisms that would normally dampen pain perception are impaired (Meeus et al., 2008). Moreover, both ascending and descending excitatory pain signals become amplified in central sensitization, leading to an elevated pain experience, relative to the extent of tissue damage (hyperalgesia) and the perception of harmless stimuli as painful (allodynia) (Staud et al., 2007). Indeed, much of the time when pain persists and becomes chronic, there is no detectable tissue damage (Wheeler, 2018). Central sensitization involves changes in the brain as well. Patients with chronic pain undergo a process of maladaptive neuroplasticity which increases activity in the locations of the neuromatrix involved with pain perception (Seifert, 2008). Research has also shown that the forebrain has the ability to alter the activity of the area of the brainstem that controls descending excitatory pain signaling. This is significant because

the forebrain is responsible for cognitions, emotions, attention and motivation, all of which affect the neurobiological process of pain (Zusman, 2002). For example, research indicates that faciliatory pain signaling is positively correlated with the level of vigilance or stress that a person is experiencing (Rygh et al., 2002), a process known as cognitive emotional sensitization. These advances have revealed that the neurobiology of pain is significantly more complicated than the brain simply modulating pain signals from the periphery, as the *Gate Control Theory* suggests. Pain is a multidirectional, whole-nervous-system process that involves a multitude of complex capacities of the human brain. Many patients ascribe to the Cartesian model of *Specificity Theory* (ie, if there is pain, then there must be damage). In recent years, educating patients on the biopsychosocial model of pain described here has been an increasingly utilized intervention for chronic pain. The next section will discuss PNE and other management strategies for addressing chronic pain.

Literature Review

In the early 2000's, a therapeutic approach to chronic pain emerged which involved teaching patients the pathophysiology of the nervous system and explaining how pain works in the body. Research has shown that Pain Neuroscience Education (PNE) is an effective treatment strategy for several subtypes of chronic pain including low back pain (Pardo et al., 2018) (Pires et al., 2014) (Ryan et al, 2010), complex regional pain syndrome (Shephard et al., 2018), pain related to lumbar surgery (Louw et al., 2015), arthritis in older adults (Louw et al., 2017), whiplash-associated pain (Oosterwijck et al., 2011), and neck pain in adolescents (Andias et al., 2018). PNE has benefits for subjects across the life sycle, from early adolescence (Andias et al., 2018) to elderly adults (Louw et al., 2017).

Meta-analyses have been conducted and produced a combination of results. Three meta-analyses concluded that PNE was an effective intervention for chronic pain syndromes (Loew et al., 2011; Louw, Zimney, et al., 2016; Wood & Hendrick, 2018), while another was inconclusive (Kurien et al., 2019). Meta-analyses looking at PNE and pain cite lack of available research as a major research limitation.

Clinical application for PNE has mostly been studied in outpatient physical therapy settings (Louw, Puentedura, et al., 2016). However, most patients with chronic pain make first contact with the health care system in a primary care setting (Fineley et al., 2018). The utility of providing PNE wherever individuals encounter healthcare providers or receive health information, such as in primary care or in preventative health education forums, may have merit but has not been sufficiently studied.

There is insufficient evidence on how to best deliver PNE to patients. A preliminary case study showed that PNE via telehealth was effective (Louw, 2014). However, in-person teaching sessions appear to be more effective at addressing pain and disability (Louw et al., 2011). More research is needed on whether PNE can be effectively delivered electronically. Electronic delivery has the advantage of being easily distributable, as well as cost-effective, potentially allowing the content to reach a large number of participants compared to one-on-one information sessions.

There is disagreement over whether PNE is more effective when paired with an exercise program (Andias et al., 2918; Pires et al., 2014), or whether it is effective as a stand-alone therapy (Ryan et al., 2010). However, the research does suggest that if a therapeutic exercise component is included alongside PNE, the messaging between the two therapies needs to be

consistent, meaning the exercise program must reinforce the foundational teachings of PNE (Blickenstaff et al., 2016).

The Pain Neuroscience Education Process

The overarching goal of PNE is to help participants reconceptualize their chronic pain. Pain reconceptualization involves embracing four concepts: (i) that pain is not a measure of tissue damage; (ii) that pain is influenced by physical, psychological and social forces; (iii) that as pain persists and becomes chronic, it becomes an even less reliable indicator of the state of the tissues and (iv) that the implicit belief that tissues are in danger positively correlates with pain (Moseley, 2010).

The first step in the delivery of Pain Neuroscience Education is to rule out "red flag symptoms," which are concerning symptoms that warrant timely medical follow up. For example, if a patient is experiencing pain and inflammation due to an acute infection or injury, they may require a medical visit, an antibiotic prescription or hospital support. Likewise, symptoms suggestive of a malignant process necessitate medical evaluation. There are many urgent causes of pain to rule out before diagnosing pain from a chronic musculoskeletal process. PNE can be helpful for many types of pain, however, it should not be prioritized over medical evaluation and follow up of concerning symptoms.

Assessment is followed by two educational sessions, ideally lasting less than 30 minutes each, with the duration depending on how successful the teaching is. Before beginning, the clinician explains the treatment rationale to the participant (Nijs et al., 2011). The goal of the first session is for the clinician to describe central sensitization and pain physiology in an effective way that allows the participant to reconceptualize their pain from a sign of tissue damage to a complex neurologic process. In individuals with chronic pain, reconceptualization is

positively correlated with PNE's efficacy (King et al., 2016). Reconceptualization involves deep learning, and behavioral and cognitive changes are expected to follow as a result. Research suggests that behavioral and cognitive changes alone, without reconceptualization are not as effective (Nijs et al., 2011). Participants are not likely to adhere to cognitive or behavioral recommendations, such as a graded exercise program, if they do not understand that their pain is caused by a hypersensitive nervous system, rather than tissue damage (Nijs et al., 2011). Doing so would be counter-intuitive to the participant who may fear worsening an injury.

Central sensitization is frequently present in various chronic musculoskeletal pain disorders. Individuals with central sensitization are often overwhelmed by all kinds of physical and emotional stressors; they may have hypersensitivity to touch, bright light, sound, smell, hot or cold sensations, mechanical loading of musculoskeletal tissues, and all kinds of physical, mental and emotional stressors. Hypersensitivity is widespread rather than local. Clinical tests assessing nociceptive processing may be used to assess presence or severity. The appearance of new symptoms, aggravation of existing symptoms, not responding to established treatments, post-exertional malaise, or a decreased pain threshold during hands-on treatment are indicators of a central, pain-hypersensitization process.

To achieve the goal of pain reconceptualization, sessions are designed to present information in a sequential manner that progressively builds layers of more complex knowledge. The sequence begins with an explanation of acute versus chronic pain and the purpose and neurobiology of both types of pain. The educator then explains how acute pain can become chronic and how biopsychosocial factors can contribute to central sensitization. The participant is allowed to ask questions throughout the session. Information is presented through multiple modes, such as oral, visual, and physical models, in appreciation of differences in learning styles

and to reinforce learning (Nijs et al., 2011). The individual is given educational material between sessions one and two that reinforces the content of session one (no new content). The *Neurophysiology of Pain Questionnaire* is provided and the individual fills it out one day prior to returning for session two (Nijs et al., 2011). The *Neurophysiology of Pain Questionnaire* has shown to be a reliable tool in assessing how a person conceptualizes the neurobiological processes of pain (Catley et al., 2013). The outcome of this survey influences the content of the second educational session (Nijs et al., 2011). After clarifying gaps in knowledge identified on the *Neurophysiology of Pain Questionnaire*, the educator focuses on applying the content to real-world scenarios specific to the individual. The educator evaluates the participant's readiness to incorporate new knowledge to manage a hypersensitive nervous system. Goal setting takes place in this session. Participants will hopefully discuss adaptive strategies such as decreased concern about tissue damage, graded exercise program, or relaxation techniques (Nijs et al., 2011).

In the implementation of PNE at SHA, this project adhered as closely as possible to the above clinical guidelines *[See Figure 3, page 38].* However, several adaptations were needed to accommodate the online format of the course. An online format was chosen out of safety considerations during the COVID-19 global pandemic. Data collection for this project took place in early 2021 when all in-person activity was suspended at SHA. The next section will describe this project including the adaptations that were made to the typical PNE process.

Methods

A program evaluation was conducted using a pre- and post- test design to elicit quantitative and qualitative data. Nine Seattle Housing Authority (SHA) buildings were invited to participate in two online pain neuroscience modules. Quantitative survey data were collected

before the start and after the completion of the modules. Qualitative data was collected at the culmination of the program.

Project IRB Determination

An application was submitted to the Seattle University Institutional Review Board (IRB) and the IRB determined the project is not human subject research. The program received determination as a "program evaluation" and permission was granted to begin the project in December 2020. In March 2021, a revision request was sent to the IRB and permission was granted to add an additional qualitative question to the data collection.

Setting

Each SHA building houses from 25 to 90 residents. The residents of SHA live independently in apartment units in the building. The residents of the building are supported by the Full Life Care Wellness Program. Full Life Care is a non-profit organization that provides services to a diverse population of low-income, older and disabled adults in King County. The Wellness Program is a grant funded service that provides nursing care and other wellness services to SHA residents as part of SHA's Aging in Place Initiative. The Wellness Team is made up of a program coordinator, two nurses and various other volunteers. Together, the team provides wellness nursing, group health education, social events, group exercise classes and other health promotion services.

There is a common area in each building where, prior to the COVID-19 global pandemic, residents gathered to socialize, watch T.V., participate in exercise classes or host holiday parties. The original proposal for this project was to host live pain neuroscience classes in this common area of each building, however, with restrictions imposed by the COVID-19 pandemic to protect the health and safety of residents, the program had to be adapted to an online format. The videos

were hosted on the Full Life Care website and the modules were available to be completed at the residents' conveniences.

Participant Recruitment

Twenty-six participants were recruited by voluntary sampling. Recruitment was conducted in two phases. The first recruitment effort took place between January 2021 and February 2021 and the second recruitment effort took place between March 2021 and April 2021. Flyers were distributed in the common area of each SHA location. Wellness team members also invited residents to participate during their regular phone outreach. Inclusion criteria overlapped with the age and income prerequisites for residing in subsidized housing. SHA provides low-income housing to older adults, and therefore all participants are over age 55 and are considered low-income (earning between 30% and 80% of the area median income, with priority given to those earning 30% or less).

Red Flags Screening

As described above, screening for red flag symptoms is the first step in conducting PNE. This was a challenge given the online, anonymous format of the PNE programming. In order to screen for concerning symptoms that would warrant timely medical follow up, a Red Flags Informational Sheet was developed and made available to all participants *[See Figure 4, page 39]*. The Informational Sheet screens for concerning pain symptoms such as acute onset of pain, fever, weight loss, or pain that has not yet been evaluated by a medical professional, among many others and encourages participants to contact their medical provider if any of the concerning signs or symptoms apply to them.

Educational Intervention

All residents who signed up received a packet that included a welcome letter with a link to the website and the *"Why do I Hurt*" handbook, a workbook designed for individuals with chronic pain which they were able to keep free of charge as part of their participation in the program. A webpage for this project was designed and created by the Full Life Care communications and technology teams to host the learning modules and surveys. This webpage can be found on the Full Life Care website: www.fulllifecare.org/pain. A '*Before You Get Started*' video available on the webpage provides a brief explanation of the project as well as an overview of the program.

The development of the online programs was informed by two clinical guidelines written by two prominent researchers in the field of PNE, Adrian Louw PT, PhD and Jo Nijs, PT, MT, PhD. Louw's (2018) guide for clinicians is titled *Pain Neuroscience Educations: Teaching People About Pain*, and provides several teaching strategies that were used in the modules. Nij's guideline (2010), which is described in detail above in the background section, is oriented toward helping the participant reconceptualize their own pain. Pain reconceptualization is a concept developed by pain researcher Lorimer Moseley and involves embracing four concepts: (i) that pain is not a measure of tissue damage; (ii) that pain is influenced by physical, psychological and social forces; (iii) that as pain persists and becomes chronic, it becomes an even less reliable indicator of the state of the tissues and (iv) that the implicit belief that tissues are in danger positively correlates with pain (Moseley, 2007). These four objectives were central in the development of the two PNE modules created for this project. Typically, PNE is performed in-person and both guidelines were designed for that context. The PNE modules adhere as closely as possible to the clinical guidelines, while also making necessary adaptations to accommodate the online video module format.

In addition to the orientation video described above, two pain neuroscience education videos were published on the Full Life Care website. The first educational video focuses on core concepts in pain neuroscience: distinguishing acute from chronic pain, describing how acute pain can become chronic, describing the purpose of pain as a safety mechanism and divorcing the concept of tissue damage as a prerequisite for pain.

Between videos one and two, participants are invited to peruse the free workbook that came with the course and to practice reconceptualizing pain. To practice pain reconceptualization, viewers are asked to participate in any physical activity that they enjoy. If during that physical activity pain occurs, participants are asked to think of that pain, not as an indicator of tissue damage, but rather as an overactive protective mechanism in the body. The physical activity component of the program was included in response to research that suggests that PNE is more effective when paired with a physical exercise program (Pires et al., 2014), (Andias et al., 2018).

The second video, which is completed a week after the first, focuses on applying the concepts of pain neuroscience to the lives of participants. The orientation of the second video towards the lives of participants was intended to approximate the individualized goal setting that should occur at the second PNE visit. In attempt to apply PNE content to the lives of participants, the second module asks participants to reflect on their own pain story. A pain story is the narrative that humans attach to their pain experience. Those narratives are typically constructed using the dominant culture's concept of pain, wherein pain is disproportionately connected to tissue damage. Participants are asked to introduce the pain neuroscience perspective in to their thinking. Essentially, the second educational video asks participants to rewrite their pain stories in a way that more holistically incorporates psychological and social aspects.

Expanding the conceptualization of pain beyond simple biological explanations aims to align participant understanding with the more current biopsychosocial model of pain neuroscience.

Data Collection and Measure

The revised *Neurophysiology of Pain Questionnaire* (rNPQ) is a 12-item survey that assesses for comprehension of the biopsychosocial concepts that underpin chronic pain *[See Table 2, Page 35]* (Catley et al., 2013). The rNPQ was administered before the first session, and after the final session. The rNPQ is a valid tool for assessing the understanding of biopsychosocial concepts of chronic pain. In an analysis of 45 individuals with low back pain the researchers found that the rNPQ tool effectively targeted the knowledge of pain in the sample and had reasonable internal consistency and test-retest reliability (Catley et al., 2013). The rNPQ is commonly used in research to assess pain knowledge (Lee et al., 2016).

An additional qualitative question was added in March 2021 with IRB review and reiteration that it involved a non-human subject project evaluation. The intention of this qualitative question was to capture some of the helpful verbal feedback being received from participants. The question asked participants to respond in an open text format to the question, "After completing this program, has your understanding of your pain changed, and if so, how has it changed? In other words, how did this program influence your own pain story?"

The survey link was available on the webpage before the first module and at the end of the second module. Survey data were entered using a coded de-identifier so the participants survey results remained confidential. When a survey was completed, the results were forwarded to a secure email account.

Data Analysis

This pre- and post-survey data analysis examined whether the pain neuroscience online program increased participants' understanding of the biopsychosocial mechanisms of chronic pain. A paired t-test was used to compare pre-program rNPQ scores with post-program rNPQ scores. The qualitative question responses were analyzed for themes using methods of content analysis and related to how the participants' conceptualizations of pain had changed after participating in the program. Because pain reconceptualization is associated with more health-promoting pain perceptions and reduced disability (Louw et al, 2016), an improvement in pain and functioning in participating residents was anticipated as an additional benefit but was not the direct goal of this project.

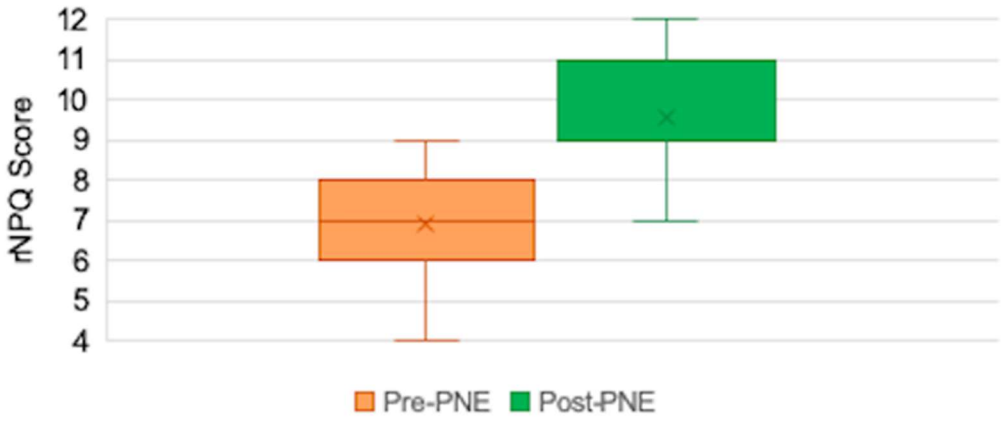
Results

Quantitative Data

A major aim of this project was to measure changes in knowledge of pain using the revised *Neurophysiology of Pain Questionnaire* pre- and post- PNE. Despite high enrollment in the program (26 people), only nine participants successfully completed both the before- and after-PNE surveys. Quantitative survey data from these participants were analyzed using a paired t-test to compare pre-education scores with post-education scores on a 12-item survey (scored out of 12 points). Post-PNE rNPQ scores showed a significant ($p = 0.02$) improvement over pre-PNE rNPQ scores *[See Figure 1, below]* with an average score increase of 2.7 points. Prior to PNE the mean rNPQ score was 6.9 and post-PNE the mean rNPQ score was 9.6. Seven out of the 9 respondents showed improved scores following PNE, and two of 9 respondents scored the same on both pre- and post- PNE surveys.

Figure 1

Results of online PNE modules at SHA



Note. Pair t-test results showing change in rNPQ scores pre- and post- PNE.

Qualitative Data

Another project aim was to assess changes in participants' understanding and interpretations of pain using a qualitative, open-ended question about the influence of the PNE program on their own pain stories. Given that the qualitative question was added only for the second round of recruiting, only five qualitative responses were collected. Nevertheless, a consistent theme emerged. The qualitative question asked, "After completing this program, has your understanding of your pain changed, and if so, how has it changed? In other words, how did this program influence your own pain story?" All respondents acknowledged factors other than tissue damage or injury can influence the experience of pain, including psychological and cognitive factors, as the quote below demonstrates.

> "My main takeaway is that I now understand it is my brain that determines whether or not I feel pain. That knowledge alone 'changes everything,' by which I mean, it changes the way I even start thinking about the pain and why it is there and what I might do about it."

Another participant emphasized the role of the brain in the quote below.

> "Injury/pain is mediated entirely by the brain. And that treating chronic pain is largely a matter of mind over matter."

Along with an emphasized understanding of the role of the brain, the qualitative responses indicated that respondents recognize that chronic pain is rarely accompanied by a tissue injury as this quote exhibits.

> "With the help of my meditative training, I just tell myself the pain is an illusion & means nothing."

Another theme that emerged from the qualitative data was an increased recognition of the complexity of chronic pain. As one respondent concisely stated,

> "Pain registers in brain. Much more complicated than originally thot."

More specifically, respondents exhibited an understanding that emotional states influence pain perception as is demonstrated in this response:

> "Another very important factor for me is that that knowledge also helps me dial back the great fear that arises within me when I think something might be wrong with me. I now understand that fear alone can help make things feel worse."

One respondent also reported improved function after taking the course in the quote below.

> "Before taking the course, pain had gradually made my left arm useless for many tasks. Now I have reclaimed a number of those functions, such as reaching dishes on shelves over my head."

Another respondent expressed a sense of personal empowerment in addressing their chronic pain and taking back functions after learning about the concept of a hypersensitive alarm

system, a concept in the program that is used to describe the process of central sensitization in chronic pain. The participant stated,

> "I have also greatly appreciated knowing about the possibility of having an extra sensitive alarm system. Now when I think this might be happening, I have a way to see if I can turn down that alarm."

One respondent was initially reluctant to verbally acknowledge their pain as a biopsychosocial process, and emphasized the tissue damage model for chronic pain. This respondent stated

> "The program was informative but I don't think it applies to my current pain."

The participant goes on to state that torn ligaments sometimes never heal. The participant stated,

> "In the last week I tried telling myself that I was healing well and that my pain was gone several times a day but I have felt no ameliorative affect from these affirmations other than my pain subsiding week by week and it's better this week than it was last week but the slight pain is still there."

Still, this participant did state,

> "I think you are on to something. I believe in the power of positive thinking but I don't just use it for pain- I used it for everything. I've traveled the world and I know my worst day is better than the best day for about 70% of the people on this planet."

While this participant initially emphasizes the tissue damage model for pain, by the end of their response, their focus shifts to cognitive influences.

Discussion

The purpose of this project was to evaluate PNE's ability to increase knowledge of pain as a biopsychosocial process among low-income adults as a preventative health education approach. The specific aims were to: 1) Implement high quality evidenced-based pain

neuroscience education online modules at 9 SHA locations in Seattle. 2) Measure changes in knowledge of pain using the revised Neurophysiology of Pain Questionnaire before and after PNE. 3) Assess changes in participants' understanding and interpretations of pain using a qualitative, open-ended question about the influence of the PNE program on their own pain stories. Given that the video content was created specifically for this purpose, the products of this inquiry are both high-quality, evidence-aligned videos as well as quantitative and qualitative data supporting their utility.

The results from the quantitative portion of this project indicate that it is possible to increase participant understanding of advanced, neurobiological concepts using this online-video format. The qualitative portion of this analysis provided evidence that pain reconceptualization did indeed occur in participants. Recall that pain reconceptualization involves embracing four concepts: (i) that pain is not a measure of tissue damage; (ii) that pain is influenced by physical, psychological and social forces; (iii) that as pain persists and becomes chronic, it becomes an even less reliable indicator of the state of the tissues and (iv) that the implicit belief that tissues are in danger positively correlates with pain (Moseley, 2010). The qualitative responses which highlighted the role of the brain, emotions and thoughts in producing pain suggested learning had occurred related to these four core concepts. Additionally, the qualitative data revealed an increase in function and sense of empowerment in addressing pain. This finding was an added benefit of the intervention that was not originally defined as a project aim. Research suggests that individuals who have a better understanding of pain neuroscience have less pain and less pain-related disability (Louw & Zimney et al., 2016). While these were not core aims of this project, it was touching to see participants benefitting in this way.

The Power of the Pain Story

Stories are powerful. They often both reflect and reinforce dominant cultural narratives. A pain story is the narrative that humans attach to their pain experience. Every person who experiences chronic pain has an associated pain story, just by virtue of the cultural nature of the human species. These narratives are often complex, multi-faceted and reflect the culture at large as well as individual values, beliefs and idiosyncrasies. Some individuals believe that their pain will not get better unless they get surgery. Others believe that the pain in their knee is the direct result of bone rubbing up against bone in a joint that is depleted of cartilage. Yet another person may have an optimistic pain story, believing that their body is slowly healing. Modern pain neuroscience research reveals that these types of beliefs, in and of themselves, are likely contributing to the experience of pain. Often pain stories are firmly rooted in the outdated Cartesian Model of pain, wherein pain is theorized as disproportionately related to tissue damage. An overarching goal of the PNE program created for this project was to help participants identify their own pain stories and invite them to amend them to include more health-promoting interpretations of pain.

Limitations

This project contains several limitations, providing directions for future investigation. The participants were recruited using voluntary sampling which may lead to a potential selection bias in the data. Given that only a small subset of participants successfully completed both surveys, that selection bias could be further exacerbated by a low response rate. Participants that did not find the program useful may have discontinued the program prematurely, and likewise, participants who did feel they benefitted from the program may have been more likely to complete it, potentially contributing to the selection bias.

Due to the COVID-19 global pandemic and the associated risk of conducting in person PNE sessions, this project had to be adapted to an online format leading to several potential limitations. The participants of this project are low-income, older adults. Research has shown that all older adults, but especially those over age 65, have more difficulty operating technology and are less likely to use computers. Additionally, access to the Internet or use of the internet may be challenging for both older and low-income adults (Czaja et al., 2006). Together these barriers may have led to results that reflect a sample of relatively younger and more financially secure older adults. That being said, all participants in the program met age and income qualifications necessary for residing in subsidized, senior housing (over age 55, earning between 30% and 80% of the area median income). Another factor influencing the sample was that the videos were only available in English with English subtitles, so the program was only feasible to those who speak and/or read English, which influenced the demographic distribution of participants.

The mode of delivery utilized in this project is also a potential limitation. While various PNE delivery modes have been studied (Louw et al., 2016), very few examine the utility of video-delivered PNE. The majority of research has been conducted on live individual counseling sessions between a patient and provider. Further research is needed to determine if online learning modules are a valid mode of PNE delivery, and until that research is completed, caution should be taken in interpreting these results too broadly.

Conclusion

In today's medical context, with relatively limited treatment options for addressing chronic pain, Pain Neuroscience Education is an effective approach that could be more widely utilized. An online video format that participants can watch at home provides a time-saving

intervention to help providers address this extraordinarily common problem. Research on Pain Neuroscience Education underscores the power of story in shaping our experience of our bodies. By helping participants identify their own pain stories and recognize the cultural narratives that inform them, we can help them to rewrite their stories. This project supports the continued use of the Pain Neuroscience Education online learning modules at SHA as an effective approach to increase understanding of the biopsychosocial mechanisms underpinning chronic pain and as a tool for pain reconceptualization.

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Participating residents at 9 SHA locations

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Clinical Mentor: Caroline Dowdle, Wellness Program Manager

Faculty Mentor: Janiece DeSocio, PhD, ARNP, PMHNP-BC, FAAN

Appendices

Table 1

Practice Guidelines for Recognizing Central Sensitization

Central sensitization is frequently present in various chronic musculoskeletal pain disorders.
Patient with central sensitization are often overwhelmed by all kinds of physical and emotional stressors.
May have hypersensitivity to touch, bright light, sound, smell, hot or cold sensations, mechanical loading of musculoskeletal tissues, and all kinds of physical, mental and emotional stressors.
Hypersensitivity is widespread rather than local.
Clinical tests assessing nociceptive processing may be used to assess presence or severity.
The appearance of new symptoms, aggravation of existing symptoms, not responding to established treatments, post-exertional malaise, or a decreased pain threshold during hands-on treatment.

Note. Summary guide for clinicians to help recognize CS (central sensitization). Summarized from: Nijs et al., 2010.

Table 2

Revised Neurophysiology of Pain Questionnaire

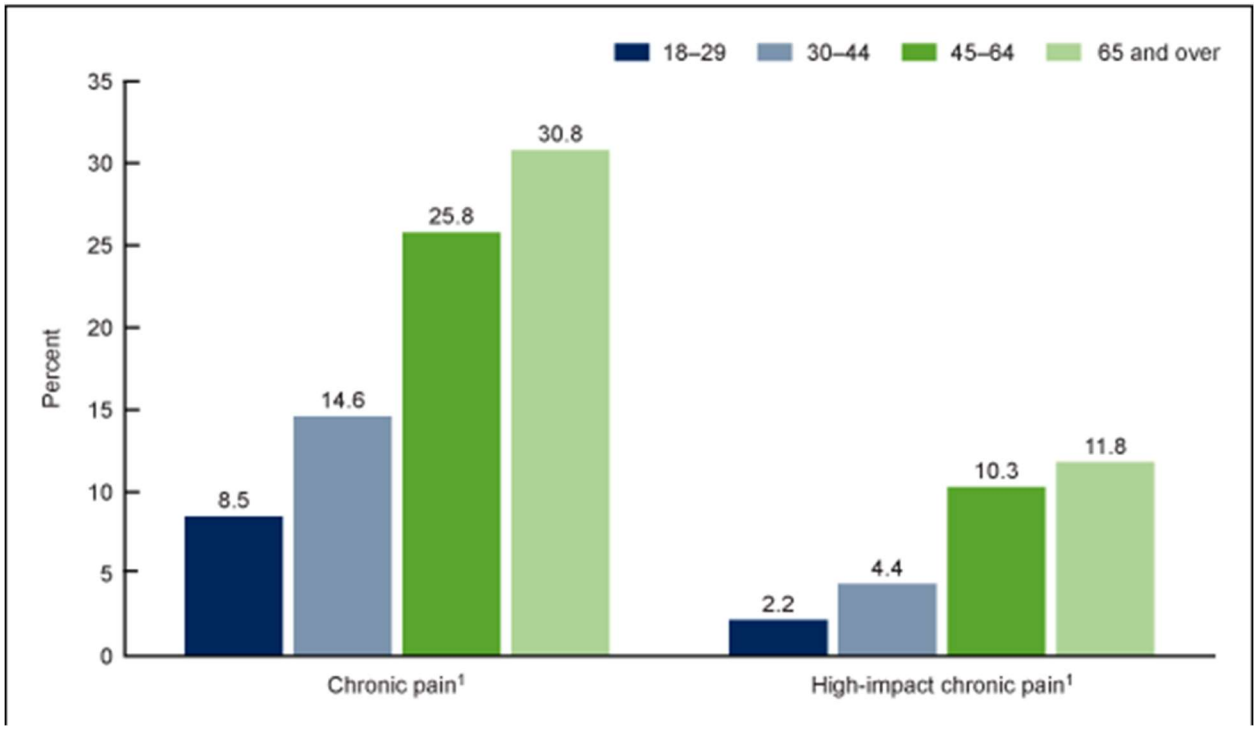
1	It is possible to have pain and not know about it.	True	**False**	Unknown
2	When part of your body is injured, special pain receptors convey the pain message to your brain.	True	**False**	Unknown
3	Pain only occurs when you are injured or at risk of being injured.	True	**False**	Unknown
4	When you are injured, special receptors convey the danger message to your spinal cord.	**True**	False	Unknown
5	Special nerves in your spinal cord convey 'danger' messages to your brain.	**True**	False	Unknown
6	Nerves adapt by increasing their resting level of excitement.	**True**	False	Unknown
7	Chronic pain means that an injury hasn't healed properly	True	**False**	Unknown
8	Worse injuries always result in worse pain.	True	**False**	Unknown
9	Descending neurons are always inhibitory.	True	**False**	Unknown
10	Pain occurs whenever you are injured.	True	**False**	Unknown

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 exactly the same.	True	**False**	Unknown
12	The brain decides when you will experience pain.	**True**	False	Unknown

Note. rNPQ items were adapted from Nogiera et al., 2018.

Figure 2

Percentage of adults aged 18 and over with chronic pain and high-impact chronic pain in the past 3 months, by age group: United States, 2019



Note. Chronic Pain and High-impact Chronic Pain Among U.S. Adults (Zelaya, et al., 2020)

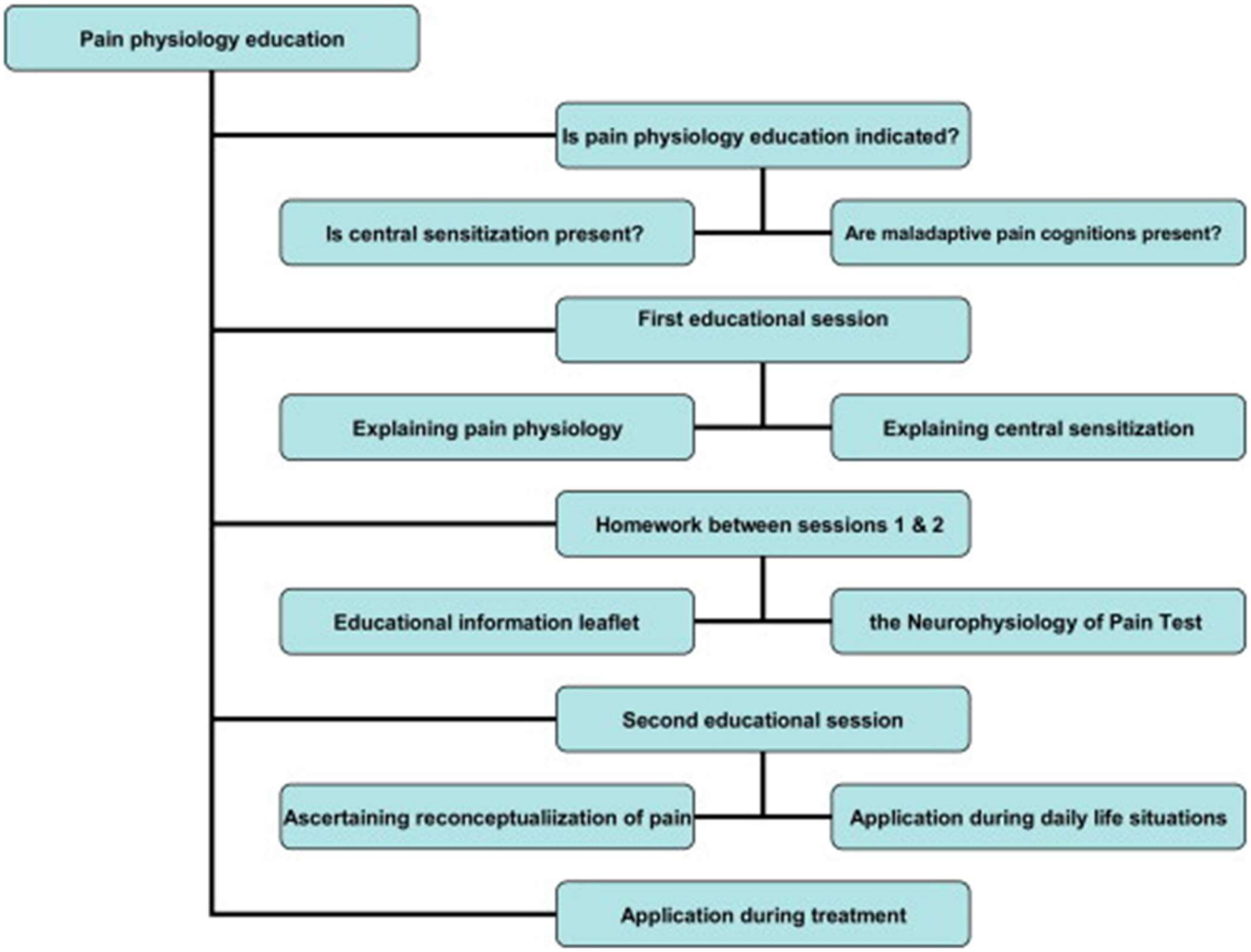
Figure 3

Cartesian Depiction of Signal Transduction

Note. René Descartes, 'The Path of Burning Pain', 1664. Wellcome Library M0014440

Figure 4

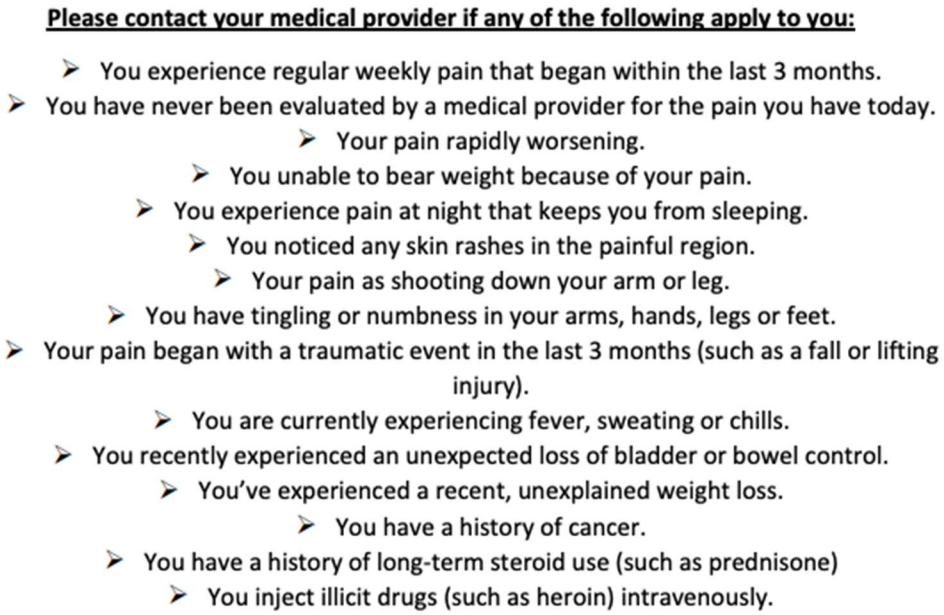
Clinical Guideline for Structuring PNE



Note. Clinical guidelines for pain physiology education in patients with chronic musculoskeletal pain (Nijs et al., 2011).

Figure 5

Red Flags Informational Sheet



Note. Screening conducted before start of PNE.