TRAUMA RELEASING EXERCISES: A POTENTIAL TREATMENT FOR CO-OCCURRING POST-TRAUMATIC STRESS DISORDER AND NON-SPECIFIC CHRONIC LOW BACK PAIN

A dissertation presented to the Faculty of
Saybrook University in partial fulfillment of the requirements for
the degree of Doctor of Philosophy (Ph.D.) in Mind-Body Medicine

by

Beverly S. Swann

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Approval of the Dissertation

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This Dissertation by Beverly S. Swann has been approved by the committee members below, who recommend it be accepted by the faculty of Saybrook University in partial fulfillment of requirements for the degree of

Doctor of Philosophy in Mind-Body Medicine

Dissertation Committee:

Selene Vega, Ph.D., Chair _____ Date _____

Werner Absenger, Ph.D. _____ Date _____

Stephanie Lindsay, Ph.D. _____ Date _____

Abstract

TRAUMA RELEASING EXERCISES: A POTENTIAL TREATMENT FOR CO-OCCURRING POST-TRAUMATIC STRESS DISORDER AND NON-SPECIFIC CHRONIC LOW BACK PAIN

Beverly S. Swann

Saybrook University

This study examined whether a 4-week, three times per week practice of Trauma Releasing Exercises (TRE) would reduce symptoms for adults with co-occurring post-traumatic stress disorder (PTSD) and non-specific chronic low back pain (nsCLBP). There is significant co-occurrence of nsCLBP and PTSD (Dunn, Passmore, Burke, & Chicoine, 2009; Loncar, Curic, Mestrovic, Mickovic, & Bilic, 2013). A link between the two conditions is chronic muscle tension, which may be reduced by using TRE (Berceli, 2005, 2008).

The study design was a randomized-controlled trial with repeated measures. A control group practiced progressive muscle relaxation (PMR). Participants (n = 11) were adults with prior diagnoses of both PTSD and nsCLBP. All data were gathered confidentially online using SurveyMonkey. Four types of data were gathered: screening, demographic, symptom-related, and self-practice data. Data analysis consisted of measures of central tendency for demographic data and variables.

Most participants in the control group did not complete the study. With limited data, most results did not reach statistical or clinical significance and were inconclusive. A statistically significant decrease in physical distress occurred for the control group after the

training. There was a clinically significant decrease in PTSD symptoms for the TRE group at the end of the 4-week self-practice period. Participants in the TRE group did self-practice, averaging between 2.67 and 3.50 times per week.

Study results did not provide sufficient evidence to support the hypotheses or answer the research question, but valuable lessons were learned that will contribute to future research. Major gaps in the literature include: the use of TRE, the role of muscle tension in PTSD, and the differences between acute and chronic muscle tension. Training and self-practice of TRE resulted in decreases of PTSD symptoms. This result supports its potential use as a treatment for PTSD. Participants did self-practice but reported they did so because they were supposed to. These data support the use of self-help techniques, but only with a high degree of accountability.

Dedication

This work is dedicated to the many people who suffer from both low back pain and post-traumatic stress injuries, particularly first responders. May the research in some way contribute to relief and healing for all of you.

Acknowledgments

Many people have provided support, guidance, assistance, and knowledge toward my dissertation. Although it is not possible to list everyone who has been on this journey with me, I want to acknowledge those who have played key roles. I cannot personally acknowledge the brave volunteers who participated in the study, but I am very grateful to them for their courage and persistence.

This dissertation almost did not happen. In the spring of 2014, I was enrolled in a different PhD program and made the very difficult decision to drop from the program. I discovered I could not perform the cognitive integration of ideas that is required for academic writing, something I had previously enjoyed and found relatively easy prior to two mild traumatic brain injuries. Dr. Rachyll Dempsey and Dr. David Hawkey, I can never thank you enough for helping me to identify and accept the cognitive disabilities. Working with you was a turning point in being able to understand what was happening and how to work with and around the blocks.

For their guidance, flexibility, humor, and unwavering belief in my work, I am very grateful to my committee chairperson, Dr. Selene Vega, and committee members Dr. Werner Absenger and Dr. Stephanie Lindsay. I could not have asked for a more wonderful team! Dr. Devorah Curtis, who served multiple roles in the College of Integrative Medicine and Health Sciences during my time at Saybrook University, has also been a great source of support and inspiration.

Several people took the time to review part or all of this voluminous work and provide feedback. Dr. David Berceli provided expertise about Trauma Releasing Exercises (TRE) and assisted in recruiting participants. Dr. Deirdre Rogers consulted on data analysis as well as

provided general support. Carrie Lin and Katherine Segal generously volunteered to test and proofread all of the online materials. Ladies, you did a fantastic job at catching my typos! Mary Shriver, Nkem Ndefo, and Ranji Ariaratnam provided valuable insight into uses of TRE as well as connecting me to folks who were researching TRE. Brooke Deputy helped with recruiting efforts and was a wonderful support.

My good friend Nancy Cowell-Miller created the original artwork that became the logo for my recruiting materials. It provided a lovely focal point for the study in my mind, and it now hangs in my Integrative Wellness Studio. Other good friends Julie Levin, Joyce Caldeira, and Valerie Keim have been my cheerleaders, as has my sister Nila Jamerson. Fellow students Dr. Ashlie Bell and Dr. Katrina Anderson joined me early on in peer support meetings because our dissertation topics were related. Thank you for all the support along the way, particularly through some of the tougher times.

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CHAPTER 1: INTRODUCTION

There is significant co-occurrence of post-traumatic stress disorder (PTSD) and non-specific chronic low back pain (nsCLBP) in adults, ranging from 16% (Dunn, Passmore, Burke, & Chicoine, 2009) to 25.1% (Loncar, Curic, Mestrovic, Mickovic, & Bilic, 2013) of people being treated for either of the conditions. Very little is known about effective treatment for people with both conditions. Multiple factors affect traditional treatment, and multiple barriers prevent people from seeking or receiving treatment (Kempson, 2007; Lewis, Roberts, Vick, & Bisson, 2013; Sayer et al., 2009; Slade, Molloy, & Keating, 2009).

A promising technique that may be helpful for treating both conditions is Trauma Releasing Exercises (TRE), a self-help method developed to release chronic muscle tension and reduce anxiety (Berceli, 2005, 2008, 2015). It can be used as a self-help tool or with a facilitator, and either individually or in groups. To date the only peer-reviewed research on TRE is a pilot study focused on anxiety (Berceli, Salmon, Bonifas, & Ndefo, 2014), leaving a large gap in the literature regarding the use and effectiveness of TRE. Psychological theories and treatments featuring muscle tension as a primary cause of pathology date back to Freud and Janet (Atarodi & Hosier, 2011; Ruden, 2008). They provide a basis for proposing the use of TRE as a treatment for PTSD and nsCLBP.

The objective of TRE is to utilize *tremoring*, theorized as a natural response to stress, to release chronically-held muscle tension (Berceli, 2005, 2008). Tremoring, or shaking, has been observed in humans and many mammals after they have experienced a stressful event (Berceli, 2005, 2008; Levine, 1997). The TRE technique specifically targets the iliopsoas muscles, more commonly known as psoas muscles, as the center of chronic muscle tension (Berceli, 2005, 2008, 2015). The psoas muscles attach to the spine as well as to the top of the femur. They are

the only muscles that connect the upper part of the body to the lower part (Staugaard-Jones, 2012). Chronic tension in the psoas muscles is indicated in nsCLBP (Andersen, Andersen, Vakkala, & Elklit, 2012; Arbanas et al., 2013; Iglesias-González, Muñoz-García, Rodrigues-de-Souza, Alburquerque-Sendín, & Fernández-de-las-Peñas, 2013). Tension in the psoas muscles has been linked to PTSD in rat studies, which may indicate the potential for similar tension in humans (Nelson, DeMartini, & Heinrichs, 2010). There is also some evidence that connects muscle tension to PTSD in humans (Kim & Yu, 2015; McDonagh-Coyle et al., 2001; Nyboe, Bentholm, & Gyllensten, 2017). This dissertation study investigated whether TRE is an effective treatment technique for people who have co-occurring PTSD and nsCLBP.

Background

The rationale for proposing TRE as a treatment for co-occurring PTSD and nsCLBP draws on several concepts: (a) the theory behind TRE; (b) key terms and definitions; (c) co-occurring PTSD and nsCLBP; (d) treatment considerations when both conditions are present; (e) current barriers to treatment; and (f) theories related to one or both conditions. This section provides background information on each of these concepts.

Tension and Trauma Releasing Exercises (TRE)

Tension and Trauma Releasing Exercises (Berceli, 2005, 2008, 2015) was developed to invoke *self-induced therapeutic tremoring (SITT)*. Tremoring is thought to release chronically held muscle tension. The TRE technique can be used as a self-help tool or with a facilitator, and either individually or in groups. Once learned, TRE requires no special equipment or travel to a treatment facility.

Berceli (2005, 2008) spent many years providing humanitarian aid in war-torn countries. He became curious about two reactions to traumatic experience that seemed to be present in

people regardless of culture or class. First, he noticed that people always curled their bodies inward when bombs exploded. Second, he noticed that children shook when bombs exploded, but adults did not. He asked the adults about his observations, and they responded that they did not want the children to know they were scared (Berceli, 2005, 2008).

From these observations, Berceli (2005, 2008) theorized that curling the body required muscle contraction, particularly of the psoas muscles. He believed that shaking, also referred to as tremoring, was the way the body released muscle contraction. He also theorized that adults learned to suppress tremors to avoid appearing scared or weak, and that suppressed tremoring led to chronic muscle contraction or tension (Berceli, 2005, 2008, 2015).

Using seven sequential exercises to progressively activate and relax muscles gently and safely, TRE specifically targets the psoas and other hip flexor muscles as the central location of chronic muscle tension (Berceli, 2005, 2008, 2015). The psoas muscles attach to the mid-spine and the tops of the femurs in both legs, making them the only muscles connecting the upper and lower body (Koch, 2012; Staugaard-Jones, 2012). The psoas muscles are key in curling the body inward, and chronic tension in the psoas muscles is linked to both nsCLBP and PTSD (Andersen et al., 2012; Flor, Turk, & Birbaumer, 1985; Iglesias-González et al., 2013; Nelson et al., 2010).

The goal of TRE is to allow the body to tremor naturally. These tremors are currently known as self-induced therapeutic tremors (SITT) but have also been called *neurogenic tremor* and *self-induced unclassified tremor* (Berceli, 2005, 2008, 2015; Berceli et al., 2014). The tremors vary widely from person to person, session to session, and even within a session. According to Berceli (personal communication, June 26, 2015), frequency and velocity of tremors are irrelevant to therapeutic benefit. Following the individual body's urge to tremor through to completion is thought to release muscle tension (Berceli, 2008, 2015).

Interventions Related to TRE

As with most complementary and alternative medicine interventions, research on TRE is in its infancy. There is some research available on other interventions that are based on similar concepts of stored muscle tension and release of that tension. These interventions are: Somatic Experiencing (SE), Rosen Method Bodywork (RMB), and Bioenergetics (BE).

Somatic Experiencing is a form of somatic psychotherapy that was developed based on observations of animals in the wild. The creator of SE, Peter Levine, observed predator and prey animals and noticed that prey animals always shook after reaching safety (Levine, 1997). He developed a psychotherapy method based on building self-awareness of body sensations and releasing stored tension related to trauma. Berceli (2008) connected his theory to Levine's work in terms of the similarity between shaking and tremoring.

Bioenergetics is also a somatic psychotherapy, based on the work of Alexander Lowen (1995). Bioenergetics utilizes a combination of talk therapy and physical exercises, which is meant to facilitate the release of stored tension from the body. The talk therapy approach and exercises are modified to fit individual needs.

Rosen Method Bodywork is not psychotherapy and is adapted from massage therapy principles. This intervention includes verbal techniques to help clients increase self-awareness (Fogel, 2013). Rosen Method Bodywork is purported to result in relaxation and decreased muscle tension (Fogel, 2013; Hoffren-Larsson, Gustafsson, & Falkenberg, 2009).

A difference between TRE and these related interventions is that the related interventions are all services that are delivered or facilitated by trained professionals, whereas TRE can be performed by anyone once an initial training is completed. Although some comparisons can be

made between TRE and these related interventions, TRE is unique in that it was designed to be a self-help tool for people without access to professionals (Berceli, 2005).

Key Terms and Definitions

Terms from multiple disciplines are used throughout this dissertation. Some terms have historically been used in different ways, and some do not have consistent, accepted meanings. To assist the reader, definitions for key terms as they are used here are presented in Table 1.

Post-Traumatic Stress Disorder (PTSD)

Post-traumatic stress disorder is defined in the *Diagnostic Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5) as a condition that develops after an individual has experienced one or more traumatic events (American Psychiatric Association (APA), 2013a). It is estimated that 8.7% of people in the US will experience PTSD over the course of a lifetime (APA, 2013a). Traumatic events occur whenever a person feels endangered or feels that someone close to them is in danger. Examples of traumatic events include car accidents, experiences of violence or sexual abuse, and participation in combat or first responder duties. Multiple symptoms lasting more than one month include intrusive thoughts or memories, dissociation, avoidance of triggers, negative moods, and hyperarousal (APA, 2013a).

Hyperarousal is of particular interest in this research study. Symptoms related to hyperarousal are: (a) irritability and aggressive behavior; (b) out of control or self-injurious behavior; (c) hypervigilance; (d) exaggerated startle response; (e) concentration problems; and (f) sleep problems (APA, 2013a). Hyperarousal is closely related to fight-or-flight responses through activation of the sympathetic nervous system (SNS), which regulates muscles and other body parts in response to threat (Porges, 2011; Siegel, 1999).

Table 1

Key Terms and Definitions

Term	Acronym	Definition
Electromyography	EMG	A method of measuring muscle activity and tension through electrodes placed on the surface of the skin.
Hyperarousal	--	A physiological state of high alert where the body is prepared to deal with danger (Weston, 2014). It is associated with a symptom cluster of PTSD, including sleep problems, irritability, reckless or self-harming behavior, concentration problems, hypervigilance, and exaggerated startle response (APA, 2013a; Weston, 2014).
Non-specific chronic low back pain	nsCLBP	Uncomfortable sensation, stiffness, or muscle tension centered at the lower end of the spine that is not related to injury or disease and lasts at least three months (Koes, Van Tulder, & Thomas, 2006).
Paraspinal muscles		Refers to a group of muscles in the low back and hip area that attach to the spine, including the iliopsoas and other hip flexor muscles.
Post-traumatic stress disorder	PTSD	A psychological diagnosis characterized by both physical and psychological symptoms including hypervigilance, exaggerated startle response, nightmares, insomnia, and flashbacks (APA, 2013a).
Self-induced therapeutic tremor	SITT	A shaking or tremoring process that is thought to release chronically held muscle tension (Berceli, 2015). SITT is formerly known as neurogenic tremor (Berceli, 2008) or self-induced unclassified therapeutic tremor (Berceli et al., 2014).
Somatic psychotherapy	--	A general term for many forms of psychotherapy that feature body-oriented concepts.
Sympathetic nervous system	SNS	Refers to the branch of the autonomic nervous system that is responsible for regulating fight/flight/freeze responses.
Tension and Trauma Releasing Exercises	TRE	A body-based self-help technique that invokes self-induced therapeutic tremoring to release chronic muscle tension and reduce anxiety (Berceli, 2005, 2008, 2015).

Weston (2014) made an argument for studying the hyperarousal subtype of PTSD separately from other symptoms because of the role hyperarousal plays in increasing other symptoms of PTSD. He theorized that in PTSD the amygdala, a part of the brain responsible for processing incoming messages and deciding whether there is danger, misinterprets incoming stimuli and sends out the message to multiple systems to continue being alert when there is no actual danger (Weston, 2014). The SNS is one of those systems, and it signals muscles to stay alert. An alert muscle is contracted or tense. With the connection between SNS activation and hyperarousal symptoms, it may be appropriate to target this set of symptoms with a technique that purports to relax muscles.

Non-Specific Chronic Low Back Pain (nsCLBP)

Several different terms are used to discuss nsCLBP: low back pain (LBP), lower back pain, chronic low back pain (CLBP), and lumbar pain. Back pain may be acute, with sudden onset and lasting a few days, or it may be chronic and lasting three or more months (Balagué, Mannion, Pellisé, & Cedraschi, 2012; Koes et al., 2006). About five percent of low back pain becomes chronic (Koes et al., 2006). Low back pain is the primary cause of disability across the world, and most low back pain has no diagnosed cause (Hartvigsen et al., 2018).

Non-specific chronic low back pain refers to back pain not directly attributable to specific illness or injury. About 90% of reported low back pain is non-specific, and it is difficult to diagnose and treat with traditional medical interventions (Hartvigsen et al., 2018; Koes et al., 2006). An estimated 84% of U.S. adults will experience low back pain during their lifetime, and 23% will have nsCLBP. Non-specific chronic low back pain was chosen for this study because it is the most common type of pain, and because it may be most closely related to chronic muscle tension (Koes et al., 2006; Scaer, 2007).

Co-Occurring PTSD and nsCLBP

Co-occurring PTSD and nsCLBP have been studied from different angles. In some studies, participants with PTSD were surveyed for pain disorders or low back pain. In others, patients at pain clinics were assessed for PTSD symptoms. The two conditions occur together with enough frequency to consider treatment that addresses both conditions (Gibson, 2012; Otis, Keane, & Kerns, 2003; Sharp & Harvey, 2001). The mutual maintenance theory suggests that the two conditions work together to make either one difficult to treat separately (Sharp & Harvey, 2001).

Estimates of the rate of co-occurrence of nsCLBP and PTSD vary widely between populations. In a study of 304 patients at pain clinics in Denmark and Finland, 70 people (23.0%) met the criteria for PTSD with CLBP ranking as the most prevalent type of pain (Andersen et al., 2012). Similarly, of 130 veterans being treated for either neck or back pain in western New York, 21 (16.2%) met the criteria for PTSD, with low back pain being the most prevalent type of pain (Dunn et al., 2009). A retrospective chart review in Atlanta of 85 veterans with PTSD showed that 66% of the participants had a chronic pain condition, with 18.8% having co-occurring PTSD and CLBP (Shipherd et al., 2007). At the high end of the range, women who had been in intimate partner violence relationships showed a 75% prevalence of co-occurring PTSD and chronic pain, though the study did not separate out low back pain (Humphreys, Cooper, & Miaskowski, 2010).

There are several reasons to study effective treatments for these co-occurring conditions. The presence of PTSD symptoms often goes unrecognized or is ignored when treating low back pain (Andersen, Ellegaard, Schiottz-Christensen, & Manniche, 2018). Interactions between the two conditions may negatively impact each other (Otis, Keane, Kerns, Monson, & Scioli, 2009),

and traditional treatments for either condition are often less effective or are sometimes ineffective for people with both conditions (Gibson, 2012; Otis et al., 2009). For example, chronic pain itself may be experienced as traumatic and add to symptoms of pre-existing PTSD. With the number of wounded and traumatized veterans returning from Iraq and Afghanistan, there is a need for more effective and accessible treatments for co-occurring PTSD and pain conditions (Gibson, 2012). Treatment barriers for each of the conditions become compounded when both are present, making self-help techniques desirable alternatives (Lewis et al., 2013).

Treatment Barriers

There are many reasons why people do not seek or receive treatment for PTSD, nsCLBP, or co-occurring PTSD and nsCLBP. A qualitative study using focus groups with 18 adults who had nsCLBP found that people often felt that professionals did not listen to them or actively engage them in care decisions (Slade et al., 2009). People with pain conditions often suffer from depression, anxiety, and substance abuse issues, reducing motivation to seek treatment (Gibson, 2012; Humphreys et al., 2010; Morasco et al., 2013).

People with PTSD also frequently experience co-occurring conditions of depression, anxiety, and substance abuse. Additionally, people with PTSD may fear being judged by others for having a mental disorder and may not seek treatment (Sayer et al., 2009). Other treatment barriers include: frustration with administrative procedures, particularly for veterans (Sayer et al., 2009); difficulty accessing treatment in rural areas (Lewis et al., 2013); and dissatisfaction with traditional medications and other treatments (Gibson, 2012). Many of these barriers might be reduced or eliminated with the use of TRE, as it is non-invasive, can be done privately, and does not require a medical professional or travel to a facility once the technique is learned.

Rationale

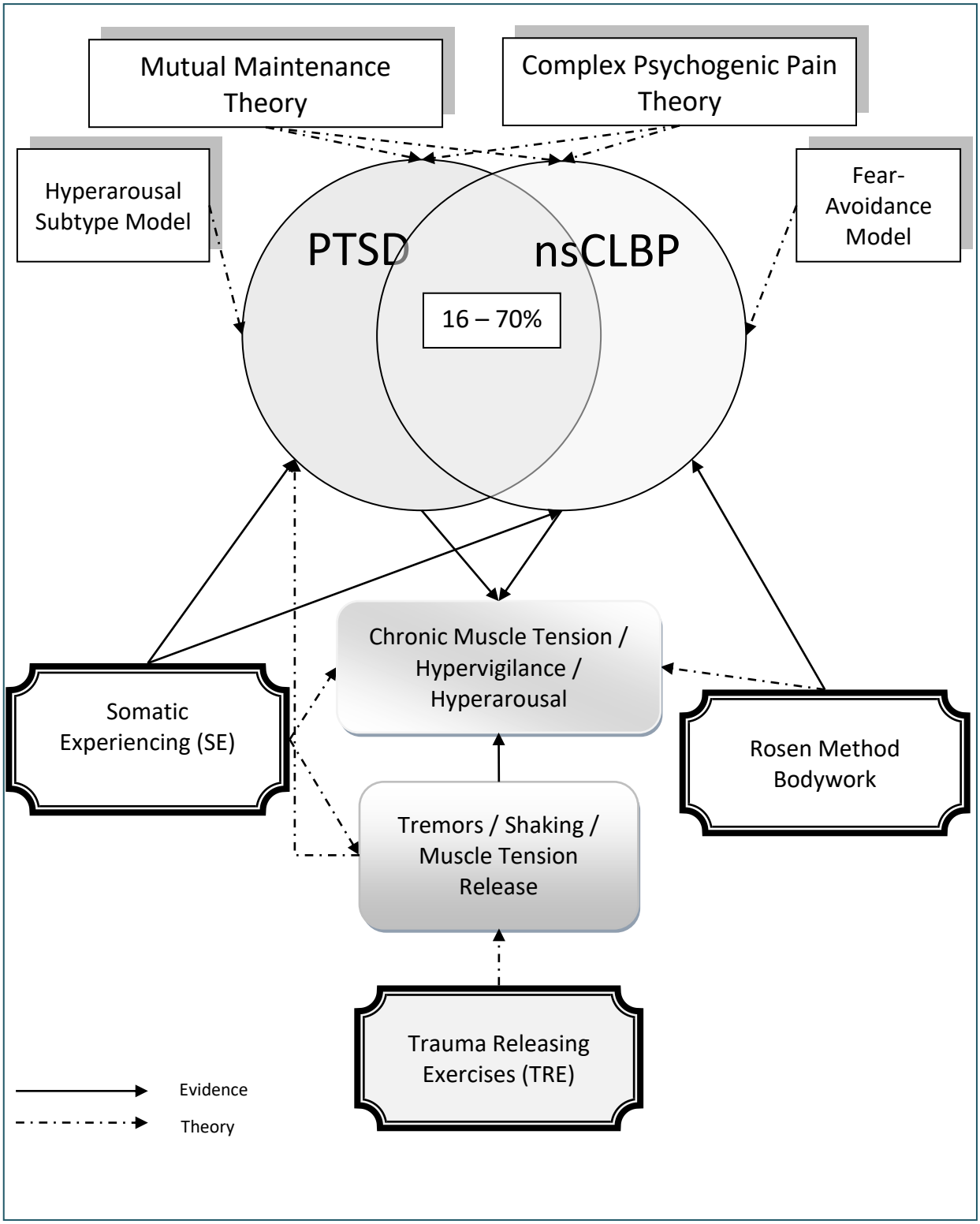
Figure 1 depicts relationships between: (a) symptoms of, and theories regarding, co-occurring PTSD and nsCLBP; (b) chronic muscle tension and the release of chronic muscle tension; (c) TRE; and (d) two modalities that are similar to TRE in including the release of tension as part of healing, Somatic Experiencing and Rosen Method Bodywork. Connections supported by research are represented by a solid line; those proposed by theory are represented by a dashed line.

Theoretical Models

Four theoretical models are presented to support researching TRE as a treatment for co-occurring PTSD and nsCLBP. These theoretical models are mutual maintenance theory, complex psychogenic pain theory, fear-avoidance model, and hyperarousal subtype model. Each are explained briefly in the following sections.

Mutual maintenance theory. This theory ties together similar physical and psychological aspects of both PTSD and chronic pain and summarizes them into seven factors that interact and lead to mutual maintenance of the co-occurring disorders (Sharp & Harvey, 2001). The seven factors are: "attentional and reasoning biases, anxiety sensitivity, reminders of the trauma, avoidance, depression and reduced activity levels, anxiety and pain perception, and cognitive demand from symptoms limiting use of adaptive strategies" (Sharp & Harvey, 2001, p. 870). These complex interactions make successful treatment difficult. Connecting the mutual maintenance theory to the practice of TRE, it is possible that the experience of developing a felt sense of safety in one's body may reduce attentional biases, anxiety, and avoidance behaviors, which would then reduce overall symptom levels for both disorders.

Figure 1. Relationships Between Theories, Conditions, Treatments, and Muscle Tension



Complex psychogenic pain theory. This theory provides a psychophysiological explanation for non-specific, or *psychogenic*, pain and for PTSD symptoms. Psychogenic pain has been theoretically linked to traumatic experience (Atarodi & Hosier, 2011). This type of pain is believed to be stored in memory as a result of suppressed fear or anger from a traumatic experience (Ruden, 2008). An example of anger or fear that was suppressed during a traumatic event might be the experience of being held hostage, where the person experiences fear and anger but is powerless to do anything. Since the person cannot act on these emotions, the need to act becomes trapped in memory and reappears as pain in the affected body areas or as the hyperarousal symptoms of PTSD (Ruden, 2008). Practicing TRE is thought to allow this kind of stored tension to move through to completion so that it is no longer held in the body. Following this theory, releasing muscle tension related to trauma would reduce or eliminate psychogenic pain.

Fear-avoidance model. This model, which is related to back pain, proposes that people with back pain are afraid of exercise and movement because of a belief that it will cause more pain or injury. This belief causes them to avoid physical activity (Glombiewski et al., 2015; Pincus, Smeets, Simmonds, & Sullivan, 2010). Since movement and exercise are an integral part of treatment for back pain, this avoidance leads to increased pain and disability as the person moves less and muscles become stiff from disuse. Sedentary people who are in pain may pay more attention to their pain and body sensations, increasing awareness and hypervigilance. It can become a vicious cycle of increasing hypervigilance, leading to increased anxiety and tension, which then leads to increased pain (Pincus et al., 2010). This cycle could potentially be changed by using TRE. The training for TRE includes a focus on safety and gentle, painless movement. It also includes many modifications for people with pain or mobility issues. The

experience of performing TRE without pain might then lead to more confidence in being able to move, as well as to reductions in the sensations that are setting off the cycle. This model is of particular importance to the current research study because fear of movement may be a barrier to self-practice of TRE.

Hyperarousal subtype model. The hyperarousal subtype this model is related to PTSD and its symptoms. According to this model, the amygdala plays a primary role in PTSD. It is a central processor of incoming messages about sensations and internal states, which include physiological arousal, levels of stress hormones, and amounts of pain. It also sends outgoing messages about danger or safety from the brain to many body systems (Weston, 2014). When these states are sensed as extreme, the amygdala can misinterpret them as a threat and send out messages that the body is in danger. The person then reacts as if a traumatic event is occurring even when there is no immediate danger, with increased heart and respiratory rates, increased muscle tone, and other reactions to support fight or flight (Weston, 2014).

Over time, these overreactions can become neurological patterns and can be generalized to similar sensations or states, a process known as *kindling* (Scaer, 2005). An example of kindling might involve a person who was bitten by a German shepherd dog as a child. The person might initially be afraid of German shepherds and then over time become afraid of all dogs, eventually leading to a fear of leaving home because of a potential encounter with a dog. At that point, going to the grocery store would feel like a dangerous and possibly traumatic event. The end result of this process is the set of symptoms associated with the hyperarousal subtype for PTSD (Scaer, 2007; Weston, 2014).

When the amygdala is overreactive, it is likely to increase the other symptoms of PTSD. In other words, hyperarousal symptoms are a catalyst or an intensifier for other types of PTSD

symptoms (Weston, 2014). If TRE can reduce hyperarousal by calming a hyperactive amygdala, then it is likely to decrease other PTSD symptoms. A significant PTSD symptom of interest in this study is muscle tension, which may be causing or exacerbating nsCLBP.

Research Question

Will a 4-week, three times per week practice of Tension and Trauma Releasing Exercises (TRE) significantly reduce symptoms of co-occurring non-specific chronic low back pain (nsCLBP) and post-traumatic stress disorder (PTSD) among a sample of adults in comparison to a control group using Progressive Muscle Relaxation (PMR)?

Hypotheses

H_1: Four weeks of self-practice of TRE will provide significantly better symptom relief of nsCLBP than PMR.

H_2: Four weeks of self-practice of TRE will provide significantly better symptom relief of PTSD than PMR.

H_0: Four weeks of self-practice of TRE will have little or no significant impact on symptoms of nsCLBP or PTSD.

Sub-Problems

In addition to the primary research question, other questions investigated in this study were:

- If TRE is effective at treating either condition, will age, income level, work/personal factors, medications, current other treatment, or other demographic exposures affect the results?
- Will participants self-practice regularly?
- Does frequency of self-practice impact symptom reduction for PTSD?

- Does frequency of self-practice impact symptom reduction for nsCLBP?

To determine whether there is existing research to answer any of these questions or to support the hypotheses, the following chapter presents a literature review of relevant topics.

CHAPTER 2: LITERATURE REVIEW

Literature Review Objective

The objective of the literature review was to gain a better understanding of whether TRE might be effective in treating co-occurring nsCLBP and PTSD. The primary link between TRE and the two conditions seems to be muscle tension. Three separate database searches were conducted with the goal of locating and summarizing relevant literature regarding (a) muscle tension and nsCLBP; (b) muscle tension and PTSD; and (c) TRE and related interventions.

The literature review was prepared according to the guidelines for Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Liberati et al., 2009). These guidelines were developed to support clear reporting of how studies are selected for inclusion in literature reviews, with a special focus on reviews that are examining interventions (Liberati et al., 2009; Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009). The PRISMA guidelines are also an attempt to standardize the way review articles are published and to facilitate replication of studies. The PRISMA format was chosen for the review because the focus is research on TRE as an intervention and on related interventions.

Literature Review Methods

Protocol and Registration

The PRISMA guidelines provide specific protocols for systematic reviews that are intended for publication (Moher et al., 2009). Systematic reviews can also be registered as having met these protocols. A formal review protocol and registration were not used in the review as it is not a systematic review intended for separate publication.

Eligibility Criteria

For the three database searches, all peer-reviewed items were included. Criteria for excluding items are described in the sections on screening.

Information Sources

Table 2 lists the electronic databases that were searched using relevant key terms with no limits. Additional articles were located from reference lists of review articles, from the research website for TRE (TRE For All, 2019), and from suggestions from database alerts. Supplemental information about ongoing and unpublished TRE research was obtained from an international group of TRE researchers (Current TRE Research Worksheet, personal communication, April 26, 2016).

Table 2

Electronic Databases Included in Searches

Vendor	Databases	Date
American Psychiatric Association	Psychiatry Online	10/8/18
Annual Reviews	Annual Reviews	10/1/18
Association of Transpersonal Psychology	Journal of Transpersonal Psychology	10/8/18
Digital Commons Network		10/1/18

Table 2

Electronic Databases Included in Searches

Vendor	Databases	Date
EBSCO	Academic Search Premier; AHFS Consumer Medication Information Alt HealthWatch; ATLA Religion Database with ATLASerials; Business Source Elite; CINAHL Complete; eBook Academic Collection (EBSCOhost); eBook Collection (EBSCOhost); Education Source; ERIC; Family & Society Studies Worldwide; Family Studies Abstracts; Funk & Wagnalls New World Encyclopedia; GreenFILE; Health and Psychosocial Instruments; Health Source - Consumer Edition; Health Source: Nursing/Academic Edition; LGBT Life with Full Text; Library, Information Science & Technology Abstracts; MEDLINE; Mental Measurements Yearbook with Tests in Print; Military & Government Collection; Newspaper Source; Primary Search; Regional Business News	10/1/18
Elsevier	Science Direct Collections [Combined] – Health Sciences, Neuroscience, and Psychology	10/1/18
Emerald	Emerald Fulltext	10/1/18
Gale	Nursing and Allied Health Collection	10/8/18
Google	Google Scholar	10/8/18
H-RAF	E-HRAF World Cultures	10/1/18
Mary Ann Liebert, Inc.	Alternative and Complementary Therapies; Ecopsychology; Journal of Alternative and Complementary Medicine: Research on Paradigm, Practice, and Policy; Journal of Medicinal Food; Journal of Alternative and Complementary Medicine: Research on Paradigm, Practice, and Policy; Journal of Medicinal Food	10/8/18
National Library of Science	PubMed	10/8/18
Natural Standards	Natural Medicines Database	10/8/18

Table 2

Electronic Databases Included in Searches

Vendor	Databases	Date
ProQuest	Academic Video Online; Dissertations & Theses @ Chicago School of Professional Psychology; ERIC; Ethnic NewsWatch; GenderWatch; PAIS; PILOTS: Published International Literature On Traumatic Stress; ProQuest Central (ABI/INFORM Collection, Accounting, Tax & Banking Collection, Arts & Humanities Database, Asian & European Business Collection, Australia & New Zealand Database, Biology Database, Business Market Research Collection, Canadian Business & Current Affairs Database, Canadian Newsstream, Career & Technical Education Database, Computing Database, Continental Europe Database, Criminal Justice Database, East & South Asia Database, East Europe, Central Europe Database, Education Database, Family Health Database, Global Breaking Newswires, Health & Medical Collection, Health Management Database, India Database, International Newsstream, Latin America & Iberia Database, Library Science Database, Linguistics Database, Middle East & Africa Database, Military Database, Nursing & Allied Health Database, Political Science Database, Psychology Database, Public Health Database, Publicly Available Content Database, Religion Database ProQuest Dissertations & Theses Global); PsycARTICLES; PsycBOOKS; PsycEXTRA; PsycINFO; PsycTESTS; Public Health Database; Research Library; Science Database; Social Science Database; Sociology Database; Telecommunications Database; Turkey Database; UK & Ireland Database; US Newsstream	10/1/18
Psychoanalytic Electronic Publishing, Inc.	PEP Archive	10/8/18
Sage	Sage Journals Online; Sage Research Methods and Cases	10/8/18
Taylor and Francis	Taylor and Francis Social Science and Humanities Library	10/8/18
Thomson Reuters	Web of Science Collection	10/8/18
Wiley	Cochrane Library Wiley Online Core Journals Collection	10/1/18

Database Search

Three main topics were the subject of the literature review: (a) nsCLBP and muscle tension, (b) PTSD and muscle tension, and (c) TRE and related interventions and muscle tension. To increase the likelihood of finding relevant information on muscle tension, the terms *psoas* and *iliopsoas* were added as keywords. Iliopsoas is the medical term for the group of muscles more commonly known as psoas. These are the muscles that TRE was originally developed to target for relaxation (Berceli, 2005, 2008). For Search 1, the term *non-specific chronic low back pain* did not reveal many results because authors and researchers use multiple terms and definitions for this condition. To improve the results, all studies relating to *chronic low back pain* were included in the search. Trauma Releasing Exercises has been referred to with variations, so the wildcard character was used to improve search results. The search strings for the three searches were:

Search 1. ("chronic low back pain") and ("muscle tension" or psoas or iliopsoas)

Search 2. ("post traumatic stress disorder" or PTSD) and ("muscle tension" or psoas or iliopsoas)

Search 3. ("trauma releas* exercises" or "tension releas* exercises" or "somatic experiencing" or "rosen method" or bioenergetics) and ("muscle tension" or psoas or iliopsoas)

For all searches, all peer-reviewed literature was included without other limitations.

Study Selection

Studies were selected based on their relevance to the three search topics and the objective of the literature review. Inclusion and exclusion criteria follow.

Study inclusion criteria. Studies were included if they represented primary research and had as a primary focus one of the following subject areas: (a) muscle tension and nsCLBP; (b) muscle tension and PTSD; and (c) muscle tension and TRE, SE, RMB, or BE.

Study exclusion criteria. Some additional studies were helpful in developing the background for the review but were excluded from the literature review analysis (n = 58). These items included articles where the primary focus was not one of the above subject areas, articles written in languages other than English, theory articles, review articles, and an unpublished manuscript describing a study in a dissertation that was already included in the analysis.

Data Collection Process and Data Items

Separate data extraction sheets were developed for each of the three searches. Key items extracted for Searches 1 and 2 were: study name, method, condition addressed (PTSD or nsCLBP), number of participants, age, gender, intervention and comparator (if any), relevant outcome measures, and relevant outcomes. For the TRE and related interventions analysis, data items of study type and intervention used were added. Items related to bias assessment were also collected and analyzed in a subsequent section.

Risk of Bias in Individual Studies

An analysis of the risk of bias within each study was conducted using an adaptation from the *Cochrane Handbook for Systematic Reviews of Interventions* (The Cochrane Collaboration, 2011) for all three search analyses.

Summary Measures

The study types, methods, conditions, interventions, and data analyses were so diverse across the selected articles that no summary measures were identified as appropriate. Most articles provided means of demographic variables such as age, but this information did not

significantly add to the discussion of research on the use of TRE in co-occurring PTSD and nsCLBP.

Synthesis of Results

With the diversity of the selected studies, no formalized synthesis of studies seemed appropriate. Instead, individual study characteristics, limitations, and relationship to the research question were noted as studies were reviewed. These notes were then formulated into a narrative review of the selected studies, which is presented in the Literature Review Search Results section.

Risk of Bias Across Studies

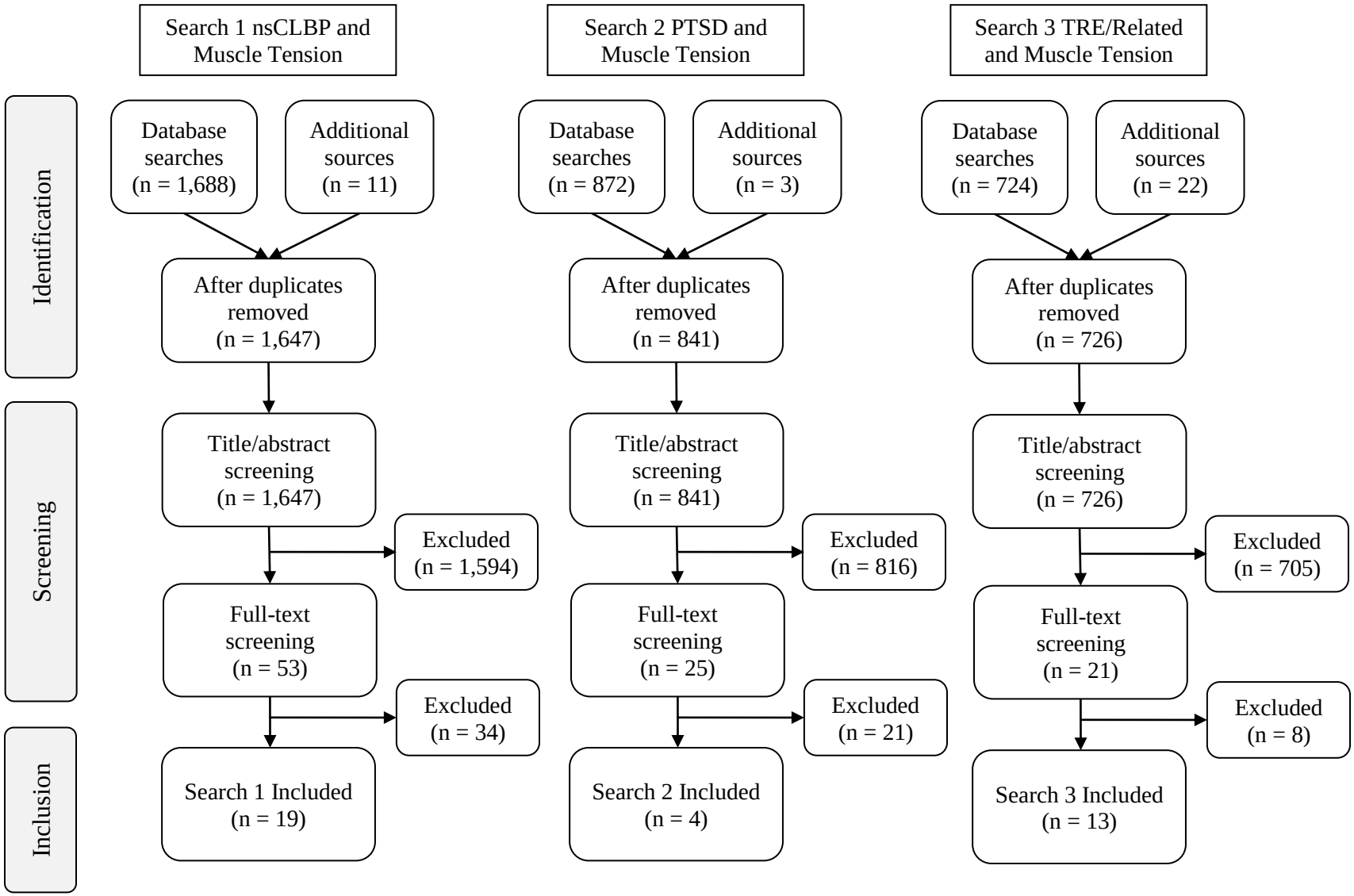
No formal assessment of bias across studies was undertaken. General observations from the detailed article reviews were consolidated into a narrative analysis. The narrative is presented in the Literature Review Search Results section.

Literature Review Search Results

Study Selection

Figure 2 depicts the steps followed for each search and the resulting number of returned items. A total of 3,284 items were initially returned from the three searches. Items from additional sources (n = 36) brought the raw total of items to 3,320. After eliminating duplicate results (n = 106), 3,214 titles and abstracts were reviewed for appropriate content. Of these, 3,115 items were excluded. Many items returned from Searches 1 and 2 were excluded because they pertained to pathology of muscles rather than muscle tension. Others were excluded because they were theoretical articles, meta-analyses, or otherwise not original research articles. A few items were excluded because they were not available in the English Language. One study was excluded because it was listed as a retraction.

Figure 2. Literature flow diagram



Adapted from: Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement (Moher et al., 2009)
Abbreviations: nsCLBP = non-specific chronic low back pain; PTSD = post-traumatic stress disorder; TRE = Trauma Releasing Exercises

A full text assessment was then performed on 99 articles. For Search 1, 34 articles were excluded for the following reasons: 29 were not directly related to muscle tension; three were not related to chronic low back pain; and two were systematic reviews. For Search 2, 21 articles were excluded for the following reasons: Seven were not directly related to PTSD; three were not original research articles; and 11 were not directly related to muscle tension. Eight items were excluded from Search 3: Three were not related to TRE or a related intervention; three were not related to muscle tension, and two were not original research.

After full-text screening, Search 1 yielded 19 studies related to nsCLBP and muscle tension. Search 2 resulted in four studies related to PTSD and muscle tension. Finally, Search 3 yielded 13 studies that related to either TRE, SE, RMB, or BE, and muscle tension. The studies selected for inclusion for each search are listed in Tables 3, 4, and 5.

Study Characteristics

Characteristics of the selected studies for each search are summarized by database search in Tables 6, 7, and 8.

Search 1: nsCLBP and muscle tension. Table 6 presents a summary of information from the 19 studies from Search 1 on muscle tension and nsCLBP. All selected studies in Search 1 used quantitative methods with a variety of design methodologies. Four studies used one-group pretest posttest designs; one used a two-group pretest posttest design; one used a three-group pretest posttest design; six used mixed-between subjects trials; two used a two-group descriptive design; two used a two-group cross-sectional design; and one used a descriptive cross-sectional method. Overall, the studies included 1,499 adult participants. Three articles did not report on gender data, with a total of 266 participants of unknown gender. Of the remaining 16 articles and 1,233 participants, 622 were female (50.4%) and 611 were male (49.6%).

Table 3

Studies Included for Search 1 nsCLBP and Muscle Tension

Author(s)	Title	Published in
Arbanas et al., 2013	MRI features of the psoas major muscle in patients with low back pain	European Spine Journal
Avrahami & Potvin, 2014	The clinical and biomechanical effects of fascial-muscular lengthening therapy on tight hip flexor patients with and without low back pain	Journal of Canadian Chiropractic Association
Burns, 2006a	Arousal of negative emotions and symptom-specific reactivity in chronic low back pain patients	Emotion
Burns, 2006b	The role of attentional strategies in moderating links between acute pain induction and subsequent psychological stress: Evidence for symptom-specific reactivity among patients with chronic pain versus healthy nonpatients	Emotion
Burns et al., 2008	Trait anger management style moderates effects of actual ("state") anger regulation on symptom-specific reactivity and recovery among chronic low back pain patients	Psychosomatic Medicine
Burns et al., 2012	Suppression of anger and subsequent pain intensity and behavior among chronic low back pain patients: The role of symptom-specific physiological reactivity	Journal of Behavioral Medicine
Glombiewski, Tersek, & Rief, 2008	Muscular reactivity and specificity in chronic back pain patients	Psychosomatic Medicine
Glombiewski et al., 2015a	Do patients with chronic pain show autonomic arousal when confronted with feared movements? An experimental investigation of the fear-avoidance model	Pain
Iglesias-González et al., 2013	Myofascial trigger points, pain, disability, and sleep quality in patients with chronic nonspecific low back pain	Pain Medicine
Jayasingh & Thomson, 2017	Efficacy of neuromuscular therapy in patients with chronic low back pain	International Journal of Ayurveda and Pharma Research
Kienbacher et al., 2016	Age and gender related neuromuscular pattern during trunk flexion-extension in chronic low back pain patients	Journal of NeuroEngineering and Rehabilitation

Table 3

Studies Included for Search 1 nsCLBP and Muscle Tension

Author(s)	Title	Published in
Kim & Yu, 2015	Effects of complex manual therapy on PTSD, pain, function, and balance of male torture survivors with chronic low back pain	Journal of Physical Therapy Science
Lewis, Holmes, Woby, Hindle, & Fowler, 2012	The relationships between measures of stature recovery, muscle activity and psychological factors in patients with chronic low back pain	Manual Therapy
Lewis, Holmes, Woby, Hindle, & Fowler, 2014	Changes in muscle activity and stature recovery after active rehabilitation for chronic low back pain	Manual Therapy
Mansuri & Shah, 2017	Comparison of core muscles activation and endurance in asymptomatic and patients with low back pain	International Journal of Therapies & Rehabilitation Research
Massé-Alarie, Beaulieu, Preuss, & Schneider, 2016	Influence of chronic low back pain and fear of movement on the activation of the transversely oriented abdominal muscles during forward bending	Journal of Electromyography and Kinesiology
Mistry, Vyas, & Sheth, 2014	Comparison of hamstrings flexibility in subjects with chronic low back pain versus normal individuals	International Journal of Therapies and Rehabilitation Research
Sarabon, Palma, Vengust, & Strojnik, 2011	Effects of trunk functional stability training in subjects suffering from chronic low back pain: A pilot study	Kinesiologica Slovenica
Volpato et al., 2014	Influence of stretching and strengthening of the iliopsoas associated with lumbar segmental stabilization exercises in patients with low back pain: The pilot study	Journal of Exercise Sports Orthopedic

Table 4

Studies Included for Search 2 PTSD and Muscle Tension

Author(s)	Title	Published in
Kim & Yu, 2015	Effects of complex manual therapy on PTSD, pain, function, and balance of male torture survivors with chronic low back pain	Journal of Physical Therapy Science
McDonagh-Coyle et al., 2001	Psychophysiological reactivity in female sexual abuse survivors	Journal of Traumatic Stress
Nelson et al., 2010	Heightened muscle tension and diurnal hyper-vigilance following exposure to a social defeat-conditioned odor cue in rats	Stress: The International Journal on the Biology of Stress
Nyboe, Bentholm, & Gyllensten, 2017	Bodily symptoms in patients with post traumatic stress disorder: A comparative study of traumatized refugees, Danish war veterans, and healthy controls	Journal of Bodywork & Movement Therapies

Table 5

Studies Included for Search 3 TRE and Related Interventions and Muscle Tension

Author(s)	Title	Published in
Andersen, Lahav, Ellegaard, & Manniche, 2017	A randomized controlled trial of brief Somatic Experiencing for chronic low back pain and comorbid post-traumatic stress disorder symptoms	European Journal of Psychotraumatology
Berceli, 2007	Evaluating the effects of stress reduction exercises	Dissertation: Arizona State University
Berceli et al., 2014	Effects of self-induced unclassified therapeutic tremors on quality of life among non-professional caregivers: A pilot study	Global Advances in Health and Medicine
Brom et al., 2017	Somatic Experiencing for posttraumatic stress disorder: A randomized controlled outcome study	Journal of Traumatic Stress
Changaris, 2010	Assessing the efficacy of Somatic Experiencing for reducing symptoms of anxiety and depression	ProQuest Dissertations and Theses
Ellegaard & Pedersen, 2012	Stress is dominant in patients with depression and chronic low back pain. A qualitative study of psychotherapeutic interventions for patients with non-specific low back pain of 3-12 months' duration	BMC Musculoskeletal Disorders
Fogel, 2013	Better or worse: A study of day-to-day changes over five months of Rosen Method Bodywork treatment for chronic low back pain	International Journal of Therapeutic Massage & Bodywork
Leitch, 2007	Somatic Experiencing treatment with tsunami survivors in Thailand: Broadening the scope of early intervention	Traumatology
Leitch, Vanslyke, & Allen, 2009	Somatic Experiencing treatment with social service workers following Hurricanes Katrina and Rita	Social Work
McCann, 2011	An evaluation of the effects of a training programme in Trauma Release Exercises on quality of life	Dissertation: Humanities University of Cape Town
Nickel et al., 2006	Bioenergetic exercises in inpatient treatment of Turkish immigrants with chronic somatoform disorders: A randomized, controlled study	Journal of Psychosomatic Research
Parker, Doctor, & Selvam, 2008	Somatic therapy treatment effects with tsunami survivors	Traumatology

Table 5

Studies Included for Search 3 TRE and Related Interventions and Muscle Tension

Author(s)	Title	Published in
Zettl, 1998	Knights in shining armor: A phenomenological exploration of the experience of trauma in emergency service personnel and the impact of Somatic Experiencing	ProQuest Dissertations and Theses

Research for these selected articles was carried out in laboratory or otherwise controlled settings. Interventions across studies varied including: (a) no direct intervention/studied existing phenomena (Arbanas et al., 2013; Iglesias-González et al., 2013; Kienbacher et al., 2016; Lewis et al., 2012; Mansuri & Shah, 2017; Massé-Alarie et al., 2016; Mistry et al., 2014); (b) fascial-muscular lengthening therapy (Avrahami & Potvin, 2014); (c) measuring muscle tension with EMG while invoking emotional states (Burns, 2006a, 2006b, Burns et al., 2008, 2012, Glombiewski et al., 2015, 2008); (d) neuromuscular therapy and stretching (Jayasingh & Thomson, 2017); (e) complex manual therapy (Kim & Yu, 2015); and (f) training in back exercises, stretching, stabilization, and/or lifestyle changes (Lewis et al., 2014; Sarabon et al., 2011; Volpato et al., 2014).

Search 2: PTSD and muscle tension. Search 2 yielded far fewer articles than Search 1, indicating less overall research into connections between muscle tension and PTSD. The four studies selected for inclusion are presented in Table 7. All four used quantitative methodology. The sample populations for the selected studies included 119 adults, with 37 females (55.2%) and 30 males (44.8%), and one study not reporting gender breakdown (Nyboe et al., 2017). One of the studies (Nelson et al., 2010) used rats as participants and is included here because of the lack of research using human participants. Design methods included one one-group pretest posttest, two two-group pretest posttest, and one controlled descriptive. Interventions in the

human studies included complex manual therapy (Kim & Yu, 2015), exposure to pleasant and unpleasant tasks (McDonagh-Coyle et al., 2001), and no intervention, but rather gathering symptom-related information through self-report (Nyboe et al., 2017). The interventions in the rat study involved experiencing social defeat and odor cues (Nelson et al., 2010). Research for the selected studies for Search 2 was carried out in laboratory or otherwise controlled settings.

Search 3: TRE and related interventions. The 13 studies selected for Search 3 are presented in Table 8. They included three dissertations and one master's thesis, along with nine peer-reviewed journal articles. Research methods for these studies were primarily quantitative, with the exception of two phenomenological-hermeneutic studies (Ellegaard & Pedersen, 2012; Zettl, 1999). Across all studies, 809 adults participated with 556 female participants (68.7%) and 253 males (31.3%). Study designs included four one-group pretest posttest, six two-group pretest posttest, one pretest posttest case series, and the two qualitative studies.

Several of the studies were conducted at on-site locations of natural disasters (Andersen et al., 2017; Leitch, 2007; Leitch et al., 2009; Parker et al., 2008). The remaining studies were conducted by practitioners in clinical settings with varying levels of control for consistency, representing the ways TRE and related interventions are used in real-world settings. Three studies utilized TRE as an intervention, while eight studies utilized SE. Rosen Method Bodywork and BE were each used as an intervention in one study. There is very little published research on RMB and BE.

Table 6

Summary of Characteristics of Studies Included in Search 1 nsCLBP and Muscle Tension Analysis

Study	Study Method	Condition/ Sample Size	Age/ Gender	Intervention/Comparator	Relevant Outcome Measures	Relevant Outcomes
Arbanas et al., 2013	Peer-review/Two-group descriptive	CLBP (n=91)	18-84/ F=49 M=42	None – MRI examination of both CLBP patients and healthy controls	MRI	CLBP group had significantly larger psoas muscles at all measurements than control group; those with degenerative conditions had smaller psoas muscles than others in the CLBP group but still larger than controls
Avrahami & Potvin, 2014	Peer-review/Two-group pretest posttest with multiple baselines	CLBP (n=18)	18-26 M=18	4 sessions of fascial-muscular lengthening therapy (FMLT); all participants had tight hip flexor muscles and received FMLT; compared participants who had CLBP with non-CLBP controls	RMDQ; VAS; Modified Thomas Test; Trunk flexion and extension strength trials	All participants showed increases in hip mobility; CLBP group had significant reduction in pain and disability
Burns, 2006a	Peer-review/ Mixed-Between subjects trial	CLBP (n=173)	18+/ F=96 M=77	Anger and sadness recall interviews/ Participants with CLBP compared to healthy controls	EMG; PSS; Self-report of pain and negative affect (0-5)	Increase in low back muscle tension and longer recovery time for CLBP group as compared to healthy controls

Table 6

Summary of Characteristics of Studies Included in Search 1 nsCLBP and Muscle Tension Analysis

Study	Study Method	Condition/ Sample Size	Age/ Gender	Intervention/Comparator	Relevant Outcome Measures	Relevant Outcomes
Burns, 2006b	Peer-review/ Mixed-Between subjects trial	CLBP (n=205)	21-67/ F=106 M=99	All participants experienced cold-pressor pain stimulus with different conditions	EMG	Participants in suppression condition had increased tension in paraspinal muscles
Burns et al., 2008	Peer-review/ Mixed-Between subjects trial	CLBP (n=84)	34-58/ F=46 M=38	Participants experienced harassment and were asked to express or suppress anger/No comparison	EMG; HR; AEI	Increased lower paraspinal muscle tension and pain for both conditions
Burns et al., 2012	Peer-review/ Mixed-Between subjects trial	CLBP (n=58)	18+/ F=30 M=28	Frustrating maze task/ Anger Suppression group compared to No Suppression	EMG; NRS	Increases in low back muscle tension for both groups after intervention, but Suppression group had significantly more
Glombiewski et al., 2008	Peer-review/Two-group between subjects trial	CLBP (n=116)	18+/ Not stated	Muscle tension measured during 4 different conditions: focus on back, recall a stressful event, cognitive stress, and social stress/Healthy control comparison	EMG	Increased muscle tension in lower back for pain participants compared to controls

Table 6

Summary of Characteristics of Studies Included in Search 1 nsCLBP and Muscle Tension Analysis

Study	Study Method	Condition/ Sample Size	Age/ Gender	Intervention/Comparator	Relevant Outcome Measures	Relevant Outcomes
Glombiewski et al., 2015	Peer-review/One-group pretest-posttest	CLBP (n=71)	18-65/ F=39 M=32	Fear of movement induction/ Clusters based on fear and anxiety (FA) identified during study: Cluster 1 = High FA (n=41) and Cluster 2 = Low FA (n=30)	EMG; NRS; PASS; PCS; PDI; TSK	Significant increase in low back muscle tension after intervention; Cluster 1 showed greater pain catastrophizing and pain anxiety
Iglesias-Gonzalez et al., 2013	Peer-review/ Descriptive cross-sectional/Purposive sample age- and sex-matched with healthy controls	nsCLBP/ (n=84)	23-55/ F=42 M=42	None/Comparison of active and latent trigger points between two groups	PSQI; Roland-Morris Activity Scale; TrP exam	Latent trigger points in the psoas muscles were the most common trigger points in both pain and control groups
Jayasingh & Thomson, 2017	Peer-review/RCT/ one-group pretest posttest	CLBP/ (n=90)	18+/ Not stated	6 weeks of neuromuscular therapy and stretching of lower paraspinal muscles/TAU	ODI; VAS-P; Trigger point counts	Intervention group had significant reduction in pain and identified trigger points compared to TAU

Table 6

Summary of Characteristics of Studies Included in Search 1 nsCLBP and Muscle Tension Analysis

Study	Study Method	Condition/ Sample Size	Age/ Gender	Intervention/Comparator	Relevant Outcome Measures	Relevant Outcomes
Kienbacher et al., 2016	Peer-review/ Between groups trial	CLBP/ (n=216)	18-90/ F=99 M=117	Back extension and trunk muscle flexion/strength measurements/No comparison; participants grouped by age: (a) age < 60 and (b) age ≥ 60	EMG; Back extension dynamometer; Modified trunk flexion-extension test	All participants had impaired muscle flexibility and range of motion; younger participants (a) had more flexibility and range of motion than older participants (b)
Kim and Yu, 2015	Peer-review/RCT/ two-group pretest posttest	CLBP & PTSD/ (n=30)	18+/ M=30	Experimental group received 8 weeks, 2x week complex manual therapy[a]/Education in self-exercise	KODI PDS-K VAS	Experimental group improved in both pain and PTSD symptoms compared to control group
Lewis et al., 2012	Peer-review/Two-group descriptive	CLBP/ (n=65)	35-57/ F=38 M=27	Muscle activity recorded while performing simple task/Healthy control group	EMG; RMDQ; Self-report Likert scale for pain (0-10)	CLBP group had significantly more muscle activity compared to healthy controls; muscle activity correlated to pain and disability

Table 6

Summary of Characteristics of Studies Included in Search 1 nsCLBP and Muscle Tension Analysis

Study	Study Method	Condition/ Sample Size	Age/ Gender	Intervention/Comparator	Relevant Outcome Measures	Relevant Outcomes
Lewis et al., 2014	Peer-review/One-group pretest posttest	CLBP/ (n=17)	37-57/ F=12 M=5	Muscle activity recorded before and after training in back exercise and lifestyle changes/No comparison	EMG; Standing stadiometer; RMDQ; Self-report Likert scale for pain (0-10)	At 6 months, participants gained significant height but did not have significant decrease in muscle activity
Mansuri & Shah, 2017	Peer-review/Two-group cross-sectional	CLBP/ (n=70)	18+/ F=31 M=39	Muscle activity and strength measured while lying in prone position/Healthy control group	Pressure biofeedback unit	CLBP group had significantly less core (abdominal) muscle activation and strength than healthy controls
Massé-Alarie et al., 2016	Peer-review/Two-group cross-sectional	CLBP/ (n=25)	21-47/ F=13 M=12	Muscle activity measured during trunk flexion and extension/ Healthy control group	EMG; ODI	CLBP group had significant muscle activation during trunk flexion compared to healthy controls
Mistry et al., 2014	Peer-review/Two-group descriptive	CLBP/ (n=60)	20-60/ Not stated	Hamstring tightness measured during knee extension/Healthy controls	Active knee extension test	CLBP group had significantly more hamstring tightness than healthy controls

Table 6

Summary of Characteristics of Studies Included in Search 1 nsCLBP and Muscle Tension Analysis

Study	Study Method	Condition/ Sample Size	Age/ Gender	Intervention/Comparator	Relevant Outcome Measures	Relevant Outcomes
Sarabon et al., 2011	Peer-review/One-group pretest posttest	CLBP/ (n=10)	39-55/ F=7 M=3	8 weeks of trunk muscle stability training/No comparison	Maximal force of static voluntary contraction test; Passive flexibility test; ODI; Self-report Likert scale 0-10	Significant changes in flexibility correlated with decreases in pain after training
Volpato et al., 2014	Peer-review/Three-group randomized pretest posttest	CLBP (n=16)	22-40/ F=14 M=2	Stabilization training only/ Stabilization training + iliopsoas stretching/Stabilization training + iliopsoas strengthening	VAS; ODI; Flexometer; Manual isometric dynamometer	The iliopsoas strengthening group and the stabilization training only groups showed significant increases in flexibility and decreases in pain compared to the iliopsoas stretching group

Abbreviations: AEI = Anger Expression Inventory; CLBP = Chronic low back pain, including conditions attributable to medical pathology; EMG = Electromyography, used to measure muscle tension; HR = Heart rate; KODI = Korean Owestry Disability Index; MRI = Magnetic resonance imaging; nsCLBP = Non-specific chronic low back pain, not directly related to illness or injury; NRS = Numeric Rating Scale for pain intensity; ODI = Oswestry Low Back Pain Disability Index; PASS = Pain Anxiety Symptom Scale; PCS = Pain Catastrophizing Scale; PDI = Pain Disability Index; PDS-K = Post-traumatic Diagnostic Scale; PSQI = Pittsburgh Sleep Quality Index; PSS = Pain Severity Scale of the Multidimensional Pain Inventory; PTSD = Post-traumatic Stress Disorder; RCT = Randomized-controlled trial; RMDQ = Roland Morris Disability Scale; TrP exam = Examination by qualified massage therapists to identify trigger points; TAU = Treatment as usual; TSK = Tampa Scale of Kinesiophobia; VAS = Visual Analog Scale; VAS-P = Visual Analog Scale for Pain

Table 7

Summary of Characteristics of Studies Included in Search 2 PTSD and Muscle Tension Analysis

Study	Study Method	Sample Size/ Age/ Gender	Intervention/Comparator	Relevant Outcome Measures	Relevant Outcomes
Kim and Yu, 2015	Peer-review/ RCT/Two-group pretest posttest	30/ 18+/ M=30	Experimental group received 8 weeks, 2x week complex manual therapy[a]/Education in self-exercise	KODI PDS-K VAS	Experimental group improved in both pain and PTSD symptoms compared to control group
McDonagh-Coyle et al., 2001	Peer-review/ One-group pretest posttest	37/ 18-62/ F=37	Exposure to pleasant and unpleasant tasks with measurements after each/No comparison	ETI; SCL; HR; CAPS-1; DES; Civilian Mississippi; STAI; EMG	Unpleasant/trauma exposures resulted in significant increases in muscle tension
Nelson et al., 2010[b]	Peer-review/ Two RCT pretest posttest studies with rats	28/ 3-5 months/ M=28	Ex. 1 – Social defeat by other rat paired with odor cue/Control group with no intervention Ex. 2 - Introduction of odor cue 4 weeks later/Control group with no intervention	Transponder implants in gastrocnemius muscles; Observation of behaviors	Ex. 1 - Defeated rats displayed anxious behaviors along with increased muscle tension; Ex. 2 - Odor cue reactivated anxious behaviors and increased muscle tension
Nyboe, et al., 2016	Peer-review/ Controlled descriptive	52/ 20-40/ Not stated	No intervention/Compared self-reported symptoms between traumatized adults and healthy adults	BAS MQ-E	Traumatized adults had significantly more muscle tension and related physical symptoms than control group

[a]Complex manual therapy consists of myofascial release, muscle energy technique, and exercises to release muscle tension
[b]Non-human participants

Abbreviations: BAS MQ-E = Body Awareness Movement Quality and Experience Scale; CAPS-1 = Clinician-Administered PTSD Scale for DSM-III-R; DES = Dissociative Experiences Scale; EMG = Electromyograhy; ETI = Early Trauma Interview; HR = Heart rate; KODI = Korean Owestry Disability Index; PDS-K = Post-traumatic Diagnostic Scale; PTSD = Post-traumatic Stress Disorder; RCT = Randomized-controlled trial; SCL = Skin conductance level; STAI = State-Trait Anxiety Inventory; VAS = Visual Analog Scale

Table 8

Summary of Characteristics of Studies Included in Search 3 Trauma Releasing Exercises and Related Interventions Analysis

Study	Study Type/ Method	Intervention/ Condition/ Sample Size	Age/ Gender	Intervention/Comparator	Relevant Outcome Measures	Relevant Outcomes
Andersen et al., 2017	Peer-review/ RCT/ Two-group pretest posttest	SE/ nsCLBP & PTSD/ (n=90)	18-65/ F=49 M=41	SE for 6-12 hours + TAU/TAU only; Follow-up after 12 months	RMDQ Likert scales for pain Harvard Treatment Questionnaire PCS TSK	Significant decrease in PTSD symptoms for SE group compared to TAU only group at both baseline and follow-up. Decrease in pain catastrophizing for both groups
Berceli, 2007	Dissertation/ RCT/Two-group pretest posttest	TRE/ None/ (n=61)	22-35/ F=36 M=25	TRE for 2 weeks, 2x week allowing tremors/Control group told to stop TRE when tremors start	STAI Form X-1 AD-ACL HRV	Decrease in anxiety-present, increase in anxiety-absent compared to control group
Berceli et al., 2014	Peer-review/ One-group pretest posttest feasibility study	TRE/ None/ (n=21)	25-62/ F=19 M=2	TRE introductory training, then 10 weeks of practice, 2-3x week/No comparison	HWQoL	91.3% completed study. Perceived quality of life improved, but actual changes not significant
Brom et al., 2017	Peer-review/ RCT/ Two-group pretest posttest	SE/ PTSD/ (n=63)	18+/ F=32 M=31	SE for 15 weekly sessions/ Waitlist; Second evaluation at 15 weeks; Third evaluation after 15 weeks for Waitlist group	CAPS PDS CES-D	Significant decreases in PTSD symptoms for both groups.

Table 8

Summary of Characteristics of Studies Included in Search 3 Trauma Releasing Exercises and Related Interventions Analysis

Study	Study Type/ Method	Intervention/ Condition/ Sample Size	Age/ Gender	Intervention/Comparator	Relevant Outcome Measures	Relevant Outcomes
Changaris, 2010	Dissertation/ Two-group pretest posttest	SE/ None/ (n=36)	18+/ F=20 M=16	Three weeks of SE sessions plus affect regulation skill-building workshop/TAU	BDI-II STAI	Significant decrease in state anxiety for SE group compared to TAU. No other significant changes
Ellegaard et al., 2012	Peer-review/ Phenomenolo-gical-Hermeneutic	SE/ nsCLBP/ (n=6)	20-33/ F=4 M=2	5-6 sessions of combined Gestalt therapy and SE with written narrative by therapist/No comparison	None	No relevant outcomes for intervention, but themes of feeling restricted by CLBP/using inner resources to cope
Fogel 2013	Peer-review/ Pretest posttest case series	RMB/ CLBP/ (n=5)	31-56/ F=5	5 months of RMB/No comparison	Self-report scales of pain, fatigue, and mood	Improvement on all measures after intervention
Leitch, 2007	Peer-review/ One group pretest posttest	SE/ Acute trauma/ (n=53)	3-75/ F=34 M=19	Brief SE (1-2 sessions) following tsunami/No comparison; Follow-up at 1 year	Self-report symptom list	90% of located participants (n=22) had significant decrease in symptoms after treatment
Leitch et al., 2009	Peer-review/ Two-group pretest posttest	SE/ PTSD/ (n=132)	22-60 F=113 M=19	Brief intervention group therapy of SE/TRM for 2 weeks, 1-2x week/ Matched control group; Follow-up after 3-4 months	SCL-90-R PCL-C	No significant change for physical symptoms, but improvement in psychological symptoms and resiliency

Table 8

Summary of Characteristics of Studies Included in Search 3 Trauma Releasing Exercises and Related Interventions Analysis

Study	Study Type/ Method	Intervention/ Condition/ Sample Size	Age/ Gender	Intervention/Comparator	Relevant Outcome Measures	Relevant Outcomes
McCann, 2011	Master's thesis/ One group pretest posttest	TRE/ None/ (n=50)	21-70/ F=42 M=8	TRE 4-day introductory training, then 4 weeks of practice, 2-3x week/No comparison	SF-36 PGWBI STAI Form Y-1	Improvement in trait anxiety and sense of well-being
Nickel et al., 2006	Peer-review/ RCT two-group pretest posttest	BE/ Pain/ (n=128)	Adult F=90 M=38	Bioenergetics therapy for 6 weeks/ Control group did gymnastics	SCL-90-R STAXI	Treatment group had improvements in pain and mood compared to control
Parker et al., 2008	Peer-review/ One-group pretest posttest	SE/ PTSD/ (n=150)	18+ F=110 M=40	1 75-minute session of SE/No treatment; Follow-ups at 4 weeks and 8 months	Post-Tsunami Checklist IES-R-A SUD	At 8 months, more than half still showed improvement and 27% completely well
Zettl, 1999	Dissertation/ Phenomenolo-gical-Heuristic Inquiry	SE/ PTSD/ (n=14)	32-50/ F=2 M=12	3-6 SE sessions and semi-structured interview	Self-report during interview	80% of participants reported decreases in symptoms of hyperarousal

Abbreviations: AD-ACL = Activation-Deactivation Adjective Checklist; BDI-II = Beck Depression Inventory, version II; BE = Bioenergetics; CAPS = Clinician-Administered PTSD Scale; CES-D = Center for Epidemiological Studies Depression Scale; CLBP = Chronic low back pain, including conditions attributable to medical pathology; HWQoL = Health, Wellness and Quality of Life Questionnaire; HRV = Heart Rate Variability; IES-R-A = Impact of Events Scale-Revised-Abbreviated; nsCLBP = Non-specific chronic low back pain not directly related to illness or injury; PCL-C = PTSD Checklist-Civilian; PCS = Pain Catastrophizing Scale; PDS = Posttraumatic Diagnostics Scale; PGWBI = Psychological General Well-Being Index; RCT = Randomized-controlled trial; RMB = Rosen Method Bodywork; RMDQ = Roland Morris Disability Questionnaire; SCL 90-R = Symptom Checlkist-90-Revised; SE = Somatic Experiencing; SE/TRM = Somatic Experiencing/Trauma Resiliency Model; SF36 = Short Form Health Survey; STAI = State Trait Anxiety Inventory; STAXI = State-Trait Anger Expression Inventory; SUDS = Subjective Units of Disturbance; TAU = Treatment as usual; TRE = Trauma Releasing Exercises; TSK = Tampa Scale for Kinesiophobia

Risk of Bias Within Studies

The risk of bias within studies analyses for the three searches is presented in Tables 9, 10, and 11.

Search 1: nsCLBP and muscle tension. See Table 9 for a detailed assessment of the risk of bias within selected studies for Search 1. Of the 19 studies related to nsCLBP and muscle tension, only three used a randomized-controlled design (Jayasingh & Thomson, 2017; Kim & Yu, 2015; Volpato et al., 2014), and 13 used control or comparison groups. Participants were blinded in only two studies (Burns et al., 2012; Jayasingh & Thomson, 2017), while researchers, data collectors, and outcome assessors were not blinded in any of the studies. Lack of blinding was considered a strong risk of bias in Kim and Yu (2005) because of the appearance of bias in the language of the article. Glombiewski et al. (2015) showed the strongest risk of bias because of the lack of solid descriptions of the study and lack of a control group. Of all the studies, Jayasingh and Thomson (2017) showed the least risk of bias. The randomized-controlled study was described well, and participants were blinded.

Search 2: PTSD and muscle tension. Table 10 contains a detailed assessment of the risk of bias within studies for Search 2. Four selected studies related to PTSD and muscle tension. Only two studies employed a randomized-controlled design (Kim & Yu, 2015; Nelson et al., 2010), and three of the four studies used a control group. Given the nature of the interventions, which involved identifiable movement and physical treatments, blinding would have been difficult with the exception of one study using rats as subjects (Nelson et al., 2010). In the Nelson et al. (2010) study, the rats were likely not aware of what was happening to the other rats. Lack of blinding was deemed a strong risk in Kim and Yu (2005) because of the biased language used in the article. In the published study, the language of the authors (Kim &

Yu, 2001) was biased toward favorable results for their interventions, which could likely have been communicated to the relatively small number of participants. There are significant concerns about the risk of bias for Nyboe et al. (2017) because the study was not well-documented in the article.

The smallest risk of bias was found in Nelson et al. (2010). This randomized-controlled study of trauma and muscle tension in rats was conducted under laboratory conditions and followed well-structured protocols, thus reducing much of the risk of bias. However, the data were difficult to generalize because we do not know if the results are applicable to humans or outside of such a structured environment.

Search 3: TRE and related interventions. See Table 11 for a detailed assessment of the risk of bias within studies for Search 3. All three TRE studies included adequate descriptions of study methods. For these studies, only one used a randomized design with a control group (McCann, 2011). For the remaining two studies using TRE, the lack of a randomized-controlled design adds a strong risk of bias because both studies were conducted within distinct communities and during in-person trainings by Berceli (Berceli, 2007; Berceli et al., 2014). There is a possibility that participants wanted to please Berceli based on the amount of time they spent with him and on his enthusiasm for the technique he developed.

Given that TRE is a movement method taught by a certified trainer, it is difficult to have blinding on the part of participants or researchers. Lack of blinding in all three studies is a strong concern, because Berceli led the training sessions. The 2007 Berceli study was also his dissertation for his doctoral degree, and he may have held personal bias as to the results of his study. Selection of the study populations in two of the TRE studies (Berceli, 2007; Berceli at al., 2014) was not described sufficiently to fully assess the risk of bias. Both were convenience

samples within well-defined communities. These possible areas of bias may have affected the outcomes of the studies.

There were similar issues with blinding in the remaining studies using related interventions, with the exception of Andersen et al. (2017). In several cases, the interventions were delivered in the aftermath of natural disasters or within communities where it would be difficult or ethically inappropriate to utilize a control group and blinding (Changaris, 2010; Leitch, 2007; Leitch et al., 2009; Parker et al., 2008). The lack of blinding was not considered to present as high a risk of bias as with the TRE studies because the related interventions were not delivered by the creators of the interventions. Five of the selected studies utilized control or comparison groups (Andersen et al., 2017; Brom et al., 2017; Changaris, 2010; Leitch et al., 2009; Nickel et al., 2006), further mitigating risk of bias. Lack of randomized study design was a concern in four of these studies (Fogel, 2013; Leitch, 2007; Leitch et al., 2009; Parker et al., 2008), but was of most concern in Fogel (2013) because of the small sample size (n = 5), length of study, and lack of demographic information about participants. With a hands-on intervention like Rosen Method Bodywork, participants would likely become very familiar with the bodyworker over the course of five months and might want to show positive results for the researcher.

Results of Individual Studies

See Table 6 for an analysis of results from studies for Search 1 regarding nsCLBP and muscle tension. Table 7 presents a similar analysis for Search 2 on PTSD and muscle tension. See Table 8 for results from studies regarding TRE and related interventions. Confidence intervals are not presented because of the heterogeneity of the interventions and the data available.

Table 9

Risk of Bias Within Studies for Search 1 nsCLBP and Muscle Tension Analysis

Study	Arbanas et al. 2013	Avrahami & Potvin 2014	Burns 2006a	Burns 2006b	Burns et al. 2008	Burns et al. 2012	Glom-biewski et al. 2008
Randomized study design?	✵	✵	✵	✵	✵	✵	✵
Well described study intervention and population?	☑	☑	☑	☑	☑	☑	☑
Selection of study population well described?	☑	☑	☑	☑	☑	☑	☑
Outcome variables reliable measures of outcome interest?	☑	☑	☑	☑	☑	☑	☑
At least 80% of enrolled participants completed study?	☑	☑	☑	☑	☑	☑	☑
Comparison groups?	☑	☑	☑	☑	☑	✵	☑
Participants blinded?	✵	✵	✵	✵	✵	☑	✵
Researchers blinded?	✵	✵	✵	✵	✵	✵	✵
Data collectors blinded?	✵	✵	✵	✵	✵	✵	✵
Outcome assessors blinded?	✵	✵	✵	✵	✵	✵	✵
Limitations?	Study limitations are discussed in the body of the review						

☑ = Some identifiable bias that is unlikely to significantly impact results

⊗ = Identifiable bias that is likely to significantly impact results

✵ = Identifiable bias that may be of concern for results

Adapted from: *Cochrane Handbook for Systematic Reviews of Interventions* (The Cochrane Collaboration, 2011)

Table 9

Risk of Bias Within Studies for Search 1 nsCLBP and Muscle Tension Analysis

Study	Glom-biewski et al. 2015	Iglesias-Gonzalez et al. 2013	Jayasingh & Thomson 2017	Kien-bacher et al. 2016	Kim & Yu 2005	Lewis et al. 2012
Randomized study design?	⊗	✵	☑	✵	☑	✵
Well described study intervention and population?	☑	☑	☑	☑	⊗	☑
Selection of study population well described?	✵	☑	☑	☑	✵	☑
Outcome variables reliable measures of outcome interest?	✵	✵	☑	☑	✵	☑
At least 80% of enrolled participants completed study?	✵	☑	☑	☑	☑	☑
Comparison groups?	⊗	✵	☑	✵	☑	☑
Participants blinded?	✵	✵	☑	✵	✵	✵
Researchers blinded?	✵	✵	✵	✵	⊗	✵
Data collectors blinded?	✵	✵	✵	✵	⊗	✵
Outcome assessors blinded?	✵	✵	✵	✵	⊗	✵
Limitations?	Study limitations are discussed in the body of the review					

☑ = Some identifiable bias that is unlikely to significantly impact results

⊗ = Identifiable bias that is likely to significantly impact results

✵ = Identifiable bias that may be of concern for results

Adapted from: *Cochrane Handbook for Systematic Reviews of Interventions* (The Cochrane Collaboration, 2011)

Table 9

Risk of Bias Within Studies for Search 1 nsCLBP and Muscle Tension Analysis

Study	Lewis et al. 2014	Mansuri & Shah 2017	Massé-Alarie et al. 2016	Mistry et al. 2012	Sarabon et al. 2011	Volpato et al. 2014
Randomized study design?	✵	✵	✵	✵	✵	☑
Well described study intervention and population?	☑	☑	☑	☑	☑	☑
Selection of study population well described?	☑	☑	☑	✵	☑	☑
Outcome variables reliable measures of outcome interest?	☑	☑	☑	☑	☑	☑
At least 80% of enrolled participants completed study?	✵	☑	☑	☑	☑	☑
Comparison groups?	✵	☑	☑	☑	✵	☑
Participants blinded?	✵	✵	✵	✵	✵	✵
Researchers blinded?	✵	✵	✵	✵	✵	✵
Data collectors blinded?	✵	✵	✵	✵	✵	✵
Outcome assessors blinded?	✵	✵	✵	✵	✵	✵
Limitations?	Study limitations are discussed in the body of the review					

☑ = Some identifiable bias that is unlikely to significantly impact results

⊗ = Identifiable bias that is likely to significantly impact results

✵ = Identifiable bias that may be of concern for results

Adapted from: *Cochrane Handbook for Systematic Reviews of Interventions* (The Cochrane Collaboration, 2011)

Table 10

Risk of Bias Within Studies for Search 2 PTSD and Muscle Tension Analysis

Study	Kim & Yu, 2005	McDonagh-Coyle et al., 2001	Nelson et al., 2010	Nyboe et al., 2017
Randomized study design?	☑	✵	☑	✵
Well described study intervention and population?	⊗	☑	☑	✵
Selection of study population well described?	✵	☑	☑	✵
Outcome variables reliable measures of outcome interest?	✵	☑	☑	✵
At least 80% of enrolled participants completed study?	☑	☑	☑	☑
Comparison groups?	☑	⊗	☑	☑
Participants blinded?	✵	✵	☑	✵
Researchers blinded?	⊗	✵	✵	✵
Data collectors blinded?	⊗	✵	✵	✵
Outcome assessors blinded?	⊗	✵	✵	✵
Limitations?	Study limitations are discussed in the body of the review			

☑ = Some identifiable bias that is unlikely to significantly impact results

⊗ = Identifiable bias that is likely to significantly impact results

✵ = Identifiable bias that may be of concern for results

Adapted from: *Cochrane Handbook for Systematic Reviews of Interventions* (The Cochrane Collaboration, 2011)

Table 11

Risk of Bias Within Studies for Search 3 Trauma Releasing Exercises and Related Interventions Analysis

Study	Andersen et al. 2017	Berceli 2007	Berceli et al. 2014	Brom et al., 2017	Chan-garis 2010	Elle-gaard et al. 2012	Fogel 2013
Randomized study design?	☑	⊗	⊗	☑	☑	☑	⊗
Well described study intervention and population?	☑	☑	☑	☑	☑	⊗	☑
Selection of study population well described?	☑	✵	✵	☑	☑	⊗	☑
Outcome variables reliable measures of outcome interest?	☑	✵	☑	☑	☑	✵	⊗
At least 80% of enrolled participants completed study?	☑	☑	✵	☑	☑	✵	✵
Comparison groups?	☑	⊗	⊗	☑	☑	⊗	⊗
Participants blinded?	☑	⊗	⊗	✵	✵	N/A	⊗
Researchers blinded?	✵	⊗	⊗	✵	✵	⊗	⊗
Data collectors blinded?	✵	⊗	⊗	✵	✵	⊗	⊗
Outcome assessors blinded?	☑	⊗	⊗	✵	✵	⊗	⊗
Limitations?	Study limitations are discussed in the body of the review						

☑ = Some identifiable bias that is unlikely to significantly impact results
⊗ = Identifiable bias that is likely to significantly impact results
✵ = Identifiable bias that may be of concern for results
N/A = Not applicable to this type of study (phenomenological-hermeneutic)

Table adapted from *Cochrane Handbook for Systematic Reviews of Interventions* (The Cochrane Collaboration, 2011)

Table 11

Risk of Bias Within Studies for Search 3 Trauma Releasing Exercises and Related Interventions Analysis

Study	Leitch 2007	Leitch et al. 2009	McCann 2011	Nickel et al. 2006	Parker et al. 2008	Zettl 1999
Randomized study design?	⊗	✵	☑	☑	✵	⊗
Well described study intervention and population?	☑	☑	☑	☑	☑	☑
Selection of study population well described?	✵	☑	☑	☑	☑	☑
Outcome variables reliable measures of outcome interest?	⊗	☑	✵	☑	✵	☑
At least 80% of enrolled participants completed study?	✵	☑	☑	☑	✵	☑
Comparison groups?	✵	☑	☑	☑	✵	✵
Participants blinded?	✵	✵	⊗	✵	✵	✵
Researchers blinded?	✵	✵	⊗	✵	✵	✵
Data collectors blinded?	✵	✵	⊗	✵	✵	✵
Outcome assessors blinded?	✵	✵	⊗	✵	✵	✵
Limitations?	Study limitations are discussed in the body of the review					

☑ = Some identifiable bias that is unlikely to significantly impact results
⊗ = Identifiable bias that is likely to significantly impact results
✵ = Identifiable bias that may be of concern for results

Table adapted from *Cochrane Handbook for Systematic Reviews of Interventions* (The Cochrane Collaboration, 2011)

Synthesis of Results

Results for each of the three searches were synthesized separately, but one study (Kim & Yu, 2015) appeared in the results for both Search 1 and Search 2, directly addressing the connection between co-occurring nsCLBP and PTSD and muscle tension.

Searches 1 and 2: nsCLBP, PTSD, and muscle tension. The premise of this dissertation study is that there is significant co-occurrence of nsCLBP and PTSD, and that chronically-held muscle tension links the two conditions. Only one study was located that addressed this premise. This study involved 30 Korean former prisoners of war who all had both PTSD and CLBP (Kim & Yu, 2015). Participants were randomized to either an experimental group that received multiple therapies designed to release muscle tension (complex manual therapy), or a control group that performed self-directed exercise. People in the experimental group reported significant improvement in both pain and PTSD symptoms as compared to the control group. The results suggested that releasing muscle tension is an effective way to treat co-occurring PTSD and nsCLBP, but muscle tension was not measured with any physiological instruments. It is not known whether muscle tension was actually released by the therapy. A moderate risk of bias within this study further limits application of the results. Although these results did not show causation between muscle tension and the two conditions, they did suggest that relieving muscle tension was connected to relieving symptoms. This study is also discussed within the context of Search 1 and Search 2 separately.

Search 1: nsCLBP and muscle tension. Search 1 was conducted to find evidence relating to whether there is a connection between muscle tension and non-specific chronic low back pain (nsCLBP). Only one study addressed nsCLBP directly (Iglesias-González et al., 2013). Populations in the more general chronic low back pain (CLBP) category were included in

the search to broaden the evidence to consider. Emphasis was also placed on studies that measured muscle tension in the paraspinal muscles, because TRE theory originally focused on the psoas muscles. Nineteen studies were selected and analyzed for this search, providing a base of literature for evidence of a connection between muscle tension and CLBP, with possible implications for the smaller population with nsCLBP.

Focusing on the psoas muscles and muscle tension, two appropriate studies were identified (Arbanas et al., 2013; Volpato et al., 2014). People with CLBP had larger psoas muscle measurements than healthy controls as measured by MRI (Arbanas et al., 2013), suggesting that larger psoas muscles may be associated with low back pain. In the same study, those with degenerative conditions such as chronic disease or spinal injuries had smaller psoas measurements than other participants with CLBP, but their psoas muscles were still larger than people in the healthy control group. People in the CLBP group who did not have identifiable degenerative conditions may be considered as having nsCLBP, but this was not stated in the article. The results suggested that there was more activity and tension in the psoas muscles for CLBP patients in general, and even higher activity and tension for those with nsCLBP as compared to healthy adults (Arbanas et al., 2013).

In the second study, strengthening and stabilizing the psoas muscles appeared to provide relief of CLBP (Volpato et al., 2014). However, stretching the psoas muscles did not result in significant changes in symptoms. An issue that was not addressed in any of the studies identified in this literature review is whether stretching muscles results in the release of chronic muscle tension. It is possible that stretching only results in temporary feelings of relief.

Broadening the lens a bit, the search returned eight studies that researched CLBP and tension in the paraspinal muscles. People with CLBP and healthy controls who had tight hip-

flexor muscles, as measured by flexion and extension strength testing, received four sessions of fascial-muscular lengthening therapy (FMLT) over two weeks. This therapy is designed to lengthen muscles and release muscle tension. Both groups showed increases in flexibility and decreases in muscle tension, but the CLBP group reported significant decreases in pain and disability compared to people in the control group, indicating that releasing muscle tension resulted in decreasing CLBP.

In multiple studies, participants with CLBP exhibited higher levels of paraspinal muscle tension and extended time for return to baseline measurements, measured by EMG, compared to healthy controls when presented with anger, sadness, or pain stimuli (Burns, 2006a, 2006b, Burns et al., 2008, 2012; Glombiewski et al., 2008). Exploring paraspinal muscle tension, Lewis et al. (2012) used EMG to measure muscle tension in paraspinal muscles while performing simple tasks to show that people with CLBP had significantly more muscle activity/tension than people in the healthy control group. This muscle tension also correlated with higher levels of pain and disability (Lewis et al., 2012). Training in back exercises and lifestyle changes for people with PTSD resulted in increased height as measured by standing stadiometer, which might indicate release of muscle constriction (Lewis et al., 2014). However, no significant changes in muscle tension were reported as measured with EMG. These results presented a confusing picture of apparent lengthening of the body while maintaining existing muscle tension.

A related subject to muscle tension is the concept of trigger points. A trigger point is a small area within a muscle that is very sensitive to touch and may be painful when the muscle contracts or is activated (Iglesias-González et al., 2013). People may have trigger points without reporting pain, but trigger points are generally associated with muscle pain and reactivity (Iglesias-González et al., 2013). Although muscle tension and trigger points are not

synonymous, it is likely that painful trigger points can cause muscles to contract, causing tension. Neuromuscular therapy is designed to reduce pain and reactivity in muscles (Jayasingh & Thomson, 2017). People with CLBP who received neuromuscular therapy for six weeks reported significantly decreased pain and had significantly fewer trigger points compared to controls (Jayasingh & Thomson, 2017). Among both nsCLBP participants and healthy controls, the highest concentration of trigger points was found in the psoas muscles (Iglesias-González et al., 2013). Taken together, these two studies suggested that pain connected to trigger points may have some connection to muscle tension, and that releasing the tension might reduce or eliminate the trigger point along with pain symptoms.

Widening the lens further to look at CLBP and general muscle tension, the database search returned six relevant studies (Kienbacher et al., 2016; Kim & Yu, 2015; Mansuri & Shah, 2017; Massé-Alarie et al., 2016; Mistry et al., 2014; Sarabon et al., 2011). Measurements of back and trunk muscles showed impairments in flexibility and range of motion among 216 adult CLBP patients, but younger participants under the age of 60 had less impairment than those over age 60 (Kienbacher et al., 2016). This result may indicate that older people who have been in pain longer have greater impairment, which could also be an indication of chronic muscle tension. Participants receiving complex manual therapy, which is designed to release muscle tension, reported better decreases in pain than a control group who performed self-exercise (Kim & Yu, 2015).

Muscle tension in abdominal muscles was also linked to CLBP. Using a pressure biofeedback unit, participants were asked to lie still and pull in their abdominal muscles as much as possible and hold for 10 seconds. People with CLBP had significantly less muscle strength and tension than people in the healthy control group (Mansuri & Shah, 2017), indicating less

muscle tension for the CLBP group. This difference in muscle tension might be explained by fatigue if the CLBP group was holding tension for long periods of time, but the study did not discuss this possibility. In a contrasting trial, Massé-Alarie et al. (2016) found that people in a CLBP group had significantly more muscle activation, as measured with EMG, in abdominal muscles during flexion movements as compared to healthy controls. The difference between the two studies was that Mansuri & Shah (2017) measured muscle activity while contracting abdominal muscles while Massé-Alarie (2016) measured muscle activity while performing movement. Neither study measured activity while being passive, which might give a better indication of the differences in muscle tension between people with CLBP and healthy adults.

Increases in trunk muscle strength did correlate with decreased pain and improved strength and flexibility for 10 participants with CLBP (Sarabon et al., 2011). Tension in hamstring muscles was also associated with low back pain. People with CLBP were found to have significantly more hamstring tightness than healthy controls when performing an active knee extension test (Mistry et al., 2014). Overall, greater muscle tension correlated to higher levels of pain and disability.

The fear-avoidance model suggests that people who have chronic back pain get caught in a cycle of avoiding physical activity because they are afraid it will hurt. Avoiding movement then leads to muscle atrophy, muscle tension, and more pain, leading to more avoidance of movement (Pincus et al., 2010). Using both EMG to measure muscle tension and skin conductance to measure fear response, Glombiewski et al. (2015) reported that participants who had higher fear levels also had greater muscle tension in paraspinal muscles when seated in a resting position. These results supported the fear-avoidance model as well as provided evidence

linking muscle tension to CLBP. Since fear is associated with PTSD, these results may also support a connection between muscle tension, CLBP, and PTSD.

The complex psychogenic pain theory (Atarodi & Hosier, 2011) proposes that pain that is not attributable to medical causes may be related to suppressed emotions, particularly negative emotions. In Burns (2006a) and Burns et al. (2012), the effects of anger on muscle tension in the low back and hip flexors among people with CLBP were explored. Participants experiencing negative emotions such as anger and sadness showed significant increases in low back muscle tension, measured with EMG, as compared to control groups. Participants in the intervention group also took longer to return to baseline than participants in the control group (Burns, 2006a). Suppressing pain, anger, or sadness correlated to increases in muscle tension in the paraspinal muscles for people with CLBP (Burns, 2006b; Burns et al., 2008, 2012), suggesting that suppression of physical or emotional experience may be an explanation for non-specific chronic low back pain. Similarly, fear was linked to significant increases in low back muscle tension as well as increases in pain levels and anxiety (Glombiewski et al., 2015). These study results provided possible connections between pain and negative emotion, which may be present in both PTSD and nsCLBP, and muscle tension. These connections are applicable to TRE in that tremoring is thought to release chronic muscle tension, along with the emotions connected to the tension.

The results of Search 1 presented evidence for relationships between CLBP and muscle tension in multiple areas, including the paraspinal muscles and psoas muscles. More specific connections to pain, muscle tension, and suppression of physical and emotional experiences provided possible links to co-occurring nsCLBP and PTSD. Although the studies analyzed did

not provide direct evidence of causation between muscle tension and low back pain, there was significant information tying the two phenomena together.

Search 2: PTSD and muscle tension. Search 2 focused on whether there is a connection between muscle tension and post-traumatic stress disorder (PTSD). Of the three database searches, this search returned the fewest number of research articles, indicating a large gap in the literature.

Of the four selected studies (Kim & Yu, 2015; McDonagh-Coyle et al., 2001; Nelson et al., 2010; Nyboe et al., 2017), the most direct connection between PTSD and muscle tension was found by Nelson et al. (2010) in a study on non-human subjects. Although this study was the strongest connection between muscle tension and PTSD, the results are discussed here for informational purposes because there is no evidence that the results are generalizable to human participants. In a two-part experiment, sensors were implanted in the hip flexor muscles of 28 male rats, allowing direct measurement of muscle tension. Half of the rats (n = 14) were then exposed to traumatizing experiences such as being threatened by aggressive rats, while the others served as a control group. The traumatized rats displayed anxious behavior and increased muscle tension compared to the control rats. Four weeks later, the previously traumatized rats were exposed to odor reminders of the traumatic experience, and muscle tension and anxious behavior again increased compared to the control rats. The hyperarousal subtype model (Weston, 2014) suggested that the amygdala was responsible for the rats' interpretation that the odor was a new traumatic experience, and for sending out messages about danger to the body, including to the hip flexor muscles. This triggering of the danger response would explain the increase in muscle tension for the traumatized rats.

Forehead muscle tension in 37 female sexual abuse survivors with PTSD was measured using EMG (McDonagh-Coyle et al., 2001). Significant increases in muscle tension occurred when the participants were exposed to traumatic imagery as compared to experiencing more pleasant images. The results suggested a connection between muscle tension and new traumatic experience for participants with existing PTSD. However, there is no data on whether healthy adults would experience the same increases in muscle tension because there was no control group. Male torture survivors reported significant decreases in PTSD symptoms after eight weeks of complex manual therapy, which is designed to release muscle tension (Kim & Yu, 2015). Kim and Yu (2015) did not use a comparison group, limiting the generalizability of their research. War veterans and refugees with PTSD reported higher levels of muscle tension than participants in a control group (Nyboe et al., 2017). Although the results from the Nyboe et al. (2017) study were the strongest evidence of a connection between PTSD and muscle tension in human adults, the study used self-report instruments rather than physiological measures of muscle tension. Results from self-report measurements of muscle tension are more subjective than results from EMG or other physiological measurements and are considered less reliable (Leedy & Ormrod, 2013).

Taken together, these three studies suggested: (a) that people with PTSD may have more muscle tension on a chronic basis than people who do not have PTSD, (b) that muscle tension may increase for people with PTSD when exposed to new traumatic experience, and (c) that PTSD symptoms may decrease when muscle tension decreases. These studies were conducted with relatively small samples and very specific populations and are not generalizable to the larger population of people with PTSD. More research is needed before any conclusions can be reached.

Search 3: TRE and related interventions. Search 3 explored whether there was evidence to support the use of TRE and release of muscle tension to treat either nsCLBP or PTSD. Three studies utilizing TRE as an intervention were analyzed (Berceli, 2007; Berceli et al., 2014; McCann, 2011). Additionally, studies using interventions that were based on related principles of muscle tension release were included in the search because there is limited published research on TRE. These interventions were: Somatic Experiencing (Andersen et al., 2017; Brom et al., 2017; Changaris, 2010; Ellegaard & Pedersen, 2012; Leitch, 2007; Leitch et al., 2009; Parker et al., 2008; Zettl, 1999); Rosen Method Bodywork (Fogel, 2013); and Bioenergetics (Nickel et al., 2006).

None of the three TRE studies related directly to PTSD or nsCLBP, limiting their applicability to the research question, but they did offer some information about the effectiveness and feasibility of using TRE as a treatment technique. The Berceli et al. (2014) study was primarily intended as a feasibility study to determine if people would use TRE consistently. This study provided some useful information about the self-practice portion for the research conducted in the current study. Results showed that 91.3% of the participants did complete the study, but the two-week time period was fairly short and most of the TRE practice sessions were facilitated rather than self-practice. The 21 participants were all staff members at an orphanage in Cape Town, South Africa, and may have had high motivation to complete the sessions. Within those limitations, there was a very high rate of participation and some perceived improvement in quality of life.

In his dissertation on TRE and anxiety, Berceli (2007) used a control group but the sham intervention he used was questionable. The sham had participants perform the TRE exercises with the instruction to stop as soon as they felt tremors. Performing the exercises often invokes

tremors differently in people and at different times (D. Berceli, personal communication, June 13, 2015), and participants new to TRE might not even notice the tremors initially or might have difficulty stopping them. The use of this sham as a comparison likely contributed to the relatively weak results of the study comparing the control group to the intervention group. Small but significant changes in anxiety measures were found, but no significant differences between the groups occurred for heart rate variability or activation levels (Berceli, 2007). A separate dissertation study on TRE focused on the effects of being trained in TRE on two separate occasions (McCann, 2011). Some improvements on measures of quality of life and decreased anxiety were reported, but these results also do not directly relate to the current study. There is no currently published research that provides any information on whether TRE may be effective at releasing muscle tension or relieving symptoms of nsCLBP or PTSD, other than some evidence that it may relieve some types of anxiety.

Separate from the database searches, an additional 19 studies on the use of TRE worldwide were either in progress or unpublished as of mid-2016 (Current TRE Research, personal communication, April 26, 2016). This information is presented to indicate the growing interest in TRE as a treatment technique. The networking group of researchers who provided this information disbanded in late 2016, and communication with the individual researchers has been limited since that time. Many of the studies were qualitative or mixed-methods in design (n = 11), which may provide information about the experience of using TRE but does not address data on effectiveness. Five of these prospective studies were focused on trauma or PTSD, and none were focused on nsCLBP or pain in general. One study was focused on chronic pelvic pain and another on fibromyalgia, possibly providing a link between TRE and chronic pain treatment. An unpublished article (Herold & Nibel, 2016) reported on the use of TRE with psychotherapists

(n = 50) who potentially had experienced vicarious trauma. Physical symptoms and quality of life were measured using self-report before the TRE training and at a one-year follow-up. Decreases in levels of all physical complaints and increases in quality of life were reported. Although this article indirectly relates to the current dissertation study, there is not enough information from which to draw conclusions. To date, no significant results pertaining to this literature review have been reported from the planned studies, but there seems to be interest in TRE as a treatment technique for many conditions, including chronic conditions.

Somatic Experiencing (SE) is a somatic psychotherapy treatment based on the theory that people who develop PTSD after a traumatic experience are not able to move the trauma through their body to resolution, resulting in chronic holding (Levine, 1997; Payne, Levine, & Crane-Godreau, 2015). Movement, touch, and experiential therapy are combined to release this trauma or tension and allow healing. In Search 3, eight studies using SE with either nsCLBP or PTSD were identified (Andersen et al., 2017; Brom et al., 2017; Changaris, 2010; Ellegaard & Pedersen, 2012; Leitch, 2007; Leitch et al., 2009; Parker et al., 2008; Zettl, 1999).

The most relevant study from this search used SE with people who have co-occurring PTSD and nsCLBP (Andersen et al., 2017). Patients at a Danish back pain center were randomized to either a treatment as usual (TAU) control group or an intervention group that received brief SE in addition to TAU. People in the intervention group reported significant decreases in pain, PTSD symptoms, and fear of movement compared to the people in the TAU-only group. Fear of movement has been identified as a reason people do not respond well to treatment for CLBP in the fear-avoidance model (Glombiewski et al., 2015; Pincus et al., 2010; Vlaeyen & Linton, 2000). Significant improvements were still present at a 12-month follow-up

in the Andersen et al. (2017) study. Unfortunately, the researchers did not use any physiological measure of muscle tension and did not ask about muscle tension in the self-report measurements.

Several studies connected the use of SE to treatment of either acute trauma or PTSD. In a dissertation study using phenomenological-heuristic inquiry design, 80% of participants reported decreases in PTSD symptoms of the hyperarousal type after three to six sessions of SE (Zettl, 1999). One of the theoretical models used to develop the current study is the hyperarousal subtype model (Weston, 2014), which connects muscle tension to PTSD symptoms. Leitch et al. (2009) and Parker et al. (2008) both used brief SE interventions with participants who had been victims of natural disasters. Both also used control groups and conducted follow-up measurements. Significant improvement occurred for psychological symptoms of PTSD for the intervention group compared to the control group in both studies, and significant improvement lasted four months (Leitch et al., 2009) and eight months (Parker et al., 2008) respectively. There were limitations to these results due to the diversity of locations, participants, types of conditions, and quality of studies, but together they provided preliminary evidence that a body-based intervention similar to TRE can be effective for PTSD symptoms after natural disasters.

Brief SE treatment was also used to treat acute trauma symptoms following a tsunami (Leitch, 2007). Acute trauma has many of the same symptoms as PTSD, but it occurs immediately after the traumatic event and resolves within two months (APA, 2013a). When acute trauma symptoms do not resolve, the diagnosis becomes PTSD. Leitch (2007) conducted brief SE sessions with 53 adults who exhibited acute trauma symptoms. Immediately following the intervention, 67% of participants reported decreases in symptoms. At a one-year follow-up it was difficult to locate most of the participants, but of the 22 people located, nearly all reported

little to no PTSD symptoms. Since there was no control group, it is unknown how many people would have developed PTSD without treatment.

Utilizing longer SE treatment in a clinical setting, Brom et al. (2017) conducted a randomized-controlled trial with 63 participants who had PTSD. People in the intervention group received a standard SE session each week for 15 weeks. A waitlist group served as a control, and they received the same treatment after the intervention group. The first group reported significant decreases in all PTSD symptoms compared to the control group, and the control group then reported similar results after receiving treatment (Brom et al., 2017).

Somatic Experiencing was developed to treat psychological trauma, but one study was located that combined SE and Gestalt therapy to treat people who had nsCLBP (Ellegaard & Pedersen, 2012). It was a small qualitative study with six participants who received five to six sessions of combined SE and Gestalt therapy. Themes of stress and restriction emerged from the qualitative analysis. Symptom-related data was not gathered, so no inferences can be made regarding SE as a treatment for nsCLBP. The study is relevant in that it linked stress to nsCLBP, which may be linked to muscle tension. Another dissertation study was not directly tied to PTSD or nsCLBP but is included in the analysis because SE was used to treat anxiety, which is indicated in both conditions. Residents at a homeless shelter received either three weeks of SE plus skill-building training or treatment as usual as a control (Changaris, 2010). Those in the SE group showed significant decreases in anxiety compared to the control group. This study also provided information about using SE with a population that might be inconsistent with participation.

A single study using Rosen Method Bodywork (RMB) with people who had CLBP was identified and analyzed (Fogel, 2013). Rosen Method Bodywork was adapted from massage

therapy principles, and it includes verbal commands about increasing self-awareness (Fogel, 2013). It was designed to promote relaxation and decrease muscle tension (Fogel, 2013; Hoffren-Larsson et al., 2009). Five female adults with CLBP received RMB treatment for 16 weeks. Outcomes were measured by self-report. Significant reductions in pain were reported, as were improvements in mood. With the small sample size and lack of a control group, the results are not generalizable to larger populations. Combined with the results from the other studies using interventions designed to release muscle tension, however, this study supported the use of TRE as an intervention in this dissertation study.

Bioenergetics (BE) is a form of psychotherapy based on work by Alexander Lowen (1995). It combines physical exercises with talk therapy to release muscle tension. A study on utilizing BE with chronic pain was located and analyzed. In a randomized-controlled trial, 128 adults with chronic pain either received six weeks of BE treatment or performed physical exercises (Nickel et al., 2006). Participants in the BE group reported significant decreases in pain and improvement in mood compared to the control group. Although there are many differences between BE and TRE, including that BE is a facilitated therapy and TRE is a self-practice technique, this study suggested that an intervention designed to reduce muscle tension could be helpful in treating chronic pain.

The best evidence for the use of muscle tension release interventions with people who have co-occurring nsCLBP and PTSD came from the research on Somatic Experiencing, which differs from TRE in three key ways: (a) SE is facilitated by a mental health professional and TRE is designed to be self-practiced after initial training; (b) SE is a form of psychotherapy and TRE is not psychotherapy; and (c) SE integrates emotional processing and TRE does not directly address emotional processing. Both interventions have the same goal – to promote healing and

reduce symptoms through the release of muscle tension. The reported success of SE for both PTSD and nsCLBP is encouraging information that TRE may be an effective treatment as well.

Risk of Bias Across Studies

Searches 1 and 2: Muscle tension and nsCLBP or PTSD. Publication bias is always a concern. In this literature review, only one study did not show a relationship between pain, emotion, trauma, and increased muscle tension (Mansuri & Shah, 2017). It is possible that articles that do not show strong results exist but have not been published. In several of the selected studies, population recruitment and selection information were missing or incomplete, making it difficult to assess selection bias. Additionally, most of the selected studies used convenience samples in the form of hospital or clinic patients, potentially introducing bias.

Search 3: TRE and related interventions. All four interventions investigated in this review are considered complementary and alternative medicine and are not mainstream therapies. Researchers in these areas likely want to prove that their intervention works, which potentially introduces significant bias. Much of the analyzed research was conducted by the creator of the intervention or by a close associate, introducing increased potential for bias. As opposed to the publication bias for the studies in Searches 1 and 2, for TRE and related interventions an opposite bias may be occurring. Because these are new or relatively unproven techniques, scholarly journals may avoid publishing positive results or any studies at all. It is difficult to know how much this impacts the available peer-reviewed literature.

Literature Review Discussion

Summary of Evidence

The research directly linking muscle tension to either PTSD or nsCLBP is preliminary, but there is enough evidence to warrant further investigation. There seems to be a strong link

between negative emotions such as fear and anger and muscle tension in the lower back and hip flexor muscles (Burns, 2006a; Burns et al., 2012; Glombiewski et al., 2015). The diagnostic criteria for PTSD include behaviors connected to fear and anger, further implying a possible role of muscle tension. Several studies reviewed here measured muscle tension in relation to low back pain using EMG, thus establishing a likelihood that people with nsCLBP do experience more muscle tension, particularly in the paraspinal muscles. The one study that linked muscle tension with co-occurring PTSD and CLBP (Kim & Yu, 2015) had some strong risk of bias, indicating a need for more clinical trials before drawing conclusions. Although there was a body of evidence regarding muscle tension and nsCLBP, very little research on muscle tension and PTSD was located.

Regarding TRE and related interventions, the selected studies varied widely in quality, populations, research methods, conditions, and outcome measures. A significant theme in the results, however, was that the use of these body-oriented methods for releasing muscle tension provided relief of symptoms. Research currently being conducted that focuses on using TRE for PTSD and pain symptoms should be provide more clarification as it is concluded and published in the future.

The overall picture from the three separate analyses is that there is some correlation between muscle tension and co-occurring PTSD and nsCLBP, but no research was found that addressed chronic muscle tension in the body. The complex psychogenic pain model is based on chronically-held muscle tension, and much of Berceli's (2005, 2008, 2015) theory is also based on chronic muscle tension. Both PTSD and nsCLBP are chronic conditions. More research is needed to understand the differences between muscle tension as an acute reaction and as a chronic condition. The second concern is whether releasing muscle tension provides relief from

PTSD and/or nsCLBP. Some preliminary evidence on TRE and related interventions suggested this is possible, but again it is unknown whether this applies to temporary relief or long-term healing. In general, there seems to be enough evidence to warrant more research in all these areas.

Literature Review Limitations

This literature review has some limitations. The issue cited above regarding the potential differences in acute muscle tension and chronically-held muscle tension has not been addressed. There is a lack of research in general on the use and effectiveness of TRE, particularly in relation to PTSD and nsCLBP. Most of the research on TRE and related interventions lacked control or comparison groups and contained multiple concerns about bias. While the available research is promising, it is also limited in generalizability.

When discussing PTSD, an important potential limitation relates to the diagnosis of PTSD. In 2013, the American Psychiatric Association (APA) released the first revision to the *Diagnostic and Statistical Manual of Mental Disorders* since 2000. This manual is considered the primary source for describing and diagnosing mental disorders. The newest edition is known as the *DSM-5* (APA, 2013a), and the previous edition was known as the *DSM-IV-TR* (APA, 2000). Most of the research studies on PTSD reviewed here, as well as the measurement instruments, were based on criteria from the *DSM-IV-TR*. While criteria for the PTSD diagnosis changed significantly between the two versions, very little change occurred in the symptom cluster of hyperarousal (APA, 2013b; Wolf et al., 2016). This symptom cluster has been the focus for PTSD in this review. The differences between the two versions of the manual are important to note for future research, but do not significantly impact the topic of this literature review.

Literature Review Conclusion

This literature review investigated several concept areas that have not been extensively researched. An overall picture of the literature reviewed here suggests that there are connections between muscle tension and co-occurring PTSD and nsCLBP. It also suggests a connection between body-based interventions designed to release muscle tension and symptom relief for PTSD, nsCLBP, or other types of back pain. After synthesizing the results from this literature review, it seems that research exploring the use of TRE for the treatment of co-occurring PTSD and nsCLBP is an appropriate next step.

CHAPTER 3: METHODOLOGY

Methods and Procedures Overview

This original research study used a randomized-controlled design with repeated measures over four weeks and a 1-month follow-up measurement. This research study was approved by the Saybrook Institutional Review Board on May 24, 2018. Inclusion criteria for the study included a previous diagnosis by qualified professionals of both post-traumatic stress disorder (PTSD) and non-specific chronic low back pain (nsCLBP), with symptoms of each lasting at least six months. Participants were adults ages 18 and older, recruited by electronic flyers distributed to both mental health and medical providers and by postings to social media. Participants in the experimental group were trained in self-practice of Trauma Releasing Exercises (TRE). A control group of participants was trained in self-practice of Progressive Muscle Relaxation (PMR), a self-help technique that had previously been found to be effective for treatment of either PTSD or nsCLBP separately (Coppieters, Cagnie, & Nijs, 2016; de Lorent et al., 2016; Kuhn et al., 2014; Kwekkeboom & Gretarsdottir, 2006; Morone & Greco, 2007).

The study design allowed for pre-test assessment of symptoms for both conditions as the first baseline data measurement (Assess1), with a second measurement following the training session (Assess2). After the second measurement, data on whether participants self-practiced, and if so how frequently, were gathered weekly for four weeks. At the end of the study, symptoms were measured a third time in a post-test (Assess3) and a final time at a 1-month follow-up (Assess4). The participant time commitment was nine weeks, with the following segments: (a) pre-training assessment; (b) one-day orientation and training with assessment; (c) four weeks of self-practice; (d) post self-practice assessment; and (e) 1-month follow-up assessment.

Data from the first measurement (pre-training; Assess1) were compared to the second measurement (post-training; Assess2) to determine the effect of being trained in either TRE or PMR, and to the two subsequent measurements (post self-practice; Assess3; and 1-month follow-up; Assess4). The four assessment periods gave information about the effect of regular self-practice over the period of four weeks and whether effects lasted at least one month after self-practice ended. Statistical analysis using Microsoft Excel for Office 365, version 1810 and GraphPad QuickCalcs (Motulskey, 2018) consisted of comparisons of results from the four measurements of symptoms and from the weekly self-practice assessments.

All data, except for the Subjective Units of Disturbance (SUDS; Tanner, 2012), were gathered in online, self-report surveys. These instruments included: Oswestry Low Back Pain Disability Questionnaire 2.0 (Fairbank, Couper, Davies, & O'Brien, 2008); Defense and Veterans Pain Rating Scale (Nassif, Hull, Holliday, Sullivan, & Sandbrink, 2015); Insomnia Severity Index (Morin, Belleville, Bélanger, & Ivers, 2011); and the PTSD Checklist for DSM-5 (Weathers et al., 2013). The only data items gathered in-person were SUDS for both physical pain and emotional disturbance (Tanner, 2012). The SUDS Assessment was administered in-person immediately before and after the training session.

Choice of Method

Quantitative, correlational methodology was chosen because it is used to test existing theory and to test the efficacy of an intervention (Jacobsen, 2012; Leedy & Ormrod, 2013). The theories being tested were (a) that chronically-held muscle tension contributes to symptoms of both nsCLBP and PTSD, and (b) that releasing the tension by using TRE and self-induced therapeutic tremors would result in significant decreases in symptoms of both conditions.

In researching the efficacy of an intervention, wait list or placebo controlled randomized-controlled studies are recommended (Menard, 2009). At the time of the study, participants had suffered from both conditions for more than six months, suggesting that their current treatment or that receiving no treatment was ineffective. This potentially could have eliminated the need for a control group, as the participants' previous history represented a *de facto* control group. However, a control or comparison group was included to provide protection against self-selection bias. The use of a control group also allowed potential analysis of whether TRE was at least as effective as another form of treatment that did have research to support it. The other form of treatment chosen for the control group was Progressive Muscle Relaxation (PMR). Without the control group, only participants who were interested in TRE might have applied for the study.

Since participants were recruited through medical and mental health providers, it was expected that most participants were receiving other forms of treatment during the study. This concern was addressed by adding demographic items regarding whether or not the person was in other treatment, and whether or not symptoms had improved, stayed the same, or worsened in the previous six months. Since this study was primarily concerned with the efficacy of TRE, the choice of a randomized-controlled study was the most appropriate design (Menard, 2009).

Participants

For this study, participants were recruited through medical and mental health providers who treat either post-traumatic stress disorder (PTSD) or non-specific chronic low back pain (nsCLBP). The target sample size was 60 participants as calculated and described below. Alternative sample sizes were also calculated in the event that 60 participants were not recruited.

Sample Size

To avoid incorrectly rejecting the null hypothesis, a study must have enough participants to result in $\alpha \leq .05$ (Kraemer & Thiemann, 1987). A power analysis prior to conducting research estimated the number of participants needed to reach this level of significance. The sample size was calculated *a priori* using G*Power 3.1.9.2 (Faul, Erdfelder, Buchner, & Lang, 2009) for repeated measures MANCOVA. Assumptions in the calculation for a significant effect size included: $\alpha = .05$; 95% power (1-β err prob); two groups; and five response variables.

The desired effect size of .25 was chosen, resulting in a total sample size of 54 participants for the study. An ideal goal for recruitment was set at 60 participants, with 30 participants randomized to each group. This sample size allowed for potential disqualification of participants and for drop-outs during the study.

In the event that recruiting efforts did not result in 60 volunteers, two other sample sizes were calculated with higher α values. This allowed for credible statistical analysis, but the risk of incorrectly rejecting the null hypothesis increased with the increased α values. The sample size scenarios and results are presented in Table 12. A sample size with as few as 32 volunteers would still have yielded viable data for multivariate analysis of the collected data for multiple situations and demographic exposures.

Table 12

Sample Size Scenario Calculations

α Error Probability	Assumed Power	Sample Size	Actual Power
α = .05	75	54	.77
α = .10	75	44	.77
α = .15	75	36	.75
α = .20	75	32	.76

Inclusion Criteria

To qualify for inclusion, a participant was required to have previous diagnoses of both post-traumatic stress disorder (PTSD) and non-specific chronic low back pain (nsCLBP), with active symptoms lasting at least six months. Participants were both medically and psychologically vulnerable, as this study focused on co-occurring PTSD and nsCLBP. To protect vulnerable participants, the Healthcare Accessibility Statement was required as part of enrollment in the study. It asked participants to attest that they had adequate health insurance or the financial ability to access medical and/or psychological care if needed. The Healthcare Accessibility Statement is shown in Appendix E. An optional Healthcare Professional Release Form was provided to assist prospective participants in talking to their healthcare professionals about the study and whether they were appropriate candidates for participation. It can be seen in Appendix F.

An area of safety concern was the participants' ability to perform mild intensity exercise. For the purpose of the study, mild intensity exercise was defined as movements that do not involve shortness of breath, perspiration, or painful or strenuous movements. The TRE protocol includes many modifications to accommodate injuries and balance issues. A key component of

TRE training is that self-regulation is taught at every step. Self-regulation helps to protect people both medically and psychologically, guiding them to stay within their physical capabilities and psychological tolerance (Berceli, 2008, 2015). Throughout the TRE training, there was an emphasis on avoiding pain and being mindful of one's body signals. Participants were instructed to stop any time they felt pain or discomfort. An effort scale of 0-10 is used in TRE instruction, with a score of ten representing the start of pain. Participants were instructed to stop whatever they were doing when they reached a level seven of effort, which might feel like sensations of warmth or tingling. Similar instructions, though not a part of typical PMR training, were included in the PMR training sessions to keep the experiences as similar as possible and to promote participant safety.

All participants were 18 years of age or older with the ability to speak, read, and write the English language well enough to understand study materials, follow simple instructions, complete written assessments, and give informed consent. Reliable, consistent access to email and Internet was required, as was reliable transportation to and from the research training site. The research training site was a movement studio at Performing Academy, located in Pleasant Hill, CA. The studio was located on the second story of the facility, and all participants were offered an alternate training space if mobility issues were a concern.

Exclusion Criteria

Reasons for exclusion from this study included: hospitalization in the past 18 months for psychiatric illness; previously diagnosed spinal injury or other serious illnesses that cause back pain; use of opioid pain medications; current or pending litigation or workman's compensation claims regarding either PTSD or nsCLBP; current suicidal ideation; current active psychosis; or daily activities that regularly require lifting more than 50 pounds. An assessment for

dissociation prior to the study was an additional precaution for disqualifying participants who were not psychologically appropriate for this study. Highly dissociative people are at significant risk of adverse psychological effects from practicing TRE without a facilitator, so participants with significant levels of dissociation were not appropriate for this study involving self-practice (Berceli, 2008). Women who were pregnant or intending to become pregnant during the duration of the study were excluded, as there is currently no evidence regarding the safe use of TRE during pregnancy (N. Ndefo, personal communication, February 12, 2016).

Recruitment

Potential participants were recruited through several methods. A flyer describing the study was distributed to local medical and mental health professionals through electronic mailing lists, professional contacts, and direct mail. See Appendix A for the recruitment flyer. A webpage was used to disseminate information about the study and the requirements for participation. Screen shots of the webpages are located in Appendix C. Online networking groups associated with medical and psychotherapy practices received email notification of the study. Additionally, several colleagues who had previously indicated interest were contacted by email or direct mail. Postings on business Facebook and LinkedIn pages directed interested parties to the recruitment webpage. The recruitment webpage contained a podcast explaining the study and the use of TRE and PMR to these professionals.

All recruiting materials contained information on how to direct potential volunteers to the study webpage for participants. The webpage contained a description of the study, links to the informed consent form, and a link to initial screening and assessment instruments. Potential participants only received links for subsequent steps if they qualified for the study. Volunteers who did not qualify for the study were notified by email.

The study was advertised as research on the effects of muscle relaxation on co-occurring PTSD and nsCLBP, rather than research specifically on TRE. As PMR is an accepted method of relaxation, participants were not informed until the end of the study that the purpose was to study the effects of TRE. This decreased the chance of selection bias for the study. Participants received a debriefing email after the last assessment was conducted, explaining that the primary focus of the study was on TRE.

Research Setting

Research was conducted in three different settings: (a) data gathering through secure, HIPAA-compliant survey using Survey Monkey; (b) in-person training sessions for either TRE or PMR; and (c) self-practice for the remainder of the study. The Survey Monkey paid version offers a business associates agreement stating that the product is HIPAA-compliant. This version was used for all online data gathering. In-person training was conducted in a movement studio appropriate for movement interventions at Performing Academy in Pleasant Hill, CA. Self-practice of TRE or PMR was performed by participants at locations of their choosing.

Instruments

Four types of instruments were used at different stages of the study: screening data, demographic data, symptom-related data, and self-practice data. Screening data were gathered prior to Informed Consent, and the survey took about four minutes to complete. Demographic data were gathered at the beginning of the study, after Informed Consent, averaging seven minutes to complete. Symptom-related data were gathered four times during the study, taking about 10 minutes to complete each time. A separate symptom-related assessment, Subjective Units of Disturbance (SUDS), was administered on paper twice at the training sessions. Self-

practice data were gathered weekly for four weeks, with participants spending about five minutes each week completing a Weekly Assessment Survey.

All instruments except for SUDS were administered online via secure survey. All were self-report questionnaires. The virtual format ensured that participants did not form a relationship with me before the study began and minimized my contact with participants during the study. The SUDS assessment was administered in paper form at the training session.

Screening Data

Eligibility1 Survey. The first level of eligibility screening was conducted online with the Eligibility1 Survey. The questions on this survey asked about items in the inclusion and exclusion criteria. Screen shots of the Eligibility1 Survey are presented in Appendix D.

Severity of Dissociative Symptoms–Adult/Brief Dissociative Experiences Scale (DES-B)-Modified. This self-report instrument was used to identify potential participants who were at risk for significant dissociative events during the study (Dalenberg & Carlson, 2013). The DES-B-Modified is a shortened version of the Dissociative Experiences Scale (DES), which is widely used in assessing levels of dissociation among adults with PTSD, borderline personality disorder, and other dissociative disorders (van Ijzendoorn & Schuengel, 1996). In comparison to other measures of dissociation, including those involving clinical interview, the DES scored a very strong Cohen's d = 1.82 (van Ijzendoorn & Schuengel, 1996). Across 16 studies, alpha reliability was found to be .93 (van Ijzendoorn & Schuengel, 1996). The DES-B-Modified was developed based on measures produced using U.S. Federal Government resources and is therefore in the public domain and freely available for use without permission so long as authorship is accurately attributed (Dalenberg & Carlson, 2013).

This instrument was administered one time during the screening phase to determine whether participants could safely participate in the study. It was referred to as Eligibility2. No data analysis was conducted, as this was a screening tool. It provided a raw total score and an average total score. The DES-B-Modified assesses levels of dissociation in the past seven days. A highly dissociative participant is at risk of adverse psychological effects from practicing TRE without a facilitator (Berceli, 2008). For this study, a raw total score of more than 18 or an average total score of more than 3.5 was considered grounds for exclusion from the study.

Demographic Data

Data for multiple demographic exposures were gathered via online survey after participants enrolled in the study. Appendix G contains the complete set of demographic data items and possible answers.

Symptom-Related Data

Subjective Units of Distress (SUDS). This self-report tool is a Likert scale of 0 to 10. The subject is asked to rate distress at the current moment, with 0 being the worst distress imaginable and 10 being the least distress imaginable. It was used at the training session to determine the immediate effect of learning TRE or PMR. There is not a standardized format for SUDS assessment; it is frequently administered verbally (Tanner, 2012). For this study, a paper form asked participants to provide both physical and emotional SUDS immediately before and after the training. This form is presented in Appendix H.

Validity for the use of SUDS is supported by Tanner (2012) as a way of measuring the participant's subjective experience of both physical and emotional distress. It correlated highly with other clinical measures of physical and emotional symptoms ($p < .05$) in a population of 182 adult patients at a psychology clinic (Tanner, 2012). Per multiple sources, SUDS is a

concept rather than a standardized instrument (Kim, Bae, & Chon Park, 2008; Tanner, 2012). It was originally developed by Joseph Wolpe in 1958 (Tanner, 2012) and is in the public domain. It was chosen for this study as a method of comparing a snapshot of the participants' physical and emotional well-being before and after the training session.

Oswestry Low Back Pain Disability Questionnaire Version 2.0 (ODI). This questionnaire assesses for functionality and disability related to low back pain in 10 major life areas (Fairbank et al., 2008; Fairbank & Pynsent, 2000; Maughan & Lewis, 2010). It was used at all four assessments (Assess1, Assess2, Assess3, Assess4). The instrument provides one numeric score of 0-100, with higher scores indicating more severe disability. Since its creation in 1976, four English versions and nine versions in other languages have been used. Version 2.0 contains all of the questions and life areas of the original version, with language that is slightly easier to understand (Maughan & Lewis, 2010). This instrument has been used in over 200 studies to date (Fairbank et al., 2008) and has a test-retest reliability of $r = 0.99$ in a 24-hour period (Fairbank et al., 2008). It has a convergent correlation with other commonly used back pain scales of 0.62-0.82 (Fairbank et al., 2008). The ODI is in the public domain and is available for free use (Fairbank et al., 2008).

PTSD Checklist for DSM-5 (PCL-5). This 20-item self-report instrument measures symptoms of posttraumatic stress disorder criteria against the *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* (APA, 2013a; Weathers et al., 2013). It was used at all four assessments (Assess1, Assess2, Assess3, Assess4). It provides a numeric raw score with a potential total score of 80. A higher score indicates the presence of more severe PTSD symptoms. It asks about each item over the past month, but it is approved for use with shorter time periods to measure change over time (National Center for PTSD, 2018), as was needed in

this study when assessing potential changes from attending the training session (Assesss1 to Assess2). The PCL-5 has demonstrated good internal consistency and good test-retest reliability of r = 0.84 (Bovin et al., 2016). Permission to freely use the PTSD Checklist DSM-5 (PCL-5) as is, without alteration, has been granted to all researchers and clinicians (www.ptsd.va.gov/professional/assessment/adult-sr/ptsd-checklist.asp).

Defense and Veterans Pain Rating Scale (DVPRS). This self-report instrument assesses low back pain in terms of its effect on functionality. It provides a single numeric score from 0-10, with 10 being the worst pain, about the effects of pain in the past seven days (Nassif et al., 2015). It was used at all four assessments (Assess1, Assess2, Assess3, Assess4). It was chosen because it measures functionality and quality of life rather than pain level, which is more subjective (M. Menard, personal communication, March 16, 2016). The DVPRS correlates well with other measures of pain even when controlling for age, gender, and other demographic exposures (Nassif et al., 2015). Permission is granted for clinicians and researchers to freely use the Defense and Veterans Pain Rating Scale (DVPRS) as is, without alteration (www.dvcipm.org/clinical-resources/pain-rating-scale).

Insomnia Severity Index (ISI). This self-report instrument is used to measure the impact of sleep problems during both sleep and waking periods (Morin et al., 2011). It provides a single numeric score with a possible total of 28. A higher score indicates disrupted or poor-quality sleep. It has been shown to be as reliable and valid as other frequently used sleep quality assessments (Morin et al., 2011), and it was chosen for this study because it specifically asks about sleep patterns in the past seven days. Permission to use the ISI was granted by Dr. Morin through eProvide (eprovide.mapi-trust.org/instruments/insomnia-severity-index).

Self-Practice Data

This instrument was administered four times during the study, once for each week of self-practice. As these data were specific to the design of this study, a weekly self-practice assessment was created using Survey Monkey. Screen shots of the Weekly Self-Practice Assessment Survey can be found in Appendix J. Questions included: (a) In the past seven days, how many times did you self-practice TRE or PMR?; (b) Did you practice all of the exercises or a modified sequence?; (c) What factors encouraged your self-practice (multiple choice answers)?; and (d) If you did not self-practice three times in the past seven days, what got in the way (multiple choice answers)? The last two questions included a choice of *Other* with space to write in answers.

Procedures

The study protocol involved two separate treatment phases and four observations or assessments. See Figure 3 for a diagram of the study flow. Four weekly self-practice assessments served primarily as a reminder to support regular self-practice. Links to the survey for each week were sent via email. The data gathered from these weekly assessments were not intended to be a part of the primary data analysis, but they added to the general discussion. If the study results showed little or no symptom reduction, a discussion of the barriers to self-practice would be useful.

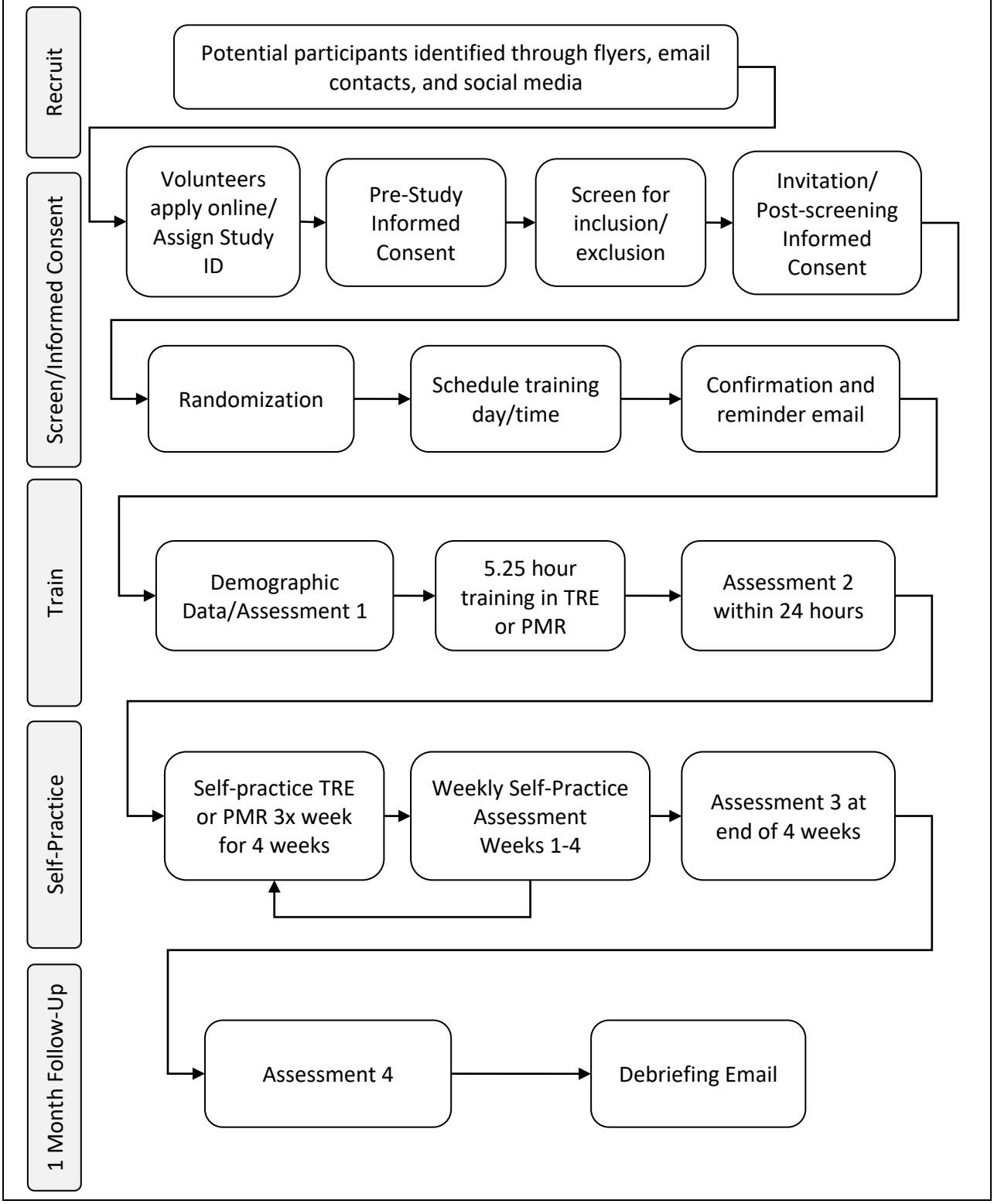
Participant time commitment, including a 1-month follow-up, was nine weeks total. The nine weeks consisted of one week of training and orientation, four weeks of self-practice, and four weeks before the follow-up assessment (no other action on the part of participants during this time).

Confidentiality and Safety

All data for the study were gathered via an online, secure vehicle, Survey Monkey. All participants were assigned a unique identifier that was attached to their data. Unique identifiers were generated in a Microsoft Excel spreadsheet using the RANDBETWEEN(1000,9999) function to generate 220 random numbers. The numbers were then hand-typed into an adjacent column, as the RANDBETWEEN function recalculates continuously. This list of random numbers was checked for duplicates, which were removed. Potential participants were then assigned to the random numbers as they indicated interest in the study. A separate table was kept with the unique identifier and the volunteer's name. This table was destroyed at the completion of the study. All data were downloaded weekly from Survey Monkey and kept in a secure spreadsheet on a stand-alone computer.

Although I am a licensed marriage and family therapist (LMFT) in the State of California, I was functioning as a private citizen while conducting this research study and while teaching TRE or PMR to study participants. As such, I was not a mandated reporter in the context of this research study, pursuant to California Penal Code 11166.g (California Legislative Information, 2017). However, had a participant appeared to be in immediate danger of self-harm or of harming another person, I would have revealed necessary information to authorities to attempt to prevent such harm. This information was in included in the Informed Consent.

Figure 3. Study Flow Diagram



Support for clarification and questions was available throughout the study by email during standard business hours. Emergency phone numbers for local suicide hotlines and emergency mental health services lines were provided as part of the Informed Consent Form in case a participant experienced a medical or psychiatric emergency during the study. The Informed Consent Form included instructions for the potential of a traumatic experience or illness or injury during the study (e.g. auto accident, injury, etc.). Participants were asked to report the date of the incident, an assessment of how much it impacted symptoms, and whether they wished to continue in the study. This report could be made via phone or email.

Screening/Informed Consent

Volunteers applied to the study through a webpage that directed them to the Pre-Screening Informed Consent and the screening survey (Eligibility1 Survey) in Survey Monkey. Screen shots of the study webpages can be found in Appendix C. The Eligibility1 Survey gathered information specific to the inclusion and exclusion criteria. If volunteers met these criteria, they then completed an assessment for safety and level of dissociation (DES-B-Modified) online. I screened this data for inclusion or exclusion. If a volunteer qualified, an invitation to complete the Post-Screening Informed Consent was sent through email. Volunteers who were not qualified to participate were notified by email. The study Informed Consent Form was provided in a PDF file, and participants were asked to read it, sign it, and indicate their consent by email or fax. They were then provided with a paper copy at the beginning of the training session to sign before proceeding.

Randomization and Scheduling

Qualified participants were randomized to either the TRE or PMR groups using Random Team Generator (Moniker Online Services LLC, 2018). Participant ID numbers were used rather than names during the randomization process to protect participant privacy.

Participants were blinded as to which group was the experimental group or the control group until the study was completed. If either technique proved to be significantly more effective than the other, participants were offered space to learn it in future classes. After participants were randomized to the two treatment groups, an invitation to formally join the study was emailed, along with the available dates and times for training sessions and instructions on how to schedule the training session. Two days before the participant was scheduled for training, an email invitation to complete the initial assessment survey was sent (Assess1). All participants received an email reminder 24 hours before their scheduled training session.

Training and Data Collection

Both TRE and PMR trainings were conducted by me. I am a certified TRE Facilitator (traumaprevention.com/member-details/?memberid=1122). No certification is required to teach PMR; however, I have extensive previous experience in teaching and facilitating PMR. Training in either TRE or PMR was conducted as an in-person, 5.25-hour session in small groups.

The training session consisted of:

- 15 minutes registration
- 15 minutes orientation to the study and facility; first SUDS assessment
- 2 hours initial training in TRE or PMR
- 1 hour lunch break on their own
- 1.5 hour second training in TRE or PMR; second SUDS assessment

- 15 minutes closing instructions

Two separate training sessions on each technique were included to increase the likelihood of self-practice. This decision was based on my experience as a facilitator and on observations of past clients I have taught TRE or PMR. The maximum length of tremoring for each TRE training session was 15 minutes, per recommendations of the TRE developer (Berceli, 2008, 2015). A script was used for the PMR training to ensure that all participants received the same instructions. The script can be found at www.therapistaid.com/worksheets/progressive-muscle-relaxation-script.pdf. Performing the instructions in this script normally takes significantly less time than performing TRE, so each instruction was given twice in order to make the experiences last roughly the same amount of time.

Each participant received a booklet describing the TRE exercises or a copy of the PMR script to help with their self-practice. A tip sheet on how to build new habits was distributed and discussed during the closing instructions to facilitate the likelihood of self-practice during the next four weeks. The tip sheet can be found in Appendix I.

Post-training assessments (Assess2) were emailed within 24 hours of the completion of the training session. Each participant was instructed, both during the orientation to the study and during the closing instructions, to self-practice on his or her own. They were asked to self-practice three times per week for 30-40 minutes at each session. Data about self-practice were gathered weekly via online survey. The primary purpose for the weekly survey was to remind participants to self-practice and to add a layer of accountability, with the goal of encouraging participants to self-practice. The secondary purpose was to gather data about self-practice, which might be helpful to other researchers and practitioners. Assessment 3 (Assess3) was

distributed by email at the conclusion of the four weeks of self-practice. An email with the link to Assessment 4 (Assess4) was sent four weeks after the end of the self-practice period.

Data Analysis

Data analysis was performed using Microsoft Excel for Office 365, version 1810 and GraphPad QuickCalcs (Motulskey, 2018). If the hypotheses were supported, there would be a strong argument for the feasibility of using TRE as a non-invasive self-help technique in this population, and directions for future research would be indicated. If significant changes in symptom levels occurred, the data would have supported using TRE for co-occurring PTSD and nsCLBP in adults. Secondary data would have described how likely people are to self-practice TRE regularly and whether this is impacted by demographic variables.

This study focused on two independent variables and five dependent variables:

- Independent variables: (a) being trained in TRE or PMR; (b) training plus self-practice of TRE or PMR
- Dependent variables: (a) nsCLBP symptoms, (b) PTSD symptoms, (c) sleep quality, (d) physical SUDS, (e) emotional SUDS, and (f) frequency of self-practice

Because there were multiple independent and dependent variables and multiple observation points, primary data analysis was planned for repeated measures MANCOVA using R Project for Statistical Computing (The R Foundation, 2017). Unfortunately, the small sample size precluded this level of analysis. Appropriately for the data collected, measures of central tendency and levels of significance were computed to compare outcomes between the two groups. Results for each instrument (ODI, DVPRS, PCL-5, ISI, SUDS) and for each assessment point (Assess1, Assess2, Assess3, Assess4) were computed. Means and standard deviation by

group along, with *p*-values between groups and between assessments, were then calculated to determine whether results reached statistical significance.

Methodology Limitations and Research Issues

All research is limited in some way. This study methodology had a few limitations. An important limitation is the possibility of bias because I trained the participants in the use of the experimental technique, TRE, or the comparison technique, PMR. Since participants spent time personally with me, they might have reported better results in an unconscious wish to please or help me. As this research was conducted as part of a dissertation and there was not significant budget to hire external trainers, this limitation is a part of the study. However, if there was an impact, it should have been seen equally in both groups since both had the same exposure. The potential bias was mitigated by keeping study materials and training presentations free of references to TRE as the primary focus of the study. Data collection through online means limited contact with me, further reducing the amount of potential bias.

Practitioners of TRE, including myself, notice better and more lasting results when people practice TRE regularly for several months. The 4-week self-practice period for this study was chosen based on direction from Saybrook University faculty. It may be that four weeks is too short a time period for significant results to occur. Should there be no significant symptom-reduction in this study, it would not mean that TRE is not an effective for treatment of co-occurring PTSD and nsCLBP. Rather, it potentially would mean that this length of self-practice is insufficient for significant results.

Another limitation to this study design was the use of self-report instruments rather than clinical interviews. This choice was made because there was no budget to hire qualified interviewers. Self-report instruments reduced the risk of bias by limiting participant contact with

me. Several of the instruments have been favorably compared to interview-based instruments, but this is still a limitation.

This chapter documented the methods used to conduct this dissertation study. The next chapter presents the results from the study.

CHAPTER 4: RESULTS

This study explored the use of Trauma Releasing Exercises (TRE) in the treatment of co-occurring non-specific chronic low back pain (nsCLBP) and post-traumatic stress disorder (PTSD) in adults. A control group using Progressive Muscle Relaxation (PMR) provided a contrast to the people using TRE. Previous studies have shown PMR to be effective in treating symptoms of either nsCLBP or PTSD (Coppieters et al., 2016; de Lorent et al., 2016; Kuhn et al., 2014; Kwekkeboom & Gretarsdottir, 2006; Morone & Greco, 2007). All participants were trained in either TRE or PMR and were asked to self-practice the technique for four weeks. Symptoms were assessed before the training, after the training, after the self-practice period, and at a 1-month follow-up. Weekly surveys gathered information during the self-practice period about whether participants practiced, how often they practiced, what motivated them to practice, and what got in the way of self-practice.

Two independent variables were utilized in this study: (a) attending the one-day training of either TRE or PMR, and (b) the full intervention of attending the one-day training plus the four weeks of self-practice. Three categories of instruments were utilized to explore the dependent variables of (a) symptoms of nsCLBP; (b) symptoms of PTSD; and (c) sleep quality.

The research question for this study was: Will a 4-week, three times per week practice of Tension and Trauma Releasing Exercises (TRE) significantly reduce symptoms of co-occurring non-specific chronic low back pain (nsCLBP) and post-traumatic stress disorder (PTSD) among a sample of adults in comparison to a control group using Progressive Muscle Relaxation (PMR)?

The following hypotheses were identified:

H_1: Four weeks of self-practice of TRE will provide significantly better symptom relief of nsCLBP than PMR.

H_2: Four weeks of self-practice of TRE will provide significantly better symptom relief of PTSD than PMR.

H_0: Four weeks of self-practice of TRE will have little or no significant impact on symptoms of nsCLBP or PTSD.

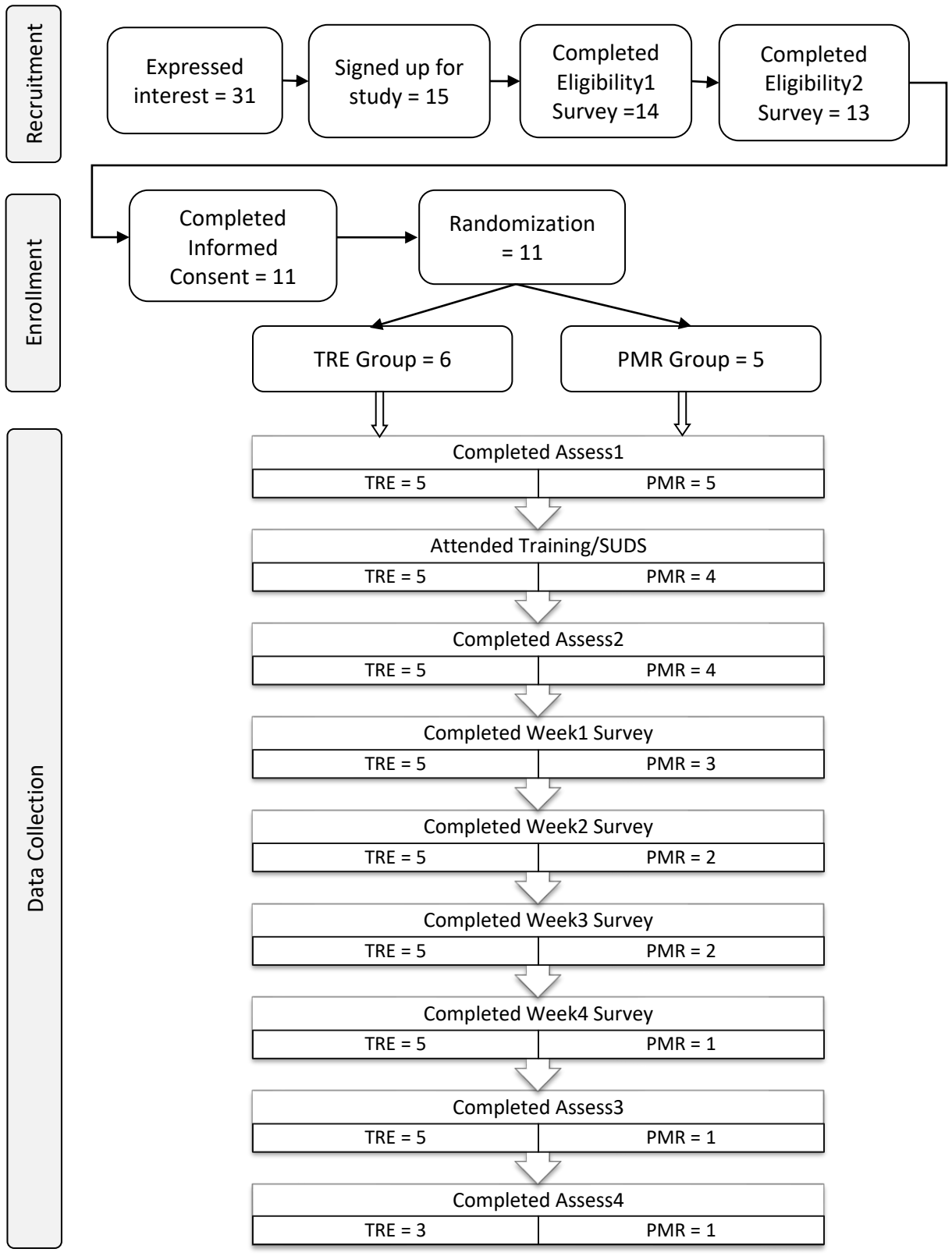
Several sub-problems were also identified: (a) If TRE is effective at treating either condition, will age, income level, work/personal factors, medications, current other treatment, or other demographic variables affect the results?, (b) Will participants self-practice regularly?, (c) Does frequency of self-practice impact symptom reduction for PTSD?, and (d) Does frequency of self-practice impact symptom reduction for nsCLBP?

This chapter begins by reporting on the number of people recruited and the resulting number of participants. The demographic data for the enrolled participants are presented. Data analysis results relating to the hypotheses are presented. Finally, where available, results relating to the sub-problems are presented. The chapter ends with a summary of key findings.

Participants

Recruitment through medical and mental healthcare professionals, along with postings to social media, yielded an estimated contact of 3,000 people in the San Francisco Bay Area of California. It is not possible to report the actual number of people contacted because the study posting was forwarded to multiple professional email groups with unknown membership. Figure 4 shows the flow of participant recruitment and movement through the study.

Figure 4. Participant Recruitment and Data Collection



Of the people contacted, 31 potential participants expressed interest in the study through email, phone, or website contact. A total of 11 people enrolled in the study (n = 11). Not all potential participants shared their reasons for not completing enrollment in the study, but the known reasons were: (a) did not meet inclusion/exclusion criteria; (b) could not attend the in-person training because of distance; (c) time commitment was too much; or (d) work commitments got in the way. One person was disqualified after completing Eligibility2 Survey because of high levels of dissociation.

After enrollment, participants were randomized to the two groups. One participant requested to be switched from the PMR group to the TRE group because he had already been practicing PMR for many years. After consultation with advisors, this request was granted. Two more people dropped out from the study before the training was conducted, one because of work commitments connected to local natural disasters, and the other because the participant felt her symptoms were very mild.

Five people were trained in TRE, and four people were trained in PMR. Figure 4 contains the number of participants who completed each step in the data collection process. All participants in the TRE group completed all assessments except for Assess4 at the 1-month follow-up. One participant in the PMR group missed the first 40 minutes of the session, expressing ambivalence about participating. She decided to continue with the training, and the first break period was used to catch her up on essential information. She later withdrew from the study after the first week because of physical discomfort. Survey completion for participants in the PMR group declined over the course of the study, resulting in insufficient data to make adequate comparisons between the groups beyond the Week2 Survey.

The small amount of data for the PMR group limited the data analysis, and very few findings rose to the level of statistical or clinical significance. Clinical significance refers to the amount of change in symptom levels that is needed to demonstrate that an intervention is helping the patient (Jacobson & Truax, 1991). Research results might not reach a level of statistical significance, meaning that they are more likely to be the result of chance. Clinical significance is concerned with whether the change in symptom-level is enough that the person has had a change in clinical status, regardless of the cause. Data analysis results are presented in the following sections.

Demographic Data

Demographic data for participants are presented in Table 13. With the small sample size, the two groups were not always equal demographically despite randomization. There were slight gender differences between the TRE and PMR groups, with the TRE group having three females and two males, while the PMR group contained three females and one male. The TRE group overall was younger with a mean age of 47.2 and a range of 32-62, compared to the mean age of 54.3 and range of 36-73 in the PMR group.

Income levels differed substantially between the two groups and were spread across the range of answers. Education levels also differed, with the TRE group all reporting at least a bachelor's level of education compared to the bachelor's level and below reported for the PMR group. Only one participant, from the PMR group, reported being a military veteran. A majority of participants was Caucasian in both groups (TRE = 3; PMR = 3). There was also a range of marital status in both groups. Demographic data were not correlated with study outcomes because of the small sample size.

Data Analysis

The original data analysis plan for the study included multivariate analysis between the multiple independent and dependent variables using R statistical software (The R Foundation, 2017). The plan was based on a target sample of 60 participants, with 30 people in each group. The study sample fell short of the target, and the original analysis plan was not feasible. Additionally, missing data from weekly surveys and the final two assessment surveys (Assess3 and Assess4) that were not returned meant that it was not possible to conduct an analysis of whether self-practice impacted the symptom-related data, or whether demographic variables had an impact on the assessment results. The qualitative data regarding self-practice motivators and barriers that were gathered in the weekly surveys provided possible reasons why people did not self-practice or did not complete the study. Although this data did not relate directly to the hypotheses, there was an opportunity to collect it during the weekly surveys, adding to the discussion and informing future researchers.

All data analysis was performed in Microsoft Excel for Office 365, version 1810 and GraphPad QuickCalcs (Motulskey, 2018). Because of the small sample size (n = 11), the inferential statistics were limited to *p*-value to demonstrate the probability of the null hypothesis being incorrectly rejected.

Summary Results

Data for the four symptom-related assessment periods, showing means and standard deviations, are presented in Table 14. Symptom-related data are grouped by type of symptom: non-specific chronic low back pain (nsCLBP); post-traumatic stress disorder (PTSD); and sleep quality. Sleep quality is presented separately because it is a factor in both nsCLBP and PTSD symptoms. Each symptom group is discussed separately in the following sections.

Table 13

Participant Demographic Characteristics (n = 9 participants)

	TRE Experimental (n = 5)	PMR Control (n = 4)
Gender		
Female	3	3
Male	2	1
Age (Mean / Range)	47.2 / 32-62	54.3 / 36-73
Income Level		
0-20k	1	1
21-30k	2	0
41-50k	0	1
51-75k	1	0
76-100k	0	1
101-200k	1	0
201k+	0	1
Education Level		
Some college	0	2
Associate degree	0	1
Bachelor's degree	1	1
Graduate degree	4	0
Military veteran	0	1
Race		
Caucasian	3	3
Hispanic	1	0
Other	0	1
Prefer not to say	1	0
Ethnicity		
Hispanic	1	0
Not Hispanic	4	4
Marital Status		
Single	2	0
Married	0	2
Divorced	2	2
Widowed	1	0

Abbreviations: PMR = Progressive Muscle Relaxation; TRE = Trauma Releasing Exercises

Non-specific chronic low back pain assessments. Hypothesis one stated: Four weeks of self-practice of TRE will provide significantly better symptom relief of nsCLBP than PMR. Three instruments were used to measure nsCLBP: Oswestry Disability Index 2.0 (ODI), Defense and Veterans Pain Rating Scale (DVPRS), and the SUDS/Physical Assessment. The SUDS/Physical Assessment was not administered as part of the four assessment periods and is not reported in this section.

Table 14

Symptom-Related Data Summary for Four Assessment Points by Condition

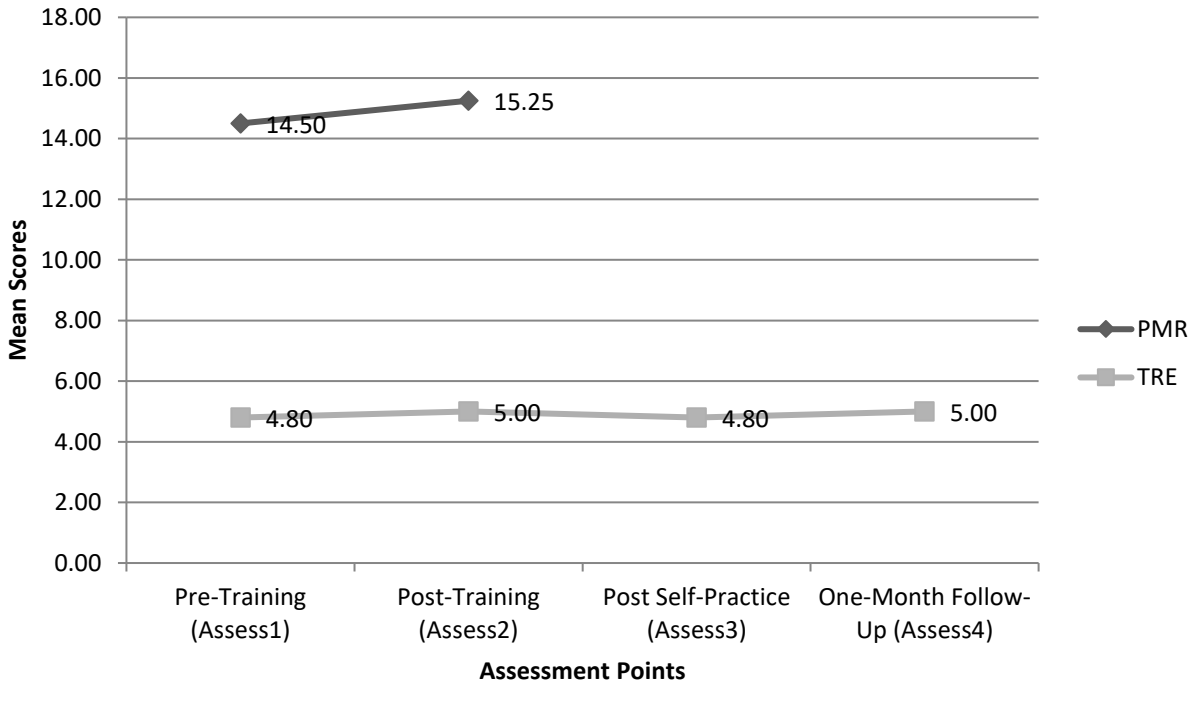
Symptom/ Instrument		Pre-Training - Assess1		Post-Training - Assess2		Post-Self-Practice - Assess3[a]		Post-Study - Assess4[a]	
		TRE	PMR	TRE	PMR	TRE	PMR	TRE	PMR
nsCLBP									
ODI	Mean	4.8	14.5	5.0	15.3	4.8	24.0	5.0	24.0
	SD	±2.4	±6.0	±2.7	±6.7	±2.7	N/A	±2.0	N/A
DVPRS	Mean	3.2	4.5	4.0	5.0	3.8	7.0	3.7	7.0
	SD	±1.6	±2.4	±1.6	±1.4	±1.8	N/A	±2.1	N/A
PTSD									
PCL-5	Mean	28.8	29.0	25.0	21.5	18.6	28.0	26.7	28.0
	SD	±9.1	±8.8	±12.0	±1.7	±14.8	N/A	±13.2	N/A
Sleep Quality									
ISI	Mean	10.6	11.8	13.0	12.3	9.6	9.0	14.3	9.0
	SD	±6.5	±2.6	±6.9	±2.2	±1.5	N/A	±6.0	N/A

[a]Only one response for PMR group at Assess3 and Assess4. Mean for these items is equal to the one response. Standard deviation is not applicable.

Abbreviations: DVPRS = Defense and Veterans Pain Rating Scale; ISI = Insomnia Severity Index; N/A = Not applicable; nsCLBP = Non-specific chronic low back pain; ODI = Oswestry Disability Index; PCL-5 = PTSD Checklist for DSM-5; PTSD = Post-traumatic stress disorder; SD = Standard deviation

Figure 5 represents a comparison of the means of group results for the ODI at the four assessment points. Because the PMR group had only one response for Assess3 and Assess4, a mean was not appropriate, and these results were not included. The ODI has a total possible raw score of 50, with higher scores indicating more pain and disability, and it measures perceived pain and disability for the past seven days. At the initial assessment (Assess1), the mean results for the two groups differed by 9.7. The gap increased slightly for the post-training assessment (Assess2), and both groups saw a small increase in mean scores. The TRE group scores remained fairly constant throughout all four assessment periods. A change of four points in score is considered the minimal change for clinical significance for the ODI (Fairbank & Pynsent, 2000). The changes in mean scores in this study did not rise to this level.

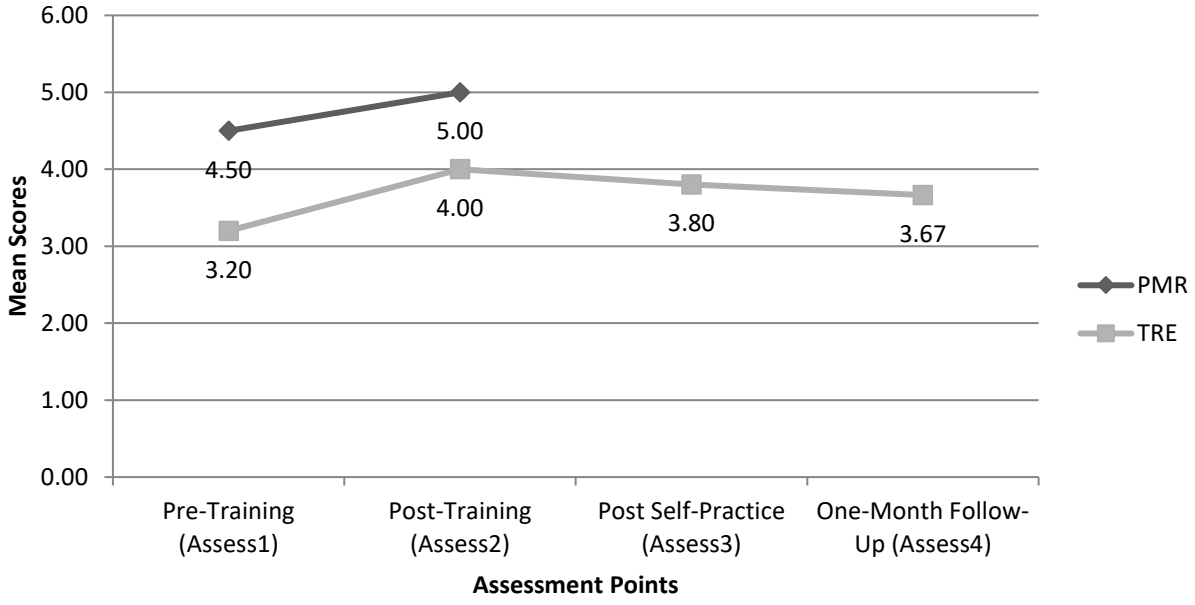
Figure 5 nsCLBP Symptoms - ODI - At Four Assessment Points



In Figure 6, data for the Defense and Veterans Pain Rating Scale (DVPRS) is reported. The DVPRS has a total possible raw score of 10, with higher scores indicating more pain and

disability. The DVPRS measures perceived pain and disability at the time of the assessment. Both treatment groups experienced increases in mean scores after the training session (Assess1), but they did not rise to the level of statistical significance. Participants in the TRE group had decreases in scores following the self-practice period (Assess3) and at the 1-month follow-up (Assess4), but scores did not return to the pre-training level (Assess1).

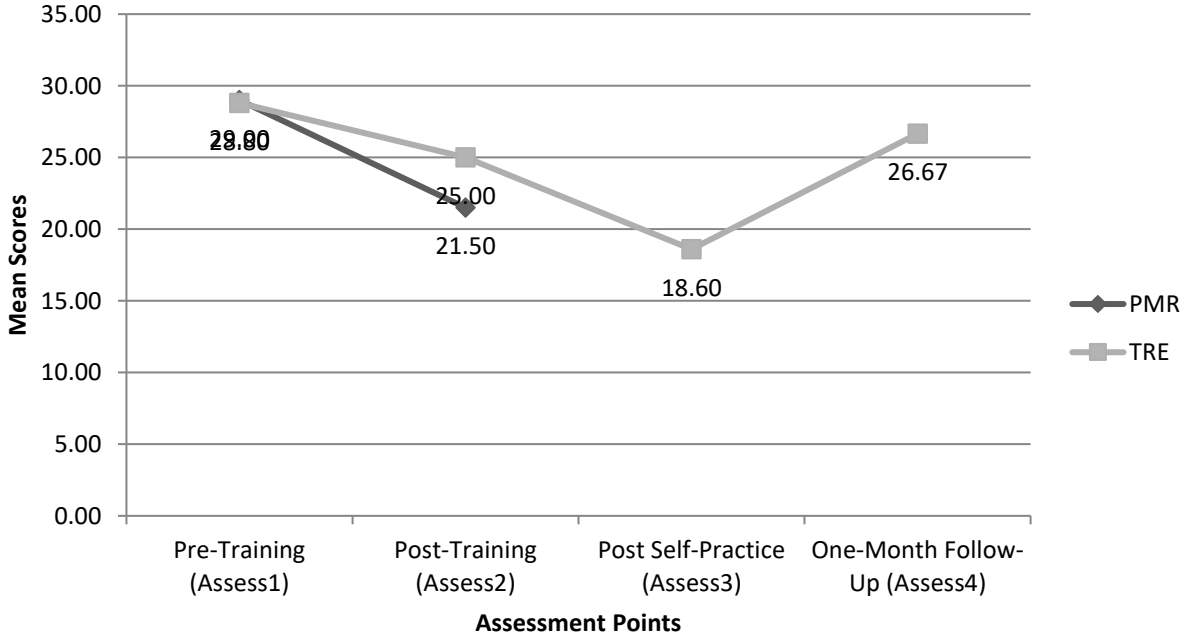
Figure 6 nsCLBP Symptoms - DVPRS - At Four Assessment Points



Post-traumatic stress disorder assessments. Hypothesis two stated: Four weeks of self-practice of TRE will provide significantly better symptom relief of PTSD than PMR. Two instruments were used to measure symptoms of post-traumatic stress disorder, the PTSD Checklist for DSM-5 and the SUDS/Emotional Assessment. The SUDS/Emotional Assessment was not administered as part of the four assessment periods and is not displayed in this section. The PCL-5 has a numeric raw potential score of 80. A higher score indicates more severe PTSD symptoms. Figure 7 displays the means of both groups for the PCL-5 over the four assessment points, with the exception of Assess3 and Assess4 for the PMR group.

Initial mean scores (Assess1) were very close for the two groups, with the PMR group scoring 29.0 and the TRE group scoring 28.8. Scores for both groups decreased after the training session (Assess2). The TRE group showed a continued drop in mean score after the self-practice period (Assess3), but it then increased at the 1-month follow-up (Assess4). For the PCL-5, a five-point change has been suggested as a minimum for understanding whether someone is responding to the intervention (National Center for PTSD, 2018). A 10-point change was suggested for establishing clinical significance (National Center for PTSD, 2018), meaning that there has been enough change in symptoms to consider the intervention as clinically effective.

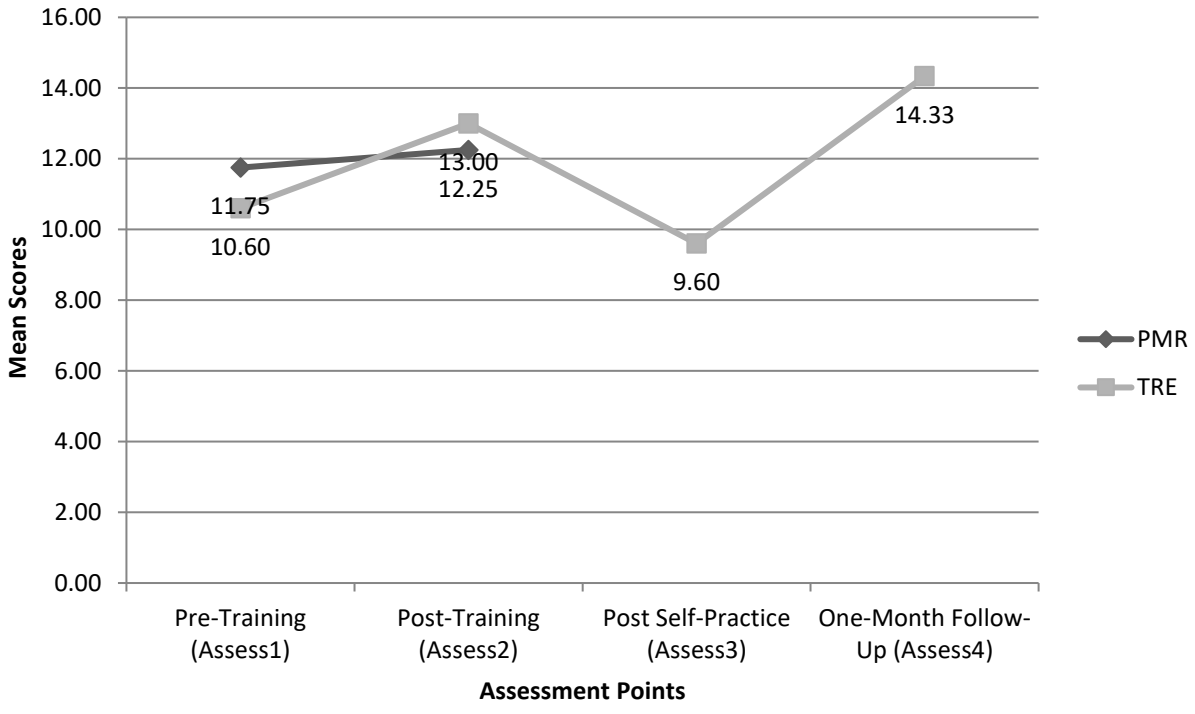
Figure 7 PTSD Symptoms - PCL-5 - At Four Assessment Points



Sleep quality assessments. Sleep quality is presented separately, but it is a component of both nsCLBP and PTSD symptoms. Figure 8 presents the results for the Insomnia Severity Index (ISI), which was used to measure sleep quality. The ISI provides a single numeric score with a possible total of 28. A higher score indicates poor-quality sleep.

At the initial assessment (Assess1) participants in the TRE group reported a mean score of 10.6, and the PMR group reported a mean of 11.8. After the training (Assess2) both groups reported increases in scores; the TRE mean score increased by 2.4, and the PMR group reported a slight increase of 0.5. Following the four weeks of self-practice (Assess3), the TRE group reported a decrease in the mean score of 3.4. One month after the end of the self-practice period (Assess4), the TRE mean rose to 14.33, which was higher than the Assess1 mean score. Only three of the five TRE participants responded to this last assessment, potentially skewing the results for Assess4. The scoring for the ISI indicates ranges of sleep quality severity with a range of 8-14 as subthreshold insomnia (Morin et al., 2011). While mean scores for both groups changed over the course of the study, no scores shifted out of this range.

Figure 8 Sleep Quality - ISI - At Four Assessment Points



Effect of Training: TRE Compared to PMR

The results of being trained in TRE or PMR are reported in this section separately from the self-practice data. These data do not directly relate to the research question or the hypotheses, but they were collected to separate out the effect of an in-person training session from the effect of self-practice. Data from the pre-training assessment (Assess1) is compared to the post-training assessment (Assess2). Though most results did not reach the level of statistical significance, *p*-values are provided for reference.

Effect of training on nsCLBP symptoms. An additional instrument was used immediately before and after the training session, the Subjective Units of Disturbance (SUDS). The highest raw score on the SUDS is 10 = Best, with higher numbers indicating less disturbance. It measures how the participant is feeling at the moment of the assessment. The Physical SUDS was used to assess nsCLBP symptoms and physical status overall. Table 15 presents the results for the Physical SUDS for both groups.

Table 15

Subjective Units of Disturbance (SUDS), Physical, Pre- Compared to Post-Training

		Pre-Training Assess1		Post-Training Assess2		Difference Pre- to Post-Training			
Group	n	Total	M	Total	M	Total	M	SD	P
TRE	5	28	5.60	37	7.40	9	+1.80	±1.92	0.11
PMR	4	19	4.75	23	5.75	4	+1.00	±1.15	0.25
Difference between groups							0.80		0.49

Abbreviations: M = Mean; PMR = Progressive Muscle Relaxation; P = *p*-value; SD = Standard deviation; TRE = Trauma Releasing Exercises

Both groups experienced increases in mean scores, with the TRE score increasing by 1.80 and the PMR increasing by 1.0. From a view of clinical significance, an increase of an entire point on a 0-10 scale may be seen as important.

On measurements from an instrument that is more specific to nsCLBP, the Oswestry Low Back Pain Disability Index 2.0 (ODI), the difference in mean scores before and after the training showed an increase for both groups. Table 16 displays the results for the ODI for pre- and post-training. On the ODI, a higher score means more pain and disability. For clinical significance, a minimum change of four points in score is needed (Fairbank & Pynsent, 2000). The changes in mean scores in this study did not rise to that level.

Table 16

Oswestry Low Back Pain Disability Index 2.0 (ODI), Pre- Compared to Post-Training

	Pre-Training Assess1			Post-Training Assess2			Difference Pre- to Post-Training			
Group	n	Total	M	n	Total	M	Total	M	SD	P
TRE	5	24	4.80	5	25	5.0	+1	+0.20	±1.79	0.91
PMR	4	58	14.50	4	61	15.25	+3	+0.75	±4.03	0.87
Difference between groups								0.55		0.78

Abbreviations: M = Mean; PMR = Progressive Muscle Relaxation; P = *p*-value; SD = Standard deviation; TRE = Trauma Releasing Exercises

A third measure of pain was used before and after the Training session, the Defense and Veterans Pain Rating Scale (DVPRS). Table 17 shows the results for the DVPRS for pre- and post-training. The DVPRS provides a single score on a scale of 0-10, with higher scores representing more pain. Participants in both groups reported slight increases in mean scores after the training session.

Table 17

Defense and Veterans Pain Rating Scale (DVPRS), Pre- Compared to Post-Training

	Pre-Training Assess1			Post-Training Assess2			Difference Pre- to Post-Training			
Group	n	Total	M	n	Total	M	Total	M	SD	P
TRE	5	16	3.20	5	20	4.0	+4	+0.80	±1.92	0.45
PMR	4	18	4.50	4	20	5.0	+2	+0.50	±1.00	0.73
Difference between groups								0.30		0.79

Abbreviations: M = Mean; PMR = Progressive Muscle Relaxation; P = *p*-value; SD = Standard deviation; TRE = Trauma Releasing Exercises

Effect of training on PTSD symptoms. Two assessments were used to measure the effect of the training intervention on PTSD symptoms, the PCL-5 and the Emotional SUDS. Similar to the Physical SUDS utilized in the nsCLBP section above, the Emotional SUDS measures how the participant is feeling at the moment on a scale of 1-10, with 10 being the best. Table 18 presents the data for the Emotional SUDS assessments pre- and post-training. Both groups reported small mean increases in scores after the training, indicating a positive emotional effect. The TRE group mean increased by 0.80, and the PMR group mean increased by 1.75.

Table 18

Subjective Units of Disturbance (SUDS), Emotional, Pre- Compared to Post-Training

		Pre-Training Assess1		Post-Training Assess2		Difference Pre- to Post-Training			
Group	n	Total	M	Total	M	Total	M	SD	P
TRE	5	31	6.20	35	7.00	4	+0.80	±0.84	0.43
PMR	4	22	5.50	29	7.25	7	+1.75	±1.50	0.04
Difference between groups							0.95		0.26

Abbreviations: M = Mean; PMR = Progressive Muscle Relaxation; P = *p*-value; SD = Standard deviation; TRE = Trauma Releasing Exercises

The PCL-5 is a more specific assessment for PTSD symptoms than the SUDS assessment, with lower scores indicating a decrease in symptoms. Table 19 shows the results for the PCL-5 for pre- and post-training. Both mean differences decreased after the training, with the PMR group reporting better results and coming close to statistical significance with a *p*-value = 0.15. For the PCL-5, a five-point change has been suggested as a minimum for understanding whether someone is responding to the intervention (National Center for PTSD, 2018). A 10-point change was suggested for establishing clinical significance (National Center for PTSD, 2018). The effects of the training alone did not reach these levels.

Table 19

PTSD Checklist for DSM-5 (PCL-5), Pre- Compared to Post-Training

	Pre-Training Assess1			Post-Training Assess2			Difference Pre- to Post-Training			
Group	n	Total	M	n	Total	M	Total	M	SD	P
TRE	5	144	28.80	5	125	25.00	-19	-3.80	±4.82	0.59
PMR	4	116	29.00	4	86	21.50	-30	-7.50	±8.66	0.15
Difference between groups								3.70		0.44

Abbreviations: M = Mean; PMR = Progressive Muscle Relaxation; P = *p*-value; SD = Standard deviation; TRE = Trauma Releasing Exercises

Effect of training on sleep quality. Table 20 presents the results of the ISI, a measure of sleep quality, for pre- and post-training. Higher scores indicate worse sleep quality, and sleep problems are components of both nsCLBP and PTSD. Both groups reported increases in mean scores after the training.

Table 20

Insomnia Severity Index (ISI), Pre- Compared to Post-Training

	Pre-Training Assess1			Post-Training Assess2			Difference Pre- to Post-Training			
Group	n	Total	M	n	Total	M	Total	M	SD	P
TRE	5	53	10.6	5	65	13.0	+12	2.40	±2.61	0.59
PMR	4	47	11.75	4	49	12.25	+ 2	0.50	±4.36	0.78
Difference between groups								1.90		0.44

Abbreviations: M = Mean; PMR = Progressive Muscle Relaxation; P = *p*-value; SD = Standard deviation; TRE = Trauma Releasing Exercises

Effect of Training Plus Self-Practice

The following results compare the pre-training assessment (Assess1) with the post-self-practice data assessment (Assess3). The goal of this study was to determine whether the full intervention, training plus four weeks of self-practice, decreased symptoms of nsCLBP and PTSD at all and/or more than the training alone. Because there was only one response from the PMR group for Assess3, it is not possible to compare the results of the two techniques beyond the post-training Assess2 assessment.

Effect of training plus self-practice on nsCLBP symptoms. Table 21 presents results for the pre-training (Assess1) and post-self-practice assessments (Assess3) for the ODI, which measures symptoms of nsCLBP. Participants in the TRE group reported no overall difference in scores between the two assessment periods.

Table 21

Oswestry Low Back Pain Disability Index 2.0 (ODI), Pre-Training Compared to Post-Self-Practice

	Pre-Training Assess1			Post-Self-Practice Assess3			Difference Pre- to Post-Self-Practice			
Group	n	Total	M	n	Total	M	Total	M	SD	P
TRE	5	24	4.80	5	24	4.80	0	0.0	N/A	N/A
PMR	4	58	14.50	1	24	N/A	N/A	N/A	N/A	N/A

Abbreviations: M = Mean; N/A = Not applicable; PMR = Progressive Muscle Relaxation; P = *p*-value; SD = Standard deviation; TRE = Trauma Releasing Exercises

Data for the DVPRS is presented in Table 22 for pre-training (Assess1) and post-self-practice assessments (Assess3). The TRE group had an increase in mean symptom scores of 0.60.

Table 22

Defense and Veterans Pain Rating Scale (DVPRS), Pre-Training Versus Post-Self-Practice

	Pre-Training Assess1			Post-Self-Practice Assess3			Difference Pre- to Post-Self-Practice			
Group	n	Total	M	n	Total	M	Total	M	SD	P
TRE	5	16	3.20	5	19	3.80	+3	0.60	±2.41	0.60
PMR	4	18	4.50	1	7	N/A	N/A	N/A	N/A	N/A

Abbreviations: M = Mean; N/A = Not applicable; PMR = Progressive Muscle Relaxation; P = *p*-value; SD = Standard deviation; TRE = Trauma Releasing Exercises

Effect of training plus self-practice on PTSD symptoms. Outcomes for PTSD symptoms were measured with the PCL-5. Results comparing pre-training (Assess1) scores with post-self-practice (Assess3) scores are presented in Table 23. Though not reaching statistical significance, the TRE group reported a mean decrease of 10.20 in PTSD symptoms. This indicates potential clinical significance (National Center for PTSD, 2018).

Table 23

PTSD Checklist for DSM-5 (PCL-5), Pre-Training Versus Post-Self-Practice

	Pre-Training Assess1			Post-Self-Practice Assess3			Difference Pre- to Post-Self-Practice			
Group	n	Total	M	n	Total	M	Total	M	SD	P
TRE	5	144	28.80	5	93	18.60	-51	-10.20	±10.96	0.23
PMR	4	116	29.00	1	28	N/A	N/A	N/A	N/A	N/A

Abbreviations: M = Mean; N/A = Not applicable; PMR = Progressive Muscle Relaxation; P = *p*-value; SD = Standard deviation; TRE = Trauma Releasing Exercises

Effect of training plus self-practice on sleep quality. Sleep quality is again considered separately as it is a component of both nsCLBP and PTSD symptoms. The ISI was used to assess sleep quality pre-training (Assess1) intervention and post-self-practice (Assess3) intervention. Table 24 presents the results. Participants in the TRE group reported a modest decrease of symptoms after the four weeks of self-practice, with a drop in mean score of 1.0.

Table 24

Insomnia Severity Index (ISI), Pre-Training Versus Post-Self-Practice

	Pre-Training Assess1			Post-Self-Practice Assess3			Difference Pre- to Post-Self-Practice			
Group	n	Total	M	n	Total	M	Total	M	SD	P
TRE	5	53	10.60	5	48	9.60	-5	-1.00	±5.57	0.75
PMR	4	47	11.75	1	9	N/A	N/A	N/A	N/A	N/A

Abbreviations: M = Mean; N/A = Not applicable; PMR = Progressive Muscle Relaxation; P = *p*-value; SD = Standard deviation; TRE = Trauma Releasing Exercises

Weekly Self-Practice Results

In addition to the symptom-related data, data were collected about the weekly self-practice habits of participants. These results are offered as information for future studies.

Table 25 displays total raw frequency of self-practice sessions for each group and for the study overall. Of eight participants who reported on weekly self-practice, a total of 24 practice sessions was desirable each week. For the participants who completed the surveys, mean self-practice frequency declined over time from 3.50 to 2.67 on Week 4.

Table 25

Weekly Self-Practice Frequency

Group	Week 1			Week 2			Week 3			Week 4		
	n	Total	Mean	n	Total	Mean	n	Total	Mean	n	Total	Mean
TRE	5	17	3.40	5	17	3.40	5	14	2.80	5	12	2.40
PMR	3	11	3.67	2	7	3.50	2	7	3.50	1	4	4.00
Total	8	28	3.50	7	24	3.43	7	21	3.00	6	16	2.67

Abbreviations: PMR = Progressive Muscle Relaxation; TRE = Trauma Releasing Exercises

Motivators for and barriers to self-practice. Participants were asked each week what factors motivated them to self-practice and what factors got in the way of self-practice. Table 26 displays the top six motivators and barriers that were selected throughout the self-practice period by members of both groups. Each participant had the option of choosing each factor at each weekly assessment, and participants were able to select as many factors as were applicable, so each factor had a possible 32 endorsements over the course of the self-practice period. These data are presented as informational with no data analysis. The information may assist other researchers in maximizing interventions that require participants to self-practice over periods of time.

Table 26

Top Six Motivators for and Barriers to Self-Practice

Motivators and Barriers	Endorsed
Motivator:	
1. I'm supposed to	17
2. Symptom relief	12
3. Stress relief	8
4. Set self an electronic reminder	3
5. Asked family or friend to remind me	1
6. Do it along with other self-care	1
Barrier:	
1. Low energy	8
2. Didn't want to	4
3. Pain	4
4. Not enough time	2
5. Don't like it	2
6. Forgot	2

Results Summary

Most of the results for this study did not reach statistical or clinical significance because of the small sample size and the missing data from the PMR group. However, some findings were still important as a basis for future research.

An overall finding involved the response rates from participants in the two groups. The TRE group had near-perfect response rates to the assessments, with the only missing data being two responses to the 1-month follow-up (Assess4). In contrast, participants in the PMR group responded less over time until only one person completed the Week4 Assessment, the post-self-practice (Assess3) assessment, and the 1-month follow-up (Assess4) assessment.

A second key finding was that symptom reports for most instruments indicated a worsening of symptoms following the training session, though these changes were not statistically or clinically significant. The exception to this was the results for both groups for the PCL-5, which measures PTSD symptoms. Both groups reported decreases after the training. The TRE group reported a clinically significant decrease after the self-practice period (Assess3).

A statistically significant change in Emotional SUDS was reported for the PMR group. This positive change in mean score of 1.75 between the baseline, immediately before the training session, and the assessment immediately after the training, reached a 95% confidence interval. The TRE group reported a more modest increase of 0.80 that was not statistically significant.

For participants who completed the weekly surveys, a range of self-practice sessions from 2.67 to 3.50 indicated that most participants did follow instructions to self-practice at least three times per week for the 4-week period.

A final finding relates to the reasons why participants did or did not self-practice. Top motivators to self-practice included that participants were supposed to practice for the study and

that they wanted symptom and stress relief. Top barriers to practice were low energy, not wanting to practice, and experiencing pain.

The next chapter provides discussion and interpretation for these results. The chapter also describes limitations of the study and makes suggestions for future research.

CHAPTER 5: DISCUSSION

Discussion Overview

This chapter begins with a summary of the research study and then provides a discussion of the major findings. Although most of the results did not meet standards for statistical or clinical significance because of the small sample size and lack of data for the control group, inferences and insights are provided where applicable. Valuable lessons learned while conducting the study, which may prove useful to future researchers, are presented. Limitations of the study and recommendations for future research are then discussed, followed by the author's concluding remarks.

Summary of Study

This dissertation research study focused on a relatively untried self-help technique, Trauma Releasing Exercises (TRE). The research objective was to test TRE as a potential treatment for co-occurring non-specific chronic low back pain (nsCLBP) and post-traumatic stress disorder (PTSD). Co-occurrence of the two conditions ranges from 16.0% to 25.1% (Dunn et al., 2009; Loncar et al., 2013), varying with the population.

The goal of TRE is to release muscle tension through tremoring, the body's natural response to traumatic experience (Berceli, 2005, 2008, 2015). Muscle tension is strongly associated with chronic low back pain. There is also some evidence that connects muscle tension with PTSD, though the amount of research in this area is much smaller than for chronic low back pain. In an extensive database search, no research was identified that used TRE as a treatment technique for either nsCLBP or PTSD. However, some evidence was found that supported using other similar therapies or methods that are based on muscle tension release to successfully treat

these conditions. Several psychological models for treating PTSD and anxiety are based on the theory that trauma is held within the body and needs to be released for healing to occur.

The study was designed as a randomized-controlled trial with repeated measures over four time points, including a 1-month follow-up. All participants (n = 11) were adults ages 18 and older. The participants were randomized into either the experimental group using TRE or a control group using Progressive Muscle Relaxation (PMR). Participants attended a 5.25 hour, in-person training session on the assigned technique. Participants were then asked to self-practice the technique for four weeks, three times a week. Participants were also asked to answer a short survey each week during the self-practice period.

Symptom-related data were gathered for both nsCLBP and PTSD through secure, online surveys. These surveys were administered one week before the training session (Assess1), one to two days after the training session (Assess2), after the 4-week self-practice period (Assess3), and at a 1-month follow-up (Assess4). Major findings for this study are presented in the next section.

Major Findings

The research question, hypotheses, and most sub-problems were not adequately addressed in the results of the study because of data limitations. One result reached statistical significance, and one result reached clinical significance. Findings are discussed here as information for future research.

Regarding the research question and hypotheses, the results did not conclusively support the use of TRE as a treatment for either nsCLBP or PTSD. Mean scores on the measures for nsCLBP had slight increases for both groups after the training session, indicating increased pain. The TRE group scores on the ODI remained nearly flat through the four assessments, while

scores on the DVPRS increased after training, then decreased over the next two assessments. There were not enough data to determine if TRE was at least as effective as PMR, which has been shown to be effective for treating each condition separately (Coppieters et al., 2016; de Lorent et al., 2016; Kuhn et al., 2014; Kwekkeboom & Gretarsdottir, 2006; Morone & Greco, 2007). No conclusions are drawn for these data.

There was insufficient data to adequately address the identified sub-problem of whether the effects of TRE differed by demographic variables such as age, income levels, marital status, and other factors. Because people in the PMR group stopped responding to the weekly surveys, there is also not enough data to address the sub-problems that related frequency of self-practice to symptom reduction for either condition.

Participants in the PMR group reported a statistically significant increase in Physical SUDS after the training session ($p = 0.04$). This result potentially supports previous research that found that PMR is effective in treating pain conditions (Coppieters et al., 2016; de Lorent et al., 2016; Kuhn et al., 2014; Kwekkeboom & Gretarsdottir, 2006; Morone & Greco, 2007). This interpretation is very broad because physical disturbance is a much larger category than pain. If the participants had been asked to rate SUDS for pain only, this result might have more meaning.

For PTSD, a different pattern emerged. Mean scores for both groups decreased after the training, with the PMR group having a larger decrease. The TRE group came close to a five-point decrease in mean score, which is the suggested threshold for determining a response to a treatment for PTSD (National Center for PTSD, 2018). Mean scores continued to decrease for the TRE group after the self-practice period, with a decrease of 11.30 from the pre-training scores. This change indicated improvement at a clinically significant level. Unfortunately, there is not enough data to compare the two groups to determine if TRE is more effective than PMR at

treating PTSD. Mean scores for the PTSD group increased at the 1-month follow-up but did not return to the baseline levels, indicating that a small positive effect may have lasted after the self-practice period was completed. It is unknown whether participants in the TRE group continued to practice TRE beyond the self-practice period. This data would be helpful to gather in a future study.

Sleep quality is a component of both nsCLBP and PTSD symptoms. Mean scores for sleep quality increased for both groups after the training, with the TRE group showing a larger increase than the PMR group. This result indicates an increase in sleep problems, which may be related to reported increases in pain levels after the training session. After the self-practice period, mean scores for the TRE group decreased to below the baseline scores, then returned to a higher level at the 1-month follow-up. The scores did not change enough to shift out of the range for subthreshold insomnia. Many factors affect sleep quality, and no measures were in place to understand the other factors that might have been impacting sleep quality during this study.

The current results do not support TRE or PMR as effective treatment for nsCLBP. There is some support for using TRE to treat PTSD, but this is very preliminary evidence.

Two independent variables were investigated in this study: (a) the effect of being trained in TRE or PMR, and (b) the effect of the training plus self-practice of the technique. Not enough data were collected to analyze results by the dependent variables of gender, marital status, level of income, level of education, race, or ethnicity as originally planned. Because of the small sample size, no inferential statistics were used. Findings are presented for each of the independent variables in the following sections.

Effect of Training Session

The first independent variable addressed by the results was the potential effect of attending a 5.25 hour training session in either TRE or PMR. Changes in mean scores between pre- and post-training assessments were compared for each group. Physical state, measured by SUDS, which includes pain, was measured immediately before and after the training. Both groups reported increases in mean physical SUDS scores after the training, indicating that they felt better physically. In addition to learning and using the technique, this improvement could be explained by increased comfort at the training session as the day progressed, decreased social anxiety after getting to know the trainer and other trainees, generally feeling better later in the day, and having had lunch.

Scores also slightly increased for both groups for nsCLBP symptoms, measured by the ODI and DVPRS, indicating increased pain after the training. These data were gathered one week before the training and 24-48 hours after the training, so they measured symptoms over a longer time period than the SUDS measurements. I do not know if any of the changes came from the intervention itself or from other factors.

The findings for PTSD measurements showed a different outcome. The emotional SUDS mean scores increased for both groups after the training, with the TRE group improving by 0.80 and the PMR group improving by 1.75 points. This increase in SUDs score indicates a decrease in emotional disturbance, which is a positive outcome. These changes in score did not rise to statistical significance, and there is not a standard measure for clinical significance for SUDS. As a mental health practitioner, I would consider the increases for both groups to be clinically significant when treating a client. In clinical application, the clinician has more information about other factors that may be influencing changes in score, which was not available during this

study. As with the physical SUDS measurements, it is unknown whether other factors such as eating lunch contributed to the change in scores.

Total raw scores and mean scores decreased for PTSD symptoms on the PCL-5 measurement for both groups after the training, with the PMR group reporting greater decreases. These changes in mean scores were not statistically or clinically significant, so no inferences are made as to the effect of the training on PTSD symptoms. The training session included two experiences of using TRE, which might be considered an equivalent to brief therapy. Compared to the positive results for brief interventions of Somatic Experiencing (SE) to treat PTSD symptoms (Leitch et al., 2009; Parker et al., 2008), the results for TRE after the training session study were not promising. These results are consistent with my clinical experience. I have observed that people need to practice consistently for several weeks to see significant relief from PTSD-related symptoms.

Similar to the pain measurement scores, sleep quality scores were worse following the training session for both groups. This was surprising considering the many anecdotal reports of improved sleep quality after practicing TRE. The expectation before the study was conducted was that there would be no immediate effect on sleep quality, and that changes would be seen after the self-practice period. People who live with chronic conditions often cope by dissociating from or ignoring symptoms. Increases in pain scores following training could be due to increased awareness, which both interventions promote. Sleep quality is often strongly affected by pain, because it is difficult for a person to sleep when experiencing pain. Bringing focus to the symptoms through the assessment and training session may have made the participants more aware of symptoms, resulting in reporting worse scores after the training session.

Effect of Training Plus Self-Practice

The second independent variable investigated in the study was the full intervention of attending the training session and then self-practicing for four weeks. Data for the PMR group for the last two assessments are not available, so the results of the two techniques cannot be compared for the full intervention.

For nsCLBP symptoms, mean scores for pain measurements stayed relatively flat throughout the four assessments for the TRE group. For PTSD symptoms, changes occurred for the TRE group across the four assessments. After the self-practice period, mean scores decreased from the baseline score by 10.20, indicating a clinically significant improvement in symptoms. This decrease in mean scores is the strongest result from the study and suggests that TRE may decrease PTSD symptoms when practiced regularly over time.

The results of this study did not establish evidence that TRE is effective at treating PTSD, but strong support for further research about the use of TRE for the treatment of PTSD was indicated. Practicing TRE can take some time to master. Many people report that the first time feels euphoric, but the subsequent times do not usually reach that same level of relief and can feel frustrating and disappointing. Outcomes for training and self-practice might be different in a protocol that separated out the training sessions or that had a longer self-practice period.

For the third area of sleep quality, the mean scores for the TRE group had a small decrease of 1.0 after the self-practice period compared to the baseline. This decrease is not enough of a change from which to draw conclusions. A longer self-practice period may be required to result in significant changes in sleep quality.

Effect at 1-Month Follow-Up

For most measures, the changes from baseline to 1-month follow-up were not large enough from which to draw conclusions. Back pain and sleep quality measurements for the TRE group were slightly worse at 1-month follow-up than at baseline. Means scores for PTSD symptoms were slightly lower at 1-month follow-up than they were at baseline, but the scores had increased from the assessment immediately after the self-practice period. There were not enough data for the PMR group to determine changes over time. Two of the five participants in the TRE group did not complete the last assessment. The lack of data likely skewed the results for the follow-up assessment scores. Four weeks of self-practice is possibly not long enough to make lasting change. With a larger sample size, this measurement would have been helpful in understanding whether TRE had a lasting effect versus a temporary one.

Self-Practice Findings

A sub-problem identified at the beginning of the study was that people might not self-practice. The eight participants who responded to some or all of the weekly surveys reported self-practicing a total of 89 times over the course of four weeks, with an average high frequency on Week1 of 3.50. This average frequency decreased over time to a low of 2.67 on Week4. I expected that self-practice rates would decline over time. In my experience, people tend to be more enthusiastic about a new practice at the beginning than they are over time. I knew that participants might have stopped self-practicing very early in the study or might have chosen not to self-practice at all, so the rate of 2.67 times per week during the last week is encouraging.

The data about the factors that motivated self-practice or that served as barriers to self-practice provided insight into a different aspect of the effectiveness of TRE. For TRE to be effective, people need to actually practice the technique. The number one reason participants

gave for self-practicing related to obligation, that they were *supposed* to do so for the study. This indicates that a high level of accountability is required to encourage people to self-practice a technique like TRE. With this knowledge, future studies may need to incorporate more ways of providing accountability such as facilitated practice sessions, accountability phone calls, or video check-in sessions in addition to the weekly survey emails. The top reasons people did not self-practice were having low energy, not wanting to practice, and experiencing pain. The first two reasons are possible signs of depression and are connected to the mutual maintenance theory, which suggests that depression is one reason that people with co-occurring pain and PTSD tend to have difficulty with treatment (Sharp & Harvey, 2001).

Developing a new practice of a self-help technique is challenging for most people. The weekly surveys had a checklist of factors that encouraged participants to self-practice, but there was not an option included that addressed autonomy or self-efficacy through using a self-help technique. Lack of autonomy and self-efficacy have previously been identified as barriers to seeking treatment (Gibson, 2012; Slade et al., 2009). In future research it would be helpful to ask participants if this played a role in choosing to self-practice.

Another factor that seemed to impact self-practice was the technique group that participants were randomly placed in. The people in the TRE group completed the bulk of the weekly surveys. People in the PMR group either dropped out of the study without informing me, or they stopped answering surveys. Most of them probably did not self-practice. In comparing the two techniques, PMR is much older and more passive than TRE. Several of the participants reported having experienced or practiced PMR in the past. A possible explanation for the dropout rate for the PMR control group is that most people signed up for the study in order to learn TRE, which is a relatively new technique. The people assigned to the PMR control group

may have lost interest when they were not assigned to the TRE intervention group. Of the six people assigned to the TRE group, five attended the training and completed all surveys except the 1-month follow-up (Assess4). Three people from the TRE group completed the 1-month follow-up assessment.

This near-perfect participation is in stark contrast to the PMR group. Of the five people assigned to the PMR group, four attended the training and completed the post-training assessment survey (Assess2). Three people completed Week1 survey. Two people completed Week2 and Week3 surveys, and only one person completed the remaining surveys. This suggests a loss of interest and subsequent lack of self-practice.

Additional Findings

Additional findings are not directly related to the research question or hypotheses. They are presented here as helpful insight for future researchers. These additional findings include issues related to recruitment, study participation, and pre-study levels of symptoms for each condition.

During the recruitment phase half the people who initially expressed interest in the study signed up to go through the eligibility process, and one-third of the 31 people who initially expressed interest eventually enrolled in the study. The recruitment materials seem to have been effective in drawing appropriate interest from the general public. One of the reasons people did not enroll in the study was that they did not have an official diagnosis of nsCLBP. Non-specific chronic low back pain is not a widely used medical diagnosis, even though the condition is common. Potential participants described talking to their doctors about back pain without ever being given the diagnosis of nsCLBP. Several people who were initially interested in the study did not enroll because they did not have an official nsCLBP diagnosis, and others may not have

contacted me at all for the same reason. In future research, other inclusion criteria in addition to a medical diagnosis should be considered so that people who have the condition but who do not know the medical name for it are still eligible to apply for the study.

There were some misunderstandings during the recruitment process about the training sessions and the requirement to attend an in-person training session, even though this was stated clearly in multiple places. People who have co-occurring nsCLBP and PTSD may have problems concentrating on written materials. The information on training sessions could have been displayed more prominently and more frequently in the recruitment materials. Video or podcast segments about the study could increase effective communication and understanding about the requirement of in-person training sessions if this study is repeated in the future.

An overall finding involved the differences in participation between the two groups. The TRE group had near-perfect response to the assessments, with the only missing data being two responses to the four-week follow-up (Assess4). In contrast, participants in the PMR group responded less over time until only one person completed the Week4 Assessment, the post-self-practice assessment (Assess3), and the 1-month follow-up (Assess4) assessment. As stated previously, people in the PMR group may have actually wanted to be in the TRE group and dropped out. Another possibility is that PMR was not providing relief and participants stopped practicing. Because the people in the PMR group did not complete the surveys, there is no information about why participants in the PMR group dropped out of the study.

Lessons Learned

There were several aspects of this study that could have been structured differently. The lessons I learned through the course of conducting the study are offered here to assist future researchers in developing their methodology.

Data were gathered about multiple demographic variables, but participants were not asked about medications they were taking, except for the exclusion criteria of opioid medications. Data analysis was not performed on these dependent variables but had the sample size been larger it would have been a helpful piece of information to understand whether certain medications affect the impact of practicing TRE. Berceli (2008) has suggested that people taking benzodiazepine medications and some other classes of medication may not be able to integrate the changes that may occur from practicing TRE. Additional medical conditions or physical disabilities are potentially confounding variables and could affect outcome. It was not possible to address all of these factors in this dissertation study, but they should be included in future, larger studies.

Recruiting participants through professional referrals turned out to be very difficult. Most medical professionals apparently do not talk to their patients about possible PTSD, and most mental health professionals apparently do not talk to their patients about chronic pain conditions. The result was that many of the professionals I contacted said that they thought the study was very interesting, but they did not know anyone who had both conditions. Given the prevalence of co-occurrence (Dunn et al., 2009; Loncar et al., 2013), it seems likely that they simply did not know about the presence of both conditions.

More interest came from lay-people on mailing lists related to PTSD and from social media postings than from contact with medical and mental health professionals. In the future, for a study like this it would be important to spend more time contacting area clinics and meeting with professionals. A questionnaire or guide as to how to determine whether patients were appropriate for the study may have resulted in the medical and mental health professionals talking to their patients about the study and having higher levels of referral. An additional

benefit to such a questionnaire is that it would promote a dialogue that does not seem to be currently happening between patients and providers. One approach might be to provide them with displays and posters for their waiting rooms, rather than emailing flyers to them. Another solution would be to allow more time for the recruitment process and then form partnerships with area universities and clinics, rather than recruiting people individually.

An unanticipated issue arose with randomization. One participant who was randomly assigned to the PMR control group asked to be switched to the TRE group because he had been practicing PMR for years. This could have been addressed in the recruiting materials and Informed Consent. Because PMR has been around for many years, and TRE is a relatively new technique, it is likely that participants would be drawn to the study to learn TRE. A recommendation for future studies is to include information ahead of time about policies on switching groups. With the small sample size, it was decided to allow this participant to switch groups in order to retain him as a participant.

For determining eligibility for the study, I relied on previous diagnoses of nsCLBP and PTSD. This was primarily a matter of time and budget and was accepted as a limitation of the study. As participants completed the assessment surveys, it became apparent that overall symptom levels for nsCLBP, PTSD, and sleep quality were relatively low. This meant that participants were at a low or subclinical level of distress to begin with, and there was little room for positive changes in symptoms. Screening for initial levels of symptoms is an important recommendation for future research.

Severity of symptoms was not addressed as part of the methodology for this study. For future research, severity of symptoms should be included for two reasons: (a) to ensure that

participants are in enough distress that an intervention will make a significant difference, and (b) because interventions may or may not be effective at differing levels of severity of symptoms.

One surprising lesson had to do with the in-person training sessions. The participants were both physically and psychologically vulnerable. During the training sessions, I quickly realized that most of them had never had an opportunity to talk about having both conditions, how it affected them, and how they had not really connected the two before learning about this study. Spending five hours with the participants meant that I came to know them and could see how much their lives were impacted by their symptoms, even though most of them were very functional in the world. I found myself experiencing deep empathy and a part of me wanted to be their therapist, drawing on my professional skills. It sometimes took a concerted effort to stay in the role of trainer and researcher. It also took quite a bit of containing to keep the participants from turning the training session into a therapy session. I had not expected any of this. In the past whenever I trained people in TRE, it was in a structured session that lasted no more than 2.5 hours. Because of the emotional aspects of suffering from chronic conditions, many participants appeared to need a way of processing this experience that did not directly impact results of the study. One possible way to navigate this issue would have been to have a separate clinician offer sessions to participants throughout the course of the study or otherwise find a way to integrate this experience as part of the study.

A separate issue arose in the training sessions. One participant in the PMR group arrived 40 minutes late and expressed ambivalence about participating. She was allowed to stay at the training session, but she then dropped out of the study after the first week of self-practice. She was disruptive multiple times during the training session because she had missed much of the orientation at the beginning. Study requirements about attendance at the training sessions could

have been more specific regarding the consequences of arriving more than a few minutes late. A recommendation would be that participants be informed that if they arrive more than 10 minutes late, they will need to reschedule the training or be disqualified from the study.

A final lesson came from problems with participant retention and participation for the PMR control group. It is unknown whether people stopped participating because they did not like PMR, because they were disappointed at not learning TRE, or for other reasons. A waitlist control group or a different control technique might improve retention and participation for control group members in the future.

Multiple design issues arose during the course of this research study that could be addressed in future studies. Although the perspective of hindsight has allowed these issues to be identified, some of them could not have been addressed within the limitations of this dissertation study.

Study Limitations

There were several limitations on this research study. Financial constraints did not allow for independent training session facilitators, so there was an increased risk of bias. The decision to use previous diagnoses of nsCLBP and PTSD was made because of time and financial limitations, resulting in some participants who did not currently have moderate to high levels of symptoms for one or both conditions. The small sample size made it inappropriate to generalize the study results to a larger population.

The use of self-report measures rather than clinical interviews and medical examinations is a limitation to the study. Self-report measures were chosen because they could be administered online without exposure to me, but they tend to be less accurate than in-person interviews.

A final limitation was the choice of a 4-week self-practice period. I originally planned an 8-week self-practice period but was advised against it by university staff. Four weeks of self-practice is likely not long enough to bring major changes to a body pattern that has been in place for many years. It is also not likely to be long enough to establish the habit of self-practice in the long-term.

There were some conditions that could not be controlled during the study. It would have been unethical to require participants to refrain from other forms of treatment during the study, so any changes in symptoms may be attributable to other treatment. Multiple wildfires in nearby areas were uncontained during the recruitment phase. The air quality in the entire region was very poor. These conditions affected many people who originally expressed interest in participating, potentially reducing the sample size and adding an unusual stressor in peoples' lives.

Recommendations for Future Research

This study researched a relatively untested technique, TRE, in a novel way. No previous studies were identified that utilized TRE for people who have co-occurring nsCLBP and PTSD. During the literature review search, only two studies were identified that addressed treatment for co-occurring nsCLBP and PTSD. There are many gaps in the literature for this topic area. Very little research has been conducted on whether there is a connection between muscle tension and PTSD. Other missing knowledge concerns the differences between acute muscle tension and chronic muscle tension, and whether either type of tension may be related to nsCLBP or PTSD. Research on using TRE separately with each condition is needed, as is research by gender and other demographic variables. There is no available information on the optimal frequency or duration of TRE self-practice periods in general or for different populations. There is no

information available on whether one or more training sessions are needed for optimal results, or whether facilitated practice is superior to self-practice. No information was located on the best methods to assist people in developing and maintaining a practice of a self-help technique. The field for research is wide open!

A basic premise of TRE, and of many psychological treatment approaches, is that traumatized people hold chronic muscle tension in their bodies. Very little evidence exists to support this premise, and of the existing research much is self-report. Using physiological measurements of muscle tension such as EMG would be very helpful to determine whether or not these theories are correct.

Ideally, multiple studies on the use of TRE for each condition, in addition to research on using TRE for the co-occurring conditions, could help to identify the factors involved in effective treatment. Studies using wait-listed control groups would be very helpful, particularly because both conditions are chronic. Other variables that may affect symptom improvement, such as concurrent medical or psychological treatment, medications, and lifestyle and job activities that require lifting, need to be factored in to understand whether TRE is effective. It is likely that other risk factors such as type of work, age, amount of other exercise, and levels of outside stressors, will have an impact on outcomes. All of these variables need to be included in future research.

One other recommendation for future research is to find effective ways to motivate people to self-practice. Self-help techniques like TRE require people to make lifestyle changes and develop new habits over time. Motivating people to make long-term change is a challenge for practitioners in nearly every field. Even if TRE is amazingly effective at relieving nsCLBP and PTSD, it does not matter if people do not practice it.

Conclusion

Although the results of the study were not able to fully address the research question or the hypotheses, this study was important for a few reasons. In several ways, this was the first study of its kind. To date, there are no published studies that use TRE for treatment of co-occurring nsCLBP and PTSD, or with a control group using PMR. Among the identified studies of related interventions, few used repeated measures and self-practice over a period of weeks. With a few changes, the study methodology provides a practical roadmap for appropriately and ethically conducting further research in this area.

My choice for the topic of this dissertation came from my personal experience of non-specific chronic low back pain and post-traumatic stress disorder symptoms. For most of my life, I experienced low back pain and ignored it. After many years of developing body awareness, resolving post-traumatic stress, and making lifestyle changes, I became more conscious of the pain but felt little relief. One day in the shower, it occurred to me that the two conditions might be connected. That thought led to a literature search where I found there was indeed a significant co-occurrence of low back pain and post-traumatic stress. Around the same time, I discovered TRE. As I moved through the process of becoming certified as a TRE trainer, I experienced relief from symptoms of both conditions. I decided to research whether TRE could be an effective treatment for co-occurring nsCLBP and PTSD.

While developing my concept for this study, I also theorized that practicing TRE might not bring lasting relief from symptoms because of dysponesis. Dysponesis refers to a learned pattern of using muscles incorrectly, which can lead to pain (Harvey, Thorne, & McPhetridge, 2012; Whatmore & Kohli, 1979). Releasing muscle tension might provide temporary relief, but if the person returns to using the muscles in the same way then pain would return. Releasing

muscle tension may only be one step in a process that also provides education and practice on how to use muscles properly without the tension and holding patterns that have been present for many years. For example, if a person stands with incorrect posture on a regular basis, muscles are being incorrectly used or overused. In theory, these muscles would become chronically tense. Releasing the tension in those muscles might relieve pain temporarily, but if the person continues to stand with the same incorrect posture then the tension and pain will return fairly quickly. Much more research is needed on muscle tension, its role in pathology, and what the impact of releasing muscle tension is before this question can be answered.

My hope is that my efforts in this study will interest and inspire others to design and conduct research that will answer the questions I have raised here. Future research will hopefully lead to healing and relief for the many people who suffer from non-specific chronic low back pain and post-traumatic stress disorder.

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APPENDICES

Appendix A: Recruitment Flyer

Study on Muscle Relaxation, Trauma, and Back Pain

Lasting trauma symptoms (post-traumatic stress disorder or PTSD) are often found in people who have chronic low-back pain (nsCLBP). Very little is known about how to effectively treat people who have both conditions. You can volunteer to participate in this research study which explores whether muscle relaxation methods can help!

R e l a x ! ! !

Study Description:

This study consists of one training session, four weeks of self-practice, and a one month follow-up survey. The time commitment is approximately 13 hours over the course of nine weeks.

The principal researcher for this study is Beverly Swann, PhD Student at Saybrook University. The study has been approved by the Saybrook Institutional Review Board.

You may be eligible to participate if:

- You're 18 years old or older
- You've been diagnosed with PTSD and chronic low-back pain
- You have email and internet access
- You can attend a 1-day training and spend 2 hours a week practicing muscle relaxation
- See website for further qualifications…

For More Information or to Complete Screening Application:

www.demosite.com

or

Email: xxx@saybrook.edu

Appendix B: Financial Interest Disclosure Statement

Muscle Relaxation Study *Beverly Swann, PhD Student**

Financial Interest Disclosure Statement

Beverly Swann is a doctoral candidate at Saybrook University and is conducting this research study as part of the requirements for a PhD in Mind-Body Medicine. This research study utilizes Trauma Releasing Exercises (TRE) as a muscle relaxation method. The study compares the use of TRE with the use of Progressive Muscle Relaxation (PMR) in the treatment of people with co-occurring post-traumatic stress disorder and non-specific chronic low-back pain.

Beverly Swann is also the sole proprietor of two small businesses: Beverly Swann, LMFT, and Cygnus Transformations (dba). Both businesses are located at:

Beverly Swann is a trained facilitator for Trauma Releasing Exercises (TRE) and has earned a certificate to teach and facilitate TRE as part of Cygnus Transformations. As such, she earns part of her income from teaching and facilitating TRE sessions with individuals and with groups.

Should TRE, a relatively untested intervention, prove effective in treating these two conditions, the results of this study could promote this part of Beverly Swann's business. It represents a financial interest in the outcome of the study.

To reduce or prevent this risk of bias, Beverly Swann has incorporated the following in the study methodology:

- Participants will be randomized to the two study groups.
- Participant contact with Beverly Swann will be limited to the in-person training for either PMR or TRE and to email contact should participants have questions or concerns during the study. Phone contact may be used should a participant experience an emergency.
- Beverly Swann will not accept study participants as clients in either business for at least two years after the conclusion of the pilot study.

Beverly Swann

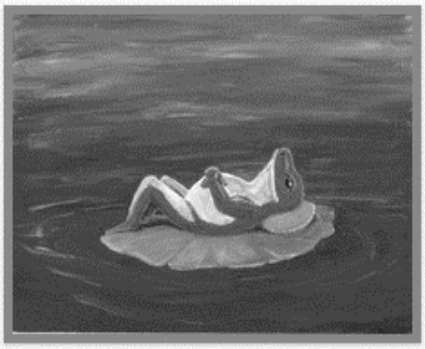
Beverly Swann, Licensed Marriage and Family Therapist,
Certified TRE Facilitator

4-23-18
Date

Appendix C: Website Screen Shots

Private: Muscle Relaxation Research Study

This research study explores two different muscle relaxation techniques: Tension and Trauma Releasing Exercises (TRE) and Progressive Muscle Relaxation (PMR).



If you are a ***healthcare professional*** who wants to refer people to the Muscle Relaxation Research Study, **click here**.

If you are want to ***volunteer to take part*** in the Muscle Relaxation Research Study, **click here**.

About the research study:

Purpose: This is a quantitative, randomized controlled study of two muscle relaxation interventions and how they might be used to treat co-occurring post-traumatic stress disorder (PTSD) and non-specific chronic low-back pain (nsCLBP).

The Problem: Evidence suggests that somewhere between 16% and 25% of people who have PTSD also have nsCLBP, and vice versa. Current treatment focuses on relieving the separate symptoms of each one. Very little is known about how the two conditions interact or how to treat them at the same time. Both conditions have been connected to chronic muscle tension. People with both may receive benefits from releasing muscle tension.

Parts of the Study: People who take part in this study will not be able to choose which type of muscle relaxation they will be trained in.

People who take part in this study will:

- Complete an online Pre-Study Informed Consent Form
- Complete two short screening surveys (10 minutes)
- Complete an online enrollment process that takes about 5 minutes

- Fill out a Study Informed Consent Form (paper)
- Be placed in one of the two groups
- Attend a 1-day, 5.25-hour training in either PMR or TRE
- Fill out an online assessment, which takes about 10 minutes
- After the training, fill out another online assessment
- Practice the technique (TRE or PMR) on their own three times a week for four weeks
- At the end of the four weeks, fill out an online assessment that takes about 10 minutes
- Fill out one final online assessment four weeks after the end of the self-practice

Impact: Both TRE and PMR are self-help techniques. Both have few or no costs or side effects. If one or both of these techniques proves to be useful in treating PTSD and nsCLBP, then the benefit to people with those conditions could be very important. These people might have relief from symptoms without taking medications, going to appointments, or paying copays or fees.

Additional Information: If you would like more information about this study, please see the page for **referring professionals** or for **potential participants**. You may also contact the principal researcher, Beverly Swann, at

Oversight: The proposal for this study was reviewed by Saybrook University Institutional Review Board, at Saybrook University, 475 14th St, Oakland, CA 94612.

Primary Researcher: Beverly Swann, MA, LMFT, PhD Student at Saybrook University,

Credentials for Primary Researcher:

- Masters in Counseling Psychology, with a specialization in Somatic Psychology, from John F. Kennedy University (2007)
- Currently completing a Doctorate in Mind-Body Medicine, with a specialization in Integrative Mental Health, from Saybrook University (anticipated 2018)
- Tension and Trauma Releasing Exercises (TRE) facilitator and provider (2016)
- Licensed Marriage and Family Therapist (LMFT) in California for seven years

Financial Interest Disclosure: Financial Interest Disclosure Statement– Beverly Swann discloses that the results of this study may have some impact on her business in the future, and she lists the ways she has attempted to reduce bias in the study surrounding that financial interest.

Private: Muscle Relaxation Study – Referring Professionals

What Referring Professionals Need to Know

Thank you for taking the time to review the research study information, and thank you for your consideration of referring a patient or client to the study. Further information about the study itself can be found at

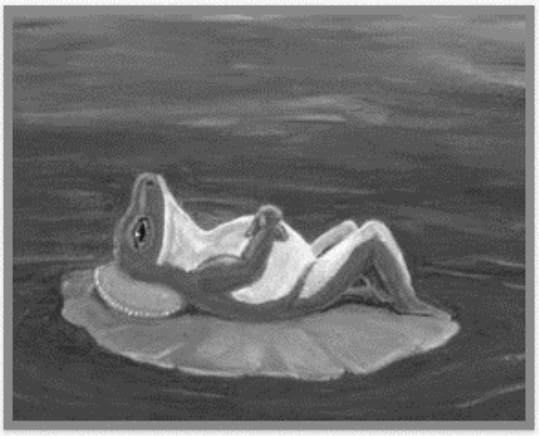
- For a podcast about this research study: xxxlink
- To refer potential participants to the study, please direct them to

Participants will be trained in one of two muscle relaxation techniques and will be asked to practice that technique for four weeks. The two muscle relaxation interventions being used in the study are Progressive Muscle Relaxation (PMR) and Tension and Trauma Releasing Exercises (TRE). TRE involves gentle physical movement which is the equivalent of mild physical exercise. The movements can be modified for individuals who have injuries or balance issues, with a constant goal of *no pain*. PMR is done in a seated position and involves the systematic tensing and releasing of muscle groups. It has no known side effects.

- For a short video about Tension and Trauma Releasing Exercises (TRE): www.youtube.com/watch?v=67R974D8swM
- For a short video (7 minutes) about the physiological process behind Tension and Trauma Releasing Exercises (TRE), presented by creator David Berceli, PhD: www.youtube.com/watch?v=eQkwLrSxd5w
- For more information about Progressive Muscle Relaxation (PMR): en.wikipedia.org/wiki/Progressive_muscle_relaxation

There is significant co-occurrence of post-traumatic stress disorder (PTSD) and non-specific chronic low-back pain (nsCLBP) in adults, ranging from 16.0% (Dunn, Passmore, Burke, & Chicoine, 2009) to 25.1% (Loncar, Curic, Mestrovic, Mickovic, & Bilic, 2013) of people being treated for either of the conditions. Non-specific chronic low-back pain is chronic low-back pain that is not attributable to specific illness or injury. Participants

must have been diagnosed with both post-traumatic stress disorder and non-specific chronic low-back pain order to be eligible for the study. To see all of the eligibility requirements, click here.



PMR was created in the 1920s by Edmund Jacobson and has been used extensively with many different populations. There is evidence to support its use for treatment of either PTSD or nsCLBP, but not for treating them concurrently (Coppieters, Cagnie, & Nijs, 2016; de Lorent et al., 2016; Kuhn et al., 2014; Kwekkeboom & Gretarsdottir, 2006; Morone & Greco, 2007).

TRE was developed and introduced by David Berceli in the 1990s for releasing chronically-held muscle tension in the body. It is intended for relieving chronic stress due to trauma, as well as acute stress due to everyday life. To date, published literature on TRE is scarce; however, a body of unpublished research suggests a likelihood that it may be very effective with people who have both PTSD and nsCLBP.

If you would like to read the literature review for this study, please email your request to:

Risks Involved:

There is some risk involved in this research study. When Trauma Releasing Exercises are performed incorrectly, participants may experience more symptoms of nsCLBP. In rare cases, participants may experience more symptoms of PTSD. The training during this research study will include two sets of instruction on how to use the muscle relaxation methods safely, to minimize these risks. Progressive Muscle Relaxation is not known to have any side effects.

If you have concerns about the requirements of the study and whether your patient/client is appropriate, please contact the primary researcher, Beverly Swann,

You may also complete the optional Healthcare Professional Release Form to indicate any recommendations or restrictions you feel are appropriate.

References:

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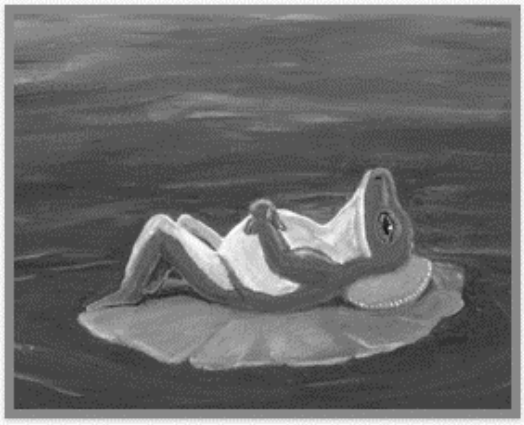
Morone, N. E., & Greco, C. M. (2007). Mind–body interventions for chronic pain in older adults: A structured review. *Pain Medicine*, *8*(4), 359–375. http://doi.org/10.1111/j.1526-4637.2007.00312.x

Private: Muscle Relaxation Study – Potential Participants

What Potential Volunteers Need to Know

About this study: This research study explores whether muscle relaxation may help people who have both post-traumatic stress disorder (PTSD) and non-specific chronic low-back pain (nsCLBP). It involves a 1-day training and 4 weeks of practicing muscle relaxation on your own. The 1-day training will occur in-person. The study assessments will occur online via a secure service.

Is this study a good fit for me?



You can take part in this research study if you meet the following qualifications:

1. You were diagnosed in the past with post-traumatic stress disorder, with symptoms that lasted at least six months.
2. You were diagnosed in the past with chronic low-back pain that is not directly related to illness or injury, with symptoms that lasted at least six months.
3. You can safely perform mild-intensity exercise.
4. You have adequate health insurance, or you have the financial resources to get medical or mental health care if you need it.
5. You are 18 years old or older.
6. You speak, read, and write English well enough to understand the study materials.
7. You are able to follow simple instructions, complete online surveys, and give informed consent in English.
8. You have reliable and consistent access to email and to the internet.
9. You have reliable transportation to and from the research training site in Pleasant Hill, CA. Public transportation is available at the training site.

You are not eligible to take part in this research study if any of the following are true:

1. You were hospitalized because of psychiatric illness in the past 18 months.
2. You were diagnosed with spinal cord injury or other serious illnesses which cause back pain.
3. You are currently using pain medications which are made from opiates.
4. You have an open lawsuit or workman's compensation claim which involves either post-traumatic stress disorder or non-specific chronic low-back pain.
5. You have experienced suicidal ideation or attempted suicide in the past three months.
6. You were diagnosed with active psychosis in the past six months.
7. You perform regular, daily activities which include lifting more than 50 pounds. This may include paid work, work at home, or work which involves caring for others.
8. You are currently experiencing high levels of dissociation.
9. You are a woman who is pregnant, or is planning to become pregnant during the time period of the study. There is no current information regarding the safe use of Trauma Releasing Exercises during pregnancy.

To apply to take part in this study:

First Name (required)

Last Name (required)

Email (required)

Submit »

If you have questions about this study, please contact the primary researcher, Beverly Swann, at

Appendix D: Eligibility Survey

Muscle Relaxation Study Eligibility 1 Survey

Welcome to Our Research Eligibility 1 Survey

Thank you for participating in this survey. Your answers will help us understand if you are eligible to participate in the Muscle Relaxation Study. All of the information you enter here will be kept confidential, and your contact information will only be gathered at the end of the survey if you agree to provide it. Information gathered here will be part of the study data, which is stored offline in a double-locked, secure facility.

If you have any questions about this survey or the research study, please contact the primary researcher, Beverly Swann, at .

Please answer all questions to the best of your ability.

Muscle Relaxation Study Eligibility 1 Survey

Eligibility For The Study

These questions relate to eligibility for the study.

* 1. Study ID (from email)

* 2. Are you age 18 years old or older?

- Yes
- No

* 3. Have you been diagnosed by a mental health professional as having had post-traumatic stress disorder (PTSD) for at least six months, and do you currently have symptoms?

- Yes
- No

* 4. Have you been diagnosed by a medical professional as having had chronic low-back pain for at least six months that is not related to a specific injury or illness (non-specific chronic low-back pain or nsCLBP), and do you currently have symptoms?

- Yes
- No

* 5. Have you been hospitalized in the past 18 months for a psychiatric illness?

- Yes
- No

* 6. Are you able to perform mild exercise safely?

- Yes
- No
- Not sure - need to ask my doctor

* 7. Are you currently pregnant, or planning to become pregnant in the next six months?

- Yes
- No

* 8. Do you have reliable email and internet access?

- Yes
- No

* 9. Do you read and write English well enough to understand these questions and other similar study materials?

- ◯ Yes
- ◯ No

* 10. Are you able to attend a one-time training which will last 5.25 hours?

- ◯ Yes
- ◯ No

* 11. Does your occupation or daily activity include:

- ☐ Office work or large amounts of time sitting?
- ☐ Intensive labor or heavy lifting more than 30% of the time?
- ☐ Driving more than 30% of the time?
- ☐ Being a caregiver to an adult more than 30% of the time?
- ☐ Being a caregiver to a child more than 30% of the time?
- ☐ Not in workforce?
- ☐ Not applicable

* 12. Are you currently taking opioid medication?

- ◯ Yes
- ◯ No

* 13. Do you have an active lawsuit or workmans compensation claim regarding either back pain or post-traumatic stress disorder?

- ◯ Yes
- ◯ No

* 14. In the past four (4) weeks, have you experienced any of the following?

- ◯ Thoughts of hurting yourself or others?
- ◯ Active psychotic episode?
- ◯ Periods of lost time?
- ◯ Not applicable

Muscle Relaxation Study Eligibility 1 Survey

Eligibility 1 Final Steps

Thank you for completing the Muscle Relaxation Eligibility 1 Survey. You will be notified by email within 24 hours to let you know if you are eligible to take part in this research study. Please provide your contact information to receive directions for the next steps.

* 15. I certify that I have answered all questions truthfully, to the best of my ability.

- ◯ Yes
- ◯ No
- ◯ Decline to answer

* 16. First Name

* 17. Valid Email Address

* 18. Valid Phone Number

Appendix E: Healthcare Accessibility Statement

Healthcare Accessibility Statement

Date: _____

Name (Printed): _____

Signature: _____

Healthcare Accessibility – Mental Health Care (Required)

As a volunteer participant in the Muscle Relaxation Study, I understand that there is a small risk that my post-traumatic stress disorder (PTSD) symptoms may increase. If that happens (select one):

☐ I am currently in treatment with a mental health professional and will share about my study participation with him/her, and I will reach out for help if needed.

☐ I have health insurance or private resources to get treatment if needed.

Healthcare Accessibility – Medical Care (Required)

As a volunteer participant in the Muscle Relaxation Study, I understand that there is a small risk that my non-specific chronic low back pain (nsCLBP) symptoms may increase. If that happens (select one):

☐ I am currently in treatment with a medical professional and will share about my study participation with him/her, and I will reach out for help if needed.

☐ I have health insurance or private resources to get treatment if needed.

Appendix F: Healthcare Professional Release Form (Optional)

Healthcare Professional Release Form (Optional)

Date: _____

Participant Name (Printed): _____

Participant Signature: _____

Participant Consent and Authorization

By signing this form, I authorize the healthcare professional below to release to Beverly Swann, PhD student and primary researcher for the Muscle Relaxation Study, health information about, and limited to, my ability to safely take part in the Muscle Relaxation Study. I may revoke, in writing, this Consent and Authorization at any time. This Consent and Authorization will expire one year from the above date.

Healthcare Professional Release and Recommendations

Your patient/client, _____ (participant name), has volunteered to participate in a research study on the use of muscle relaxation for adults who have co-occurring non-specific chronic low back pain (nsCLBP) and post-traumatic stress disorder (PTSD).

Participants will be trained in one of two muscle relaxation techniques and will be asked to practice that technique for four weeks. The two techniques are Trauma Releasing Exercises (TRE) and Progressive Muscle Relaxation (PMR). TRE involves gentle physical movement which is the equivalent of mild physical exercise. The movements can be modified for individuals who have injuries or balance issues, with a constant goal of *no pain*. PMR is done in a seated position and involves systematically tensing and releasing of muscle groups. It has no known side effects. For more information, please see the study website:

By completing this form, you are not assuming any responsibility for this research study. Please identify the recommendations or restrictions you may have for this participant below:

☐ I am not aware of any contraindications for participation in this study.

☐ I release the above-named participant for participation in this study, with the following restrictions:

☐ The above-named participant should NOT participate in this study.

Date: _____

Healthcare Professional Name (Printed): _____

Healthcare Professional Signature: _____

Address: _____

City/State/Zip: _____

Phone: _____

Fax: _____

Appendix G: Demographic Data Survey Items

Table A1

Demographic Data Survey Items

Demographic Data	Data type	Possible answers
Gender	Nominal	Female Male Female to Male Male to Female Other
Age	Ratio	Numeric answer 18+
Income Level	Nominal	Ranges: 0-20k 21-30k 31-40k 41-50k 51-75k 76-100k 101-200k 201k+
Education Level	Nominal	Some high school High school completion Some college Vocational/Technical School Associate degree Bachelor's degree Graduate degree Other
Military Veteran	Nominal	Yes/No
Race	Nominal	African-American Asian-American Caucasian Hispanic Other
Ethnicity	Nominal	Hispanic Not Hispanic Prefer not to answer

Table A1

Demographic Data Survey Items

Demographic Data	Data type	Possible answers
Marital status	Nominal	Single Long-term partner Married Separated Divorced Widowed
Are you currently in treatment for nsCLBP?	Nominal	Y/N
In the past six months, have your symptoms:	Nominal	Gotten worse Stayed the same Gotten better
Are you currently in treatment for PTSD?	Nominal	Y/N
In the past six months, have your symptoms:	Nominal	Gotten worse Stayed the same Gotten better

Appendix H: Subjective Units of Disturbance Worksheet

Subjective Units of Disturbance (SUDS) Assessment

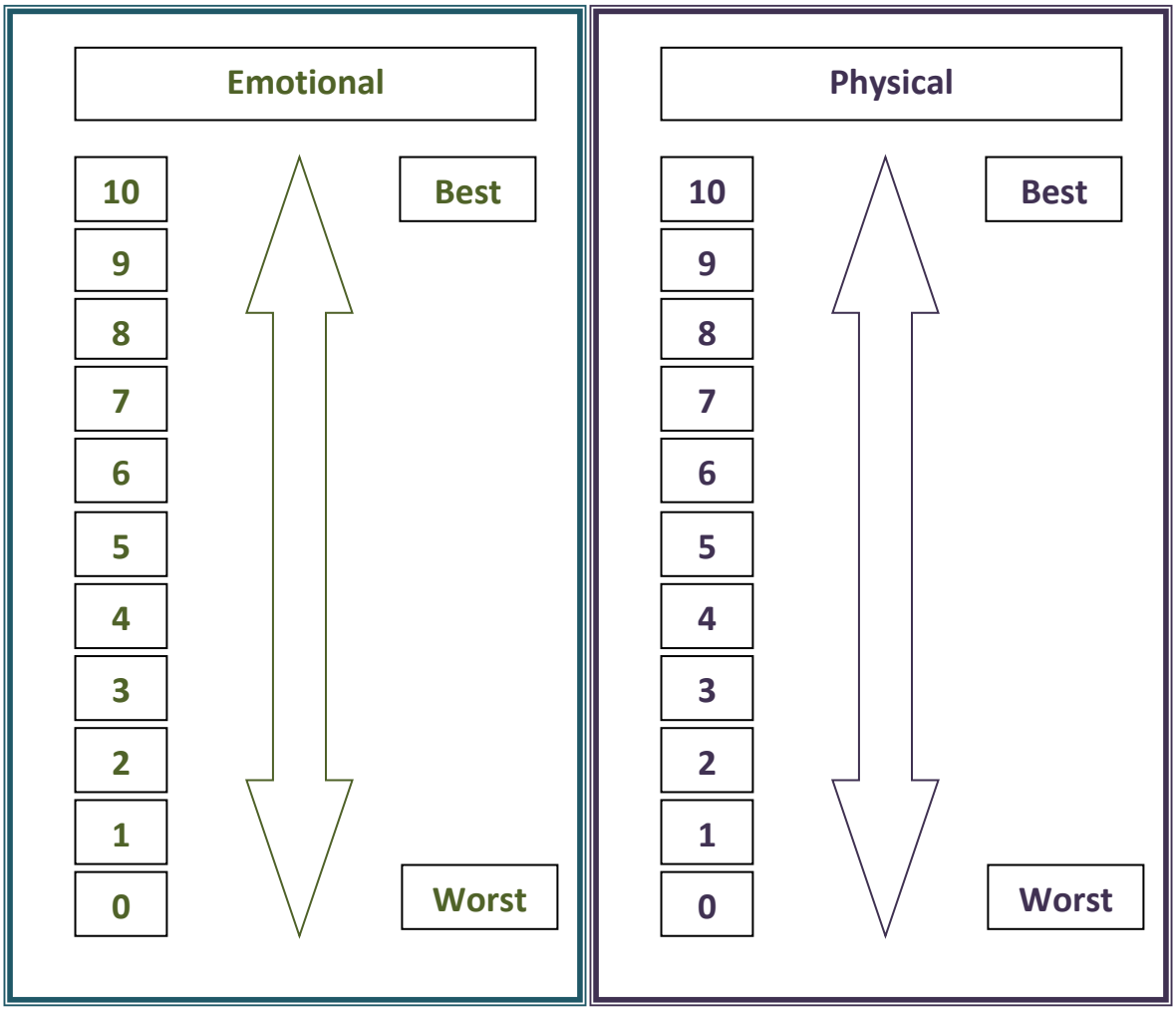
Study ID: _____

Subjective Units of Disturbance (SUDS) is a measurement of how you are feeling at this moment. You don't have to think about how you felt yesterday or how you will feel tomorrow. This is only about right here and now.

Please mark with an **X** on each scale below for how you are feeling at this moment. One scale is for how you feel emotionally. The other scale is for how you feel physically. On the SUDS scale:

Ten (10) = Best you have ever felt

Zero (0) = Worst you have ever felt



Appendix I: Self-Practice Tip Sheet

Self-Practice Tip Sheet

Developing a new habit can be a challenge. To make it easier to self-practice either Trauma Releasing Exercises (TRE) or Progressive Muscle Relaxation (PMR) as part of this research study, here are some tips on making self-practice a little easier.

- ***Decide on regular practice times and put them on your calendar.*** During the four weeks of this study, you are asked to practice either PMR or TRE (whichever group you are assigned to and trained in) three times a week. Give some thought to the best days and times of day for you, and then put these in your calendar or planner. It is helpful to also schedule an alternate time late in the week, since life has a way of getting in the way of even the best plans.

- ***Use the reminder feature on your phone.*** Set one or more reminders about your self-practice to help you remember, especially in the beginning when you may get busy and forget.

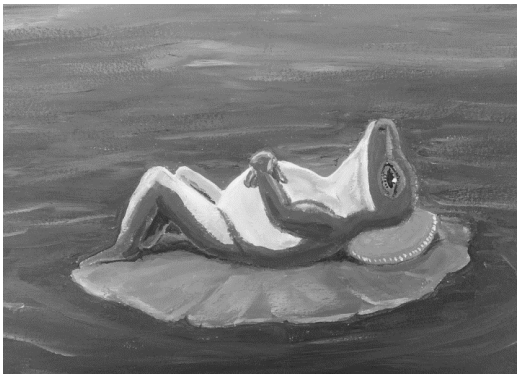
- ***Make sticky note reminders*** and put them in places you'll see often: the bathroom mirror, medication bottles, computer monitors, etc.

- ***Ask friends and loved-ones to help you remember***.

- ***Find a comfortable place for your self-practice*** where you won't be disturbed. Keep a few blankets, pillows, and other comforts close by.

- If you do have to miss a scheduled self-practice, look at your calendar right away and ***reschedule while it is fresh in your mind***.

- ***Post this tip sheet*** somewhere you'll see it regularly!



Appendix J: Weekly Self-Practice Assessment Survey

Muscle Relaxation Study Weekly Assessment

Weekly Self-Practice Questionnaire

This short survey asks questions about your weekly self-practice of Trauma Releasing Exercises (TRE) or Progressive Muscle Relaxation (PMR).

If you have any questions about the survey or the research study, please contact the primary researcher, Beverly Swann,

* 1. Study ID (from email)

* 2. How many times did you self-practice in the past seven (7) days?

- 0 - not at all
- 1 - one time
- 2 - two times
- 3 - three times
- 4+ - four or more times

* 3. If you self-practiced, did you do the full set of exercises, or a modified set? Please indicate how many times you did each in this past week:

Full set of exercise	
Modified set of exercises	
Did not self-practice in the past week	

* 4. What factors encouraged you to practice (check all that apply)?

- Stress relief
- Symptom relief
- Fun
- I'm supposed to
- Other (please specify)
- Set self an electronic reminder
- Asked family or friend to remind me
- Rewarded my self for practice
- Not applicable

* 5. If you didn't self-practice three (3) times in the past week, what got in the way (check all that apply)?

- [ ] Not enough time
- [ ] Pain
- [ ] Low energy
- [ ] Didn't want to
- [ ] Other (please specify)
- [ ] Don't like it
- [ ] No private place to practice
- [ ] Not worth it
- [ ] Not applicable