

9-2021

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Recommended Citation

Abraham C, Sloan SN, Coker C, Freed B, McAuliffe M, Nielsen H, Riscoe T, Steele R, Dettwiler A, Oberley G, Zaremski K, Joy K, Selby A, Wells-Lewis R, Creamer BA. Osteopathic Manipulative Treatment as an Intervention to Reduce Stress, Anxiety, and Depression in First Responders: A Pilot Study. *Missouri Medicine*. 2021; 118(5).

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Osteopathic Manipulative Treatment as an Intervention to Reduce Stress, Anxiety, and Depression in First Responders: A Pilot Study

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Abstract

In this pilot study, we examined the efficacy of Osteopathic Manipulative Treatment (OMT) for improving symptoms of stress, anxiety, and depression (SAD) to determine a correlation between overall improvement in health and quality of life for first responders. Participants received weekly OMT or sham OMT targeting autonomic imbalance. Indicators of SAD were examined pre- and post-study. Overall, this pilot study suggests improvement in both the social-psychological (mental) self-assessments, and alterations in SAD-associated biomarkers from OMT.

Introduction

Recent data has shown that at least 30% of first responders in the United States will develop behavioral health conditions such as SAD.¹ Traumatic events such as death, serious injury, and violence are at higher prevalence in these fields when compared to other civilian professions and put personnel at an increased risk for experiencing poor physical and mental health. Of the most notable psychological consequences from

repeated exposure to traumatic events is the development of serious stress, anxiety, and/or depression that can sometimes lead to Post-traumatic Stress Disorder (PTSD).² In fact studies have shown law enforcement officers to develop PTSD at rates ranging from 6-32%, EMT/paramedics ranging from 9-22% and firefighters with rates of 17-32%, whereas adults in the United States typically range from 7-12%.³ Such large ranges in rates would suggest other third-variable risk factors are at play such as, within groups — at the individual level and between groups — at the level of occupation type. Regardless of these other variables, first responders should be considered a special population at an increased risk for developing even mild to moderate mental health disorders, including stress and anxiety. In addition to PTSD, first responders are also at greater risk for developing depression, substance abuse, and suicide ideation and attempts.⁴ A 2017 survey of more than 4,000 first responders found that 6.6% had attempted suicide, which is more than 10 times the rate in the general population.⁵ Additionally, a 2016 study has shown that amongst

34 first responders who completed biological and psychological evaluations, 18% (n=6) met criteria for anxiety, 47% (n=16) met criteria for depression and 33% (n=12) met criteria for PTSD.⁶ While there is some success for treatment with efficacious, evidence-based therapies, current treatments are associated with either nonresponse, or high rates of dropout.⁷⁻⁹ As such, there is a tremendous need for the development of comprehensive interventions which aim to relieve the allostatic load in first responders.¹⁰

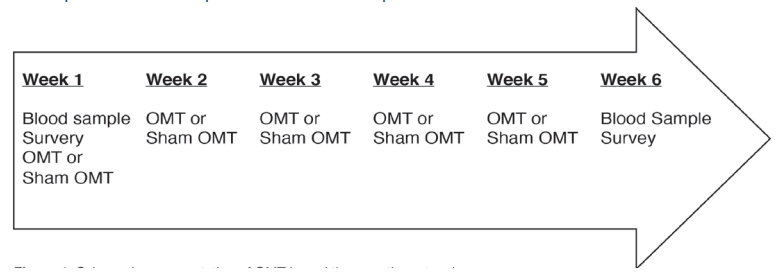
Since mental stress can cause measurable musculoskeletal tension, the concept of using OMT as a therapy to alleviate such symptoms has been examined.^{11, 12} Osteopathic manipulative treatment is targeted to treat somatic dysfunction—the impaired or altered function of related components of the body framework system: skeletal, arthrodiagonal, and myofascial structures, and their related vascular, lymphatic, and neural elements (*Glossary of Osteopathic Terminology*). Stress may result in segment facilitation demonstrated as exaggerated muscle tension. The reduction in muscular tension through the use of OMT may reciprocally reduce emotional stress by shifting the balance of sympathetic and parasympathetic systems to a more parasympathetic/relaxed state and could therefore benefit the mental health of those who are dealing with stress, anxiety, and depression resulting from their profession. To date, there have been only a few studies investigating the effectiveness of OMT in patients experiencing stress, anxiety, and/or depression. Nevertheless, it seems logical that OMT could benefit these patients.

It is known that emotional and physical stress can induce a physiological response in the human body that allows us to adapt and respond to that stress. Chronic exposure to stress can lead to maladaptive alterations in stress response, hormone levels, and many other physiological processes in response to the increased allostatic load. Recent data suggests that stress, anxiety, and depression can alter the levels of serum inflammatory biomarkers such as interleukins, in addition to a number of hormones.^{13, 14} In a state of stress, the body shifts to a sympathetic dominant state with relative increased sympathetic activity and decreased parasympathetic activity. When a person experiences chronic stress, there will be elevated levels of catecholamines (epinephrine and norepinephrine) and decreased levels of acetylcholine. A major physiological response to stress is to induce the hypothalamic-pituitary-adrenal (HPA) axis to cause the release of

cortisol, a glucocorticoid which triggers gene-expression changes in target tissues.¹⁵⁻¹⁹ Proposed mechanisms include altered circulating cortisol levels, dysregulated sensitivity to glucocorticoids, or alterations in feedback mechanisms, all which facilitate an extended or possibly intensified sympathetic nervous system activation.¹¹ This inability to regulate the HPA axis has been reported following chronic or severe stress and can lead to an allostatic load which transitions into an overexposure to stress molecules.²⁰ Increased allostatic load has also been linked to increased vulnerability to many psychiatric and physical disorders.^{21, 22} One might hypothesize that patients with increased stress are likely to have sympathetic nervous system associated somatic dysfunction. Addressing these dysfunctions with appropriate osteopathic manipulative techniques could aid in as above.²³ It is important to note that serious adverse effects of OMT are extremely rare and thus are considered to be a safe method of treatment.²⁴

Examples of stress-related treatments include a specific focus on the suboccipital and thoracic regions which are associated with increased heart rate variability, improved autonomic homeostasis, decreased muscular tension, and reduced perception of stress.²⁰ Rib raising treatment has been shown to reduce sympathetic output which results in parasympathetic predominant state—otherwise understood as a relaxed state.²⁵ Compression of the fourth ventricle (CV4) influences ANS function, and has been shown to alter the physiological parameters of blood flow velocity, heart rate, blood pressure, and cerebral tissue oxygenation.²¹ In a study done by Cutler et al. in 2005,²⁶ patients who received CV4 when compared to those who received the sham treatment were found to have more rapid sleep onset and decreased muscle sympathetic nerve activity. Other studies determined that CV4 promotes muscle relaxation and a general state of relaxation when measuring alpha band activity (related to relaxation, awake and idle state) on EEG.²⁷ Stimulation of the parasympathetic nervous system is achieved as a result of the effect on the brainstem. Similar to rib raising, CV4 shifts autonomic balance to a parasympathetic predominant state by increasing parasympathetic activity and decreasing sympathetic activity resulting in an overall relaxed state.²⁸ Sacral rocking is an OMT technique that exaggerates sacral movement.²⁹ Sacral rocking can relieve patients of lower back pain and balance autonomic dysfunctions influencing the gastrointestinal and genitourinary systems. Treatment increases parasympathetic outflow from the sacral

Figure 1. Schematic representation of OMT-based therapeutic protocol. Blood sampling and self-reported social-psychological (mental) assessment surveys were collected on weeks 1 and 6. The OMT or Sham OMT protocol was performed once per week on weeks 1-5.



nerves.³⁰ Inhibitory techniques use mechanical pressure to reduce regional autonomic output (habituation). Suboccipital inhibition (SI) reduces the muscle tension reducing parasympathetic inhibition.³¹ Tension headaches are often associated with myofascial trigger points or muscle tenderness,³² which can lead to autonomic imbalance and motor disturbances in that region. Treatment using SI led to hypoalgesic effects—decreased sensitivity to painful stimuli and relieving pain.³³ Treatment with SI improved the emotional and mental well-being, and better quality of life.³²

The benefit of human touch has also been shown to have therapeutic effects, which OMT is expected to provide as well. For example a review of research by Tiffany Field, a leader in the field of touch, found that benefits from touch start at birth, showing newborns that received just three 15-minute sessions of touch therapy each day for 5-10 days gained 47% more weight than premature infants who had received standard medical treatment.³⁴ She also found that massage therapy reduces pain in pregnant women and alleviates prenatal depression in both them and their spouse.³⁵ Another study from UC Berkeley's School of Public Health found that receiving eye contact and a pat on the back from a doctor may help survival rates for those suffering with complex diseases.²² While OMT is a focused therapy option conducted only by a trained licensed doctor of osteopathy, touch therapy and its benefits were also taken into account for this research by including a sham OMT group. Sham therapy is defined as false treatment. It is typically used as the control group in OMT studies in order to compare the effects of the treatment or therapy in question.³⁶ In a study done by Licciardone et al. 2013, sham OMT involved light touch, active and passive ranges of motion, improper patient positioning, decreased physician force, and purposeful misdirected movements.³⁷

In this pilot study we examined the efficacy of OMT for improving symptoms of SAD and sought to determine a correlation between overall improvement in health and quality of life for first responders who received OMT.

Methods

Research Study Design

We designed a single blind study to investigate OMT as a therapy for reducing stress, anxiety, and depression in the first responder population of a rural area in Joplin, Missouri. Approval was obtained from the Missouri Southern State University Institutional Review Board (IRB# 1512565-1). Participants were assigned randomly to either: 1) an OMT group, or 2) a sham OMT group. Names and any identifying information were not used, and all participants were assigned a random identifier on all documents throughout the study. Each participant signed a consent form authorizing participation in the pilot study. The duration of the pilot study was six weeks. Intravenous blood samples and surveys were collected on week one and week six. OMT was performed week one through week five, for a total of five treatments (Figure 1).

Baseline Demographics

Socio-demographic data were collected for each first responder: age, gender, marital status, racial/ethnic identity, highest education, and household income at the initial timepoint (Table 1).

Osteopathic Manipulative Therapy Protocol

The OMT protocol for this study was developed by Andi Selby, DO, and Kelley Joy, DO, consisting of four standard OMT methods: Rib Raising, Sacral Rock, Suboccipital Inhibition, and CV4 treatments (Table 2). Participants were instructed by the operator when to inhale and exhale as to receive better extension and flexion of the treated area and ultimately the desired outcome of treatment.

Sham Protocol

The sham protocol, also created by Dr. Selby, was adapted from the OMT protocol described above. Sham OMT was performed by individuals who received sham training but had no additional experience in performing OMT prior to this study. Participants were

| Total Participants | | N=9 |
|--------------------------|--|-----------------------------|
| Gender | | |
| Male | | 9 (100%) |
| Age (years/mean) | | |
| | | 40 (range: 34-47 years old) |
| Education | | |
| Some college/Associate's | | 5 (55%) |
| Bachelor's | | 3 (33%) |
| Professional Degree | | 1 (11%) |
| Race/Ethnicity | | |
| White | | 8 (89%) |
| Hispanic | | 1 (11%) |
| Household Income | | |
| <\$49,000 | | 2 (22%) |
| \$50,000-\$99,999 | | 5 (53%) |
| >\$100,000 | | 2 (22%) |
| Marital Status | | |
| Never Married | | 1 (11%) |
| Married | | 7 (78%) |
| Separated/divorced | | 1 (11%) |

Table 1. Participant socio-demographic profile variables.

scales previously used in trauma studies,⁴⁰ including a seven-point Likert scale (strongly agree to strongly disagree) that measured indicators of Satisfaction with Work and a Vicarious Trauma Scale with measures of distress from exposure to work experiences, such as interactions with traumatized or distressed people and difficult situations, as well as feelings of helplessness, and being overwhelmed by their workloads. Finally, a Coping Mechanisms Scale with nearly a dozen possible items (including both positivity and negatively perceived coping mechanisms) was administered.

Vital Signs Collection

Participant vital signs, including height, weight, pulse oximetry, blood pressure, pulse, and respiration rate were recorded prior to each OMT or sham session.

| OMT Technique | Key Steps in Treatment | Desired Outcome |
|----------------------------|---|--|
| Rib raising | 4 second cycles of rhythmic pressure on rib angle | Reduced sympathetic output |
| Sacral Rock | Augmentation of sacral flexion and extension | Increased parasympathetic output |
| Suboccipital Inhibition | Continuous unaltered pressure | Increased parasympathetic output |
| CV4 (stillpoint induction) | Progressive encouragement of occipital extension until a still point is reached | Global shift towards parasympathetic balance |

Table 2. OMT study protocol procedures, key steps, and desired outcomes

Biomarker Sample Collection

The amount of 5mL of whole blood was collected via venipuncture from each participant using sterile techniques at week one and week six timepoints. Samples were stored and processed according to ELISA manufacturer directions.

ELISA

Biological indicators of stress and anxiety were assessed using enzyme-linked immunosorbent assays. Measures of human IL-6 (KHC0061), IL-1beta (BMS224-2), TNF-alpha (BMS223HS), cortisol (EIAHCOR), IL-2 (EH2IL2), C reactive protein (KHA0031), and IL-17alpha (BMS2017) were purchased from Thermo Fisher Scientific (<http://www.thermofisher.com>). Human BDNF (ab99978) was purchased from Abcam (<http://www.abcam.com>). Manufacturer protocols were followed, and assays were carried out using Synergy HTX Multimode Reader, software Gen5 3.05.

not instructed when to inhale or exhale and any touch used did not consist of extension or flexion, but rather only enough pressure to make the participants were aware they were being touched.

Scales

Various assessments of stress and anxiety were collected at week one and at week six. The Perceived Stress Scale was completed by participants to self-report their perception of stress.³⁸ For first responders' self-reported measurement of anxiety, we used the State Trait Anxiety Inventory.³⁹ We incorporated three

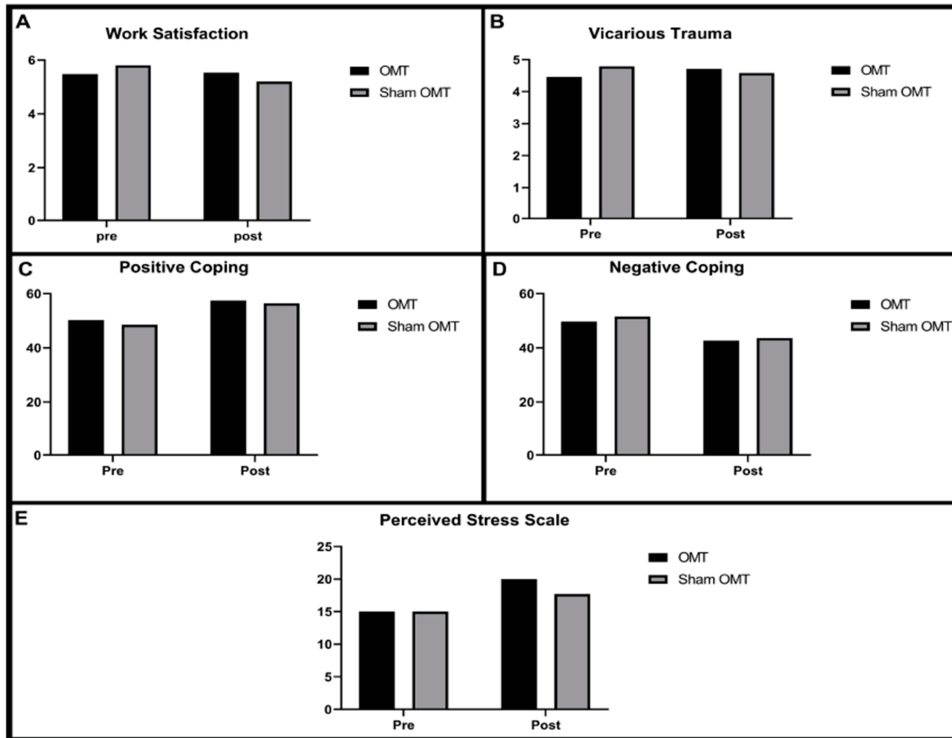


Figure 2. Mean values of self-reported social-psychological (mental assessments of stress and anxiety) were performed using the following scales and surveys collected on week 1 (Pre) and week 6 (Post). A. Work Satisfaction (scale of 1-7) B. Vicarious Trauma (scale of 1-10), C. Positive Coping Mechanisms (mean total), D. Negative Coping Mechanisms (Mean total), E. Perceived Stress Scale.

Statistics

All statistical analysis was carried out using GraphPad Prism version 8.2.1 for Windows, GraphPad Software, San Diego, California USA. All statistical significance was measured at $p=.05$.

Results

A total of nine participants were recruited into the pilot study (six OMT and three sham OMT). Six total participants completed the study (three OMT and three sham OMT). Socio-demographic data for the nine total participants are presented in Table 1.

When evaluating the social-psychological (mental) survey data, we observed that the average work satisfaction (Figure 2A) for both groups was on the higher side (5.2 – 5.8 out of 7), with the OMT (experimental) group reporting a slight increase in job satisfaction from week one to week six, and the sham OMT (control) group reporting a slight decrease in their job satisfaction. These data also indicate that the sham OMT group experienced a slight decrease in vicarious trauma indicators (Figure 2B) across the course of the study, while the OMT group's indicators of vicarious trauma increased slightly over the six-week

period. Both the sham OMT group and the OMT group increased their positive coping mechanisms (Figure 2C) over the study, and both groups also reported a decrease in negative coping strategies (Figure 2D). Finally, both the sham OMT and OMT groups reported increases in their perceived stress scores at the end of the six-week study (Figure 2E).

Analysis of serum biomarkers for stress, anxiety and depression were carried out via ELISA assay on week one and week six of the study. No statistically significant change in biomarker levels were observed, however, there were trends that indicate a

slight decrease (Figure 3). Levels of IL-6, BDNF, IL-2, IL-17 α , and cortisol trended lower at week six than week 1 in the OMT group. In addition, IL-17 α levels were also decreased in the sham OMT group at week six when compared to week one. Only levels of human C reactive protein trended higher at week six in the OMT group (Figure 3D). In the sham OMT group, IL-6, IL-2, hCRP, and cortisol all trended higher, but did not reach statistical significance. It is important to note that there was a high degree of variance across each group, and due to the relatively small number of participants, this likely is associated with a lack of statistical significance over time.

Discussion

In this pilot study we were able to identify numerical increases in positive coping mechanisms and decreases in negative coping mechanisms for all participants over the course of the study. The pre- to post-study increases in satisfaction with work satisfaction for the OMT treatment group was in the expected direction. On the other hand, data on first responders' impressions of vicarious trauma associated

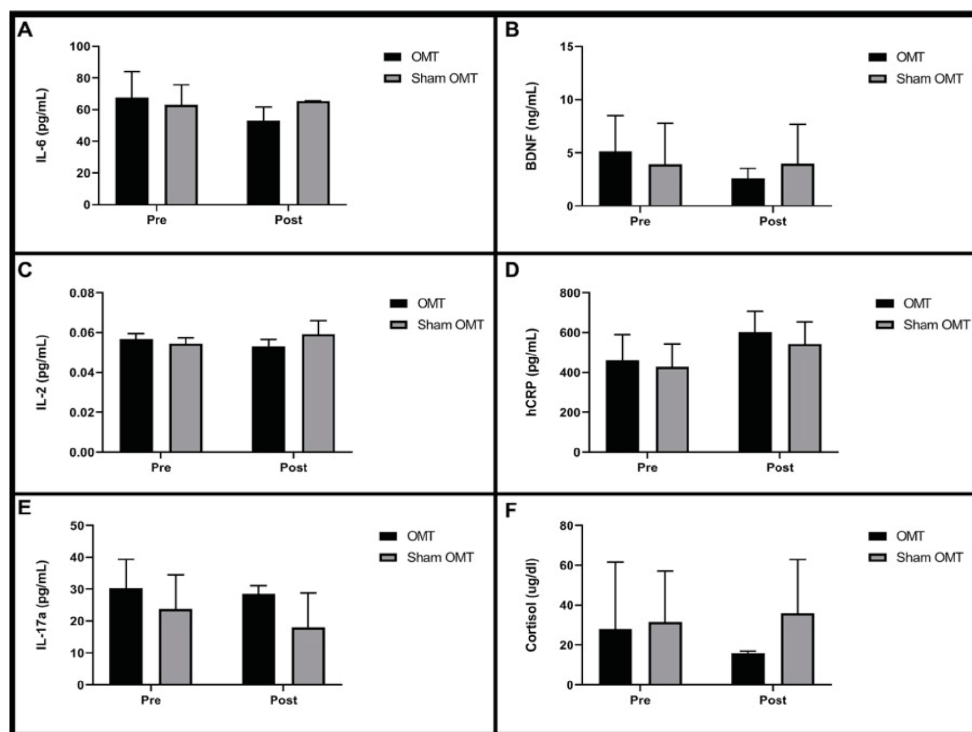


Figure 3. Serum analysis of biomarkers of stress and anxiety before and after OMT. 5mL of whole blood was collected on week 1 (Pre) and week 6 (Post) from each participant. Biological indicators of stress and anxiety were assessed using enzyme-linked immunosorbent assays (ELISA) for measures of: A. IL-6, B. BDNF, C. IL-2, D. hCRP, E. IL-17a, F. Cortisol. Samples were analyzed in triplicate and group means are reported along with +/- SE of the mean.

with work were not expected: control group members felt less and treatment group members felt more vicarious trauma by the end of the study.

Further, perceived stressors increased for both groups. These findings could be influenced by variations in individuals' exposure to stressful or anxious situations, such as differing responsibilities held across work positions, having different shifts or working in different stations that influence the calls to which each first responder was dispatched. However, a larger social factor may have been the emergence of the Covid-19 pandemic, increasing national, state and community-level fears and requiring the quick implementation of social distancing protocols. Somewhat contradictory, both groups also reported increased calmness, security, and feelings of ease and relaxation by the end of the study. The extra attention, human touch, and social interactions experienced by our participants were likely felt by those who received both authentic or sham OMT.

The authors note a likely confounding effect of having both prescription and non-prescription drugs labeled as a "negative" coping strategy to work-related

stressors. Future studies may deconstruct this item, since compliance with physician's orders to take prescription medication may be perceived as a "positive."

This pilot study detected trends toward a decrease in serum biomarkers associated with stress, anxiety, and depression. Inflammatory cytokines are currently being further investigated as primary biomarkers for a number of neurological conditions, including anxiety and major depressive disorder. Our data indicate that several of the interleukins and other hormones potentially associated with these conditions

were influenced by this protocol. Increasing the frequency of treatment and/or the duration of the study may show a continuation of this trend to statistical significance. In addition, the addition of educational materials designed for the reduction of stress, anxiety and feelings of depression may work in conjunction with OMT to improve these conditions in first responders.

Conclusion

First responders are commonly exposed to traumatizing incidents or disasters in the course of their duties. Police, firefighters, EMTs, and paramedics who respond to these emergencies and tragedies are likely to experience psychological and physical stress, and this constitutes a great risk for their physical and behavioral health. This pilot study highlights the therapeutic potential of OMT for SAD reduction in this population. Further research is needed on this topic, expanding the sample size and modifying the methods based on the findings of this study to develop more evidence-based conclusions.

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Disclosure

None reported.

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