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Original Research

A Proposal for the Use of Craniosacral Therapy in Firefighter Cadets to Decrease Cortisol Levels and Improve Postural Stability—A Randomized Trial

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Abstract

Background: Stress is a physiological response to the mental, emotional, or physical challenges that people encounter. Reactions to stress are also associated with increased secretion of numerous hormones including; glucocorticoids, e.g., cortisol, catecholamines. **Methods**: The research aimed to check whether craniosacral osteopathic therapy performed over a period of five weeks would affect the values of cortisol level and postural stability amongst sixty firefighter cadets (aged 18–24; 21.63 ± 1.41), involved in rescue operations at traffic accidents (the firefighter cadets underwent qualified paramedic training). The participants were divided into two groups: craniosacral therapy experimental group (30 people) and a control group (27 people). **Results**: The obtained results show that craniosacral therapy can lead to lower levels of cortisol $p < 0.001$. It is difficult to state unequivocally that craniosacral osteopathic therapy influenced the values of postural stability; it was noted for the ellipse area in the group subjected to craniosacral therapy for the lower limbs with eyes open p-value = 0.0002. **Conclusions**: Craniosacral therapy may have a beneficial effect in reducing high cortisol levels.

Keywords: cortisol; postural stability; firefighter cadets; craniosacral therapy

1. Introduction

The state of being healthy can be defined as life "without stress", in which the human body keeps the markers of stress within normal ranges. Professional firefighters involved in rescue operations also have to be qualified paramedics. Fire officers are members of a professional group particularly exposed to high anxiety and a form of stress called traumatic stress, resulting from participation in events in which their physical safety is often threatened. Factors that distinguish a firefighter's work involve action and exposure to psychological anxiety [1–3]. High trait anxiety, defined as greater susceptibility to anxiety as a state, has been shown to be detrimental to both psychological and physiological functions, particularly among people who frequently experience stressful events [2]. Cortisol is an essential mediator between psychological states and health-related outcomes. Cortisol is the end product of the functioning of the hypothalamic-pituitary-adrenal axis (HPA), which helps to regulate the stress response [4,5]. Current data show the adverse effects of cortisol on hippocampal neurons and the prefrontal cortex, which leads to altered memory and cognitive functioning [6–8]. Cortisol may also intensify age-related neurodegenerative processes in the brain [7]. The adverse effects of glucocorticoids on hippocampal and prefrontal neurons may lead to a decrease in volume of these structures and, on the other hand, a dysfunction of these brain regions enhances HPA axis activity [8]. Furthermore, experimental data show that both stress and exogenous glucocorticoids induce behavioural changes characteristic of psychiatric conditions, mainly depression and anxiety disorders [9–12]. Supporting a person burdened with excessive anxiety is focused on balancing the excitability of the autonomic nervous system, reducing muscle tension and decreasing the level of perceived stress [13,14]. It is well known that cortisol is significantly increased by psychological stressors, especially in chronic stressful events. Although short term psychological stress can play a protective role, providing stimuli for "fight or flight responses" and adaptive hormonal responses to maintain systemic homeostasis, excessive or chronic stress, through elevated cortisol, can have a maladaptive, widespread influence on health outcomes [3]. Firefighters involved in rescue operations should have very high levels of physical fitness—a high level of motor skills, correlated with balance, related to postural stability. Postural stability will be a factor that will also affect health, functioning in space—moving around, or keeping the body in a static position. Postural stability is the ability to maintain an upright standing position while standing freely [15]. This condition is characterised by the vertical alignment of the body axis concerning the minor axis of support, monitored by the posture control system [15]. The determinant of postural stability is the location of the centre of gravity in the support field defined by the foot contour (support quadrilateral) [16]. Pilates and core stability exercises are generally applied in order to improve postural stability [17,18].

Current healthy lifestyle trends mean that people are looking for ways and means to help support good health. In recent years, more attention has been devoted to techniques related to the holistic approach [19–21]. Craniosacral osteopathy relies on delicate manipulation and specialised compression techniques to minimise tension within the skull, pelvis, diaphragm, chest and sacrum. Osteopathic craniosacral therapy on bones in the skull leads to a loosening of connective tissue structures, the tension of which is usually the cause of health problems. Osteopathic craniosacral therapy for the elimination of stress overload also aims to improve the action of the circulatory system and eliminate somatic complaints such as migraines or muscle pains [22–24]. However, the current evidence supporting the efficacy of osteopathic craniosacral therapy in reducing excessive anxiety is promising, at least as a complementary therapy in generalised anxiety disorder, but not sufficient [25,26]. Osteopathic treatment could influence a firefighter's autonomic nervous system when under stress. Therefore, this study aimed to determine the effectiveness of osteopathic craniosacral therapy on cortisol levels and its effect on postural stability in healthy male firefighter cadets. The occupation of firefighter is associated with high-stress levels and physical effort, consisting of both static and dynamic body positions during firefighting operations.

2. Materials and Methods

2.1 Participants

The participants of the study consisted of Fire Service cadets from the State Fire Service College. As part of mandatory classes studied to become firemen, the cadets were being assigned to rescue teams sent to road traffic accidents, including fatal accidents (participants of the study were involved in rescue operations twice a week, the cadets had taken part in a qualified paramedic course, the team's commander was an experienced firefighter and also a paramedic; the cadets declared a willingness to continue their paramedic education after having completed the Fire Service College). Fifty-seven firefighter cadets aged 18–24 (21.63 $\pm$ 1.41), with a mean Body Mass Index of 24.44 $\pm$ 3.05 kg/m^2, voluntarily participated in the study. Participants were recruited through meetings organized at the firefighting academy, as well as posters and leaflets. All participants were briefed on the study protocol using an information sheet, and their informed written consent for participating in the study was obtained. Interested candidates were screened by interview to check their eligibility according to the inclusion and exclusion criteria. Inclusion criteria were as follows: male, firefighter academy cadet and voluntary participation. The decision to recruit only men for the study was dictated by previous studies on cortisol levels according to which circulating cortisol levels are influenced by gender (in particular: menstrual cycle phase in females) [27]. To minimize this problem, only men were selected. Exclusion criteria included any history of osteopathic therapy, daily smoking, alcohol abuse, heavy caffeine use (>300 mg/day), medication intake, drug abuse, reported medical illness, history of endocrine disorder, psychiatric disorder and cardiovascular disease. A random number generator was used to assign the subjects to the groups. Each participant received a number drawn for allocation to one of the study groups. The therapeutic intervention sessions were conducted once a week for five consecutive weeks, with experimental sessions conducted between 9:30 AM and 1:00 PM. This study was a randomised controlled trial.

2.2 Cortisol Assessment

All samples were collected under basal conditions after 10–12 h overnight fasting at baseline, and again after five weeks. The blood samples (15 mL) were collected in the morning (7:00–9:00 AM) from the antecubital vein with the subject seated in a comfortable position, using Vacutainer tubes. The blood was distributed in one tube with gel and clot activator (10 mL) to obtain serum. Cortisol levels were measured using an Eagle Biosciences Cortisol ELISA (enzyme-linked immunosorbent assay) kit (cat. DCM020-9) from DiaMetra (Perugia, Italy). All the samples were analysed in the same Elisa kit assay sensitivity was 0.8 nmol/L, and the inter- and intra-assay variation coefficients were all below 10%.

2.3 Postural Stability

Postural stability was assessed in all subjects using the Zebris FDM (Medical GmbH, Germany) platform, which is a certified stabilometric platform. The results obtained were stored on a computer with the Zebris FDM program loaded. Postural stability in standing positions was assessed using the platform, standing on both legs and on one leg, both right and left. The subject stood on the platform for 30 seconds, looking ahead, the upper limbs by their sides. One test was carried out standing on two legs, and another on one-leg. A further test performed was standing with eyes closed on both legs and then on one leg with eyes closed, performed on the right and then the left leg. The research study design included postural assessments using the platform tests of subjects from both experimental and non-intervention (control) groups. Then, for five weeks, the experimental study group subjects underwent craniosacral osteopathic therapy. The therapeutic sessions for each of the participants within the control group took place once a week and were performed at the same time of day. The participants in the non-intervention control group did not receive any treatment. During the last days of the five-week study, both groups underwent postural stability assessment, as performed at the beginning of the study. Both parameters of path length and ellipse area were considered.

2.4 Craniosacral Therapy

Before applying osteopathic craniosacral therapy, all participants from the study group (N = 30) were acquainted with its methodology. Therapy sessions were held in a warm, quiet room. The therapeutic intervention sessions were conducted once a week for five consecutive weeks, with experimental sessions conducted between 9:30 AM and 1:00 PM. With the participants supine, the same female therapist administered the therapy each time according to the previously described procedure [28,29]. In this study we used structural approach craniosacral therapy. Following the release of mobilised structures, the therapist applied individual phases of osteopathic craniosacral therapy (sacrum compression and traction, AO—Atlanto-occipital joint, mobilization of the frontal bone, parietal bones, sphenoid bone and temporal bones, and the final step was the CV4 technique—for a full description of the procedure Liem [28,29]. For the non-intervention group (N = 27), the therapist only held the subject's head (while the subject was in the supine position) and did not use her hands for the application of any osteopathic techniques. The treatment time for both groups' individual subjects was 20 min, which was ensured by using a stopwatch. None of the 57 participants had received any osteopathic therapy before the study, and the study subjects did not have any previous knowledge or experience of the osteopathic craniosacral procedures.

2.5 Statistical Analysis

For the current research project, statistical analysis using R software ver. 4.0.3 (Viena, Austria) [30] was performed. Both the craniosacral osteopathic therapy experimental group and the control group were analyzed. Using the non-parametric Wilcoxon test, the values of cortisol level, path length, and ellipse area measured before and after the beginning of the study were compared for the experimental and control groups. When analyzing the effect of cortisol in the group provided with osteopathic craniosacral therapy and in the non-intervention control group, a multivariate principal component analysis (PCA) and results were presented as a biplot [31]. A statistically significant difference in the examined parameters was set at p-value $<$ 0.05.

3. Results

In the case of cortisol levels, we observed a significant change amongst the subjects in the experimental group receiving craniosacral osteopathic therapy after five weeks compared with baseline p values $<$ 0.001 (Table 1, Fig. 1). We did not notice a significant change in the cortisol value in the control group, p-value = 0.3016 (Table 1, Fig. 1).

Statistical analysis showed no significant change in the craniosacral group for path length. On the other hand, for the path length parameter in the control group, a significant change was noted when assessing postural stability when standing on both legs with both eyes open, p-value = 0.0111 (Table 2). For the ellipse area, we recorded a statistical change in the group in which craniosacral osteopathic therapy was performed for the left lower limb with open eyes, p-value = 0.0002 (Table 2). There was a statistical change in the left leg stance with eyes closed in the control group, p-value = 0.0195 (Table 2).

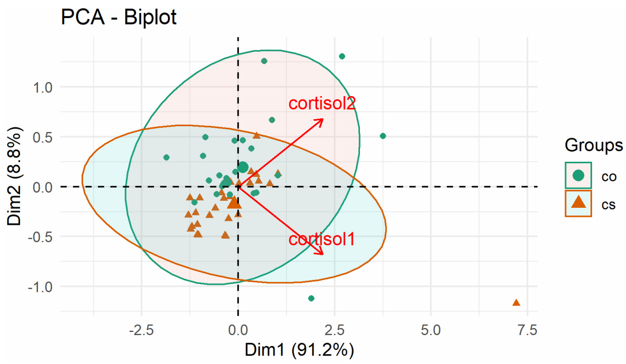

Fig. 1. PCA for cortisol in the experimental and non-intervention control groups (cs—the experimental craniosacral osteopathic therapy group, co—the control group).

Table 1. Wilcoxon test of cortisol levels (C) before starting the study and after five weeks for the experimental craniosacral osteopathic (cs) group and the non-intervention control group (co).

Groups	Before vs. after	p-value
cs	C1 vs. C2	**<0.001**
co	C1 vs. C2	0.3016

In Table 1, statistically significant difference in bold.

4. Discussion

It would be recommended to use natural mood improving cortisol decreasing methods amongst professions burdened with high levels of stress. The current study evaluated whether craniosacral therapy could help reduce cortisol levels and improve postural stability in healthy male firefighter cadets. Our study demonstrated that craniosacral therapy significantly affected assessment scores in hormone stress levels, while affecting the postural stability of the participants to a much lesser degree. Although manual therapies are offered chiefly for chronic tension, some research studies have recommended using this therapeutic modality to increase patients' general well-being and suppress anxiety [32–35]. A recent prospective study showed that osteopathic therapy could indeed be an effective intervention for decreasing perceived stress, as well as improving mental health outcomes [36]. Dixon *et al.* [24] also proved that osteopathic manipulative therapy might improve the effects of conventional therapy in generalised anxiety disorders. This treatment modality may also induce a relaxation response. For example, Girsberger and co-authors

Table 2. Wilcoxon test for path length and ellipse area before starting the study and after five weeks in the craniosacral osteopathic (cs) group and in the control group (co), kkdoo (standing on two legs with eyes open), kdoo (single right leg stance with eyes open), lkdoo (single left leg stance with eyes open), kkdoz (standing on both legs with eyes open), kkdoz (double-legged stance with eyes closed), pkdoz (single right leg stance with eyes open), lkdoz (single left leg stance, eyes closed).

Groups	Before vs. after	*p*-value path length
cs	kkdoo	0.2894
cs	pkdoo	0.8236
cs	lkdoo	0.3285
cs	kkdoz	0.5158
cs	pkdoz	0.0667
cs	lkdoz	0.4161
co	kkdoo	**0.0111**
co	pkdoo	0.5422
co	lkdoo	0.4770
co	kkdoz	0.5938
co	pkdoz	0.2531
co	lkdoz	0.0754
Groups	Before vs. after	*p*-value ellipse area
cs	kkdoo	0.8712
cs	pkdoo	0.1579
cs	lkdoo	0.0002
cs	kkdoz	0.3931
cs	pkdoz	0.1519
cs	lkdoz	0.2449
co	kkdoo	0.2531
co	pkdoo	0.1096
co	lkdoo	0.0797
co	kkdoz	0.8192
co	pkdoz	0.2531
co	lkdoz	0.0195

In Table 2, statistically significant difference in bold.

[37] demonstrated the influence of craniosacral techniques on reducing autonomic nervous system tension. Therefore, the current study's authors assumed that osteopathic craniosacral therapy might support stress reduction, and measured the outcomes using a biochemical stress marker. We observed that young firefighter cadets showed higher serum cortisol concentrations. This finding is not surprising, as systemic cortisol is among the most widely used biomarkers of acute and chronic stress [38]. After five weeks of craniosacral therapy, the authors observed a reduction in cortisol levels (Table 1, Fig. 1). In the study by Lopresti and co-authors [39], ashwagandha extract was used to lower cortisol levels and shown to be effective. Forest bathing can decrease stress and thus reduce cortisol levels [40]. Therapeutic massage has also been shown to be effective in reducing stress levels [41]. Listening to music may be a way to reduce stress and cortisol in everyday life [42,43]. The results presented indicate no statistically significant differences between cortisol levels and postural stability after five weeks of craniosacral osteopathic therapy. However, in the path length measurements results (Table 2) and within the ellipse area outcomes (Table 2) are noteworthy. It is difficult to state unequivocally whether craniosacral osteopathic therapy positively influenced postural stability amongst the subjects in the experimental group. The research findings may be limited due to craniosacral osteopathic therapy being performed only on a single research group (cs) as well as by the fact that the control group (co) received no therapy of any sort.

Postural stability is described as the control of balance, orientation and position of the body in space. A standard definition of postural stability is based on the Center of Gravity (COG) position on the support plane. Neuromuscular control does not show a linear direction of action, which means that the COG does not focus on one point but oscillates around it, called swaying [44–46]. In assessing postural stability, the center of gravity point of the feet's pressure on the ground is also often considered—the Center of Pressure (COP). The center of the feet's pressure highlights the deviation in the center of gravity (COG) and reflects the response to stimuli on the foot, playing a significant role in maintaining balance [45,47]. It has been shown that the system of stable postural control is characterised by high sensitivity to slight changes in signals coming from the environment and inside the body, mediating the resulting reactions [44,48]. On the other hand, postural responses enable the maintenance of the correct balance and position of the body in space while responding to stimuli able to disturb posture [48,49].

There are two types of stability: functional and structural, the latter also known as mechanical stability [45,50]. Fibrous-elastic tissues and muscular control are amongst the factors influencing functional stability. Structural stability is influenced by articular surfaces and their ability to bear static and dynamic loads. Structural stability is essential to achieving bodily equilibrium, while functional stability supports this [45,50]. Analysis of the literature shows a lack of inquiry into the influence of craniosacral osteopathic therapy on postural stability. Hitherto, postural stability has been assessed solely in terms of locomotor trauma [51,52].

5. Conclusions

Taken together, we have demonstrated that craniosacral therapy might exert a beneficial effect in reducing high levels of cortisol. It should be acknowledged that there was a lack of an equivalent female group, to estimate the effect of sex in this study. In addition, the small size of the groups could be another limitation; therefore, these issues should be investigated with more group participants included in future studies.

Author Contributions

Conceptualization—MW, and EŻ; data curation—MW; formal analysis—MW, IS, and EŻ; statistical analysis, software—IS; investigation—MW, IS, and EŻ; methodology—MW and EŻ; project administration—MW; supervision—MW, IS, and EŻ; validation—MW, IS, and EŻ; visualization—MW and EŻ; writing - original draft—MW, IS, and EŻ; writing - review & editing—MW, IS, and EŻ. All authors have read and agreed to the published version of the manuscript.

Ethics Approval and Consent to Participate

All procedures performed in studies involving human participants were carried out in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. The study protocol was approved by the Bioethics Committee of the Nicolaus Copernicus University in Toruń, operating in Collegium Medicum in Bydgoszcz (permit No. KB/99/2016).

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Conflict of Interest

The authors declare no conflict of interest.

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