# Evaluation of the effects of musculofascial therapy on the degree values for physiological spine curvatures, altered due to long-term kick-boxing training

**Authors' Contribution:**
**A** Study Design
**B** Data Collection
**C** Statistical Analysis
**D** Manuscript Preparation
**E** Funds Collection

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**Source of support:** statutory funds of the Department of Functional Anatomy, University School of Physical Education in Poznan, Poland

**Received:** 23 January 2015; **Accepted:** 12 June 2015; **Published online:** 19 June 2015

**ICID:** 1157752

## Abstract

**Background & Study Aim:** Changes of spinal curvatures caused by training effect of different sport disciplines have been discussed by many researchers. However, there is a distinct lack of records on the effect training kick-boxing has on the functional parameters of the spine. The aim of this paper was the knowledge about the degree values of spine curvatures among subjects training kick-boxing and the effect of myofascial therapy on these spine parameters.

**Material & Methods:** The study group comprised of 15 males (18-25 years of age), who have been training kick-boxing. The control group comprised of 15 males in the same age range, who did not train any sports. The degree values for spine curvatures were determined with a tensometric electrogoniometer by Penny & Giles, modified by Boocock. Subjects training kick-boxing underwent 2-week soft tissue therapy based on the methodology of Anatomy Trains by T. Myers.

**Results:** The study group and the controls differed significantly in terms of all the analyzed degree values for spine curvatures. Kick-boxers presented with deeper spine curvatures, when compared to both respective reference limits and the controls. The therapy exerted beneficial effect, decreasing deepened spine curvatures (significant at $p \leq 0.001$). However, the result was not maintained, as shown by the measurements taken three months after completing the therapy. Nevertheless, the curvatures did not return to the pretreatment values.

**Conclusion:** Training kick-boxing can lead to an increase in degree values of spine curvatures. Myofascial techniques should be an integral part of kick-boxers' biological regeneration program.

**Keywords:** combat sport • electrogoniometry • physical therapy modalities • rehabilitation • spine

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**Fascia** – connective tissue membrane. Encapsulates muscles, muscle groups or even organs. Maintains integrity of human, covering, joining and providing appropriate tension of its various parts [1].

**Myofascial bands** – longitudinal structures composed of many muscles and surrounding fascial network, organized in various systems that cover human body [1].

**Physiological spinal curvatures** – the spine is a S-shaped structure when observed from the side. It forms anterior curvatures in its cervical and lumbar segments (cervical and lumbar lordosis, respectively) and a posterior curvature in the thoracic segment (thoracic kyphosis).

**Tensometric electrogoniometer** – a portable, non-invasive device for determination of the spinal mobility and angular values. It comprises a set of tensometric sensors and a digital recorder.

**Anatomy Trains Concept by Thomas Myers** – first described in 1997 in the Journal of Bodywork and Movement Therapies. Based on postmortem examinations. Myers have developed a map of 12 longitudinal musculofascial bands covering the whole human body [1].

**Superficial front line** – according to Myers, this band runs along the anterior part of human body. It runs in the cranial direction. It begins on the dorsal surface of the foot and ends on the cranial fascia [1].

**Deep tissue massage** – a form of musculofascial therapy that involves specific, predominantly compression-based, techniques. During this highly precise tailored form of therapy, a therapist used not only hands, but also forearms and elbows [13].

**Musculofascial therapies** – a group of various therapies targeted on muscular structures tightly connected with surrounding fascial network. They are aimed at alleviation of pain, restoration of mobility, elasticity of soft tissues and normal function of the locomotor system.

## INTRODUCTION

Up until the first half of the 20th century, the human body was perceived in mechanical terms – as a collection of different parts: bones, muscles, organs. The motor system was analyzed based on the effect single muscles or muscle groups had on joints. In reality, the living human organism constitutes a unified whole, with no divisions into particular units within that whole. The human body does not function in sections; movement or muscle tonus of a given part causes a general reaction [1]. This is possible due to the connective tissue, which constitutes the so-called fascia. The available sources indicate the existence of 12 myofascial bands, which go through, surround and penetrate all areas of the human body [1-3].

The effect training different sports disciplines has on the degree values of spine curvatures has been discussed by many researchers [4-8]. However, there is a distinct lack of records on the effect training kick-boxing has on the functional parameters of the spine. Kick-boxing is a sports discipline that requires the trainee to take certain positions and perform certain movements. This causes some muscle groups to be more involved than others, which can increase tension in some myofascial bands and result in changes in the spine curvatures.

The aim of this paper was the knowledge about the degree values of spine curvatures among subjects training kick-boxing, and the effect of myofascial therapy on these spine parameters.

## MATERIAL AND METHODS

### Participants

The study group comprised of 15 males between 18 and 25 years of age (mean age 21 years), who have been training kick-boxing 2 hours, 4 times a week, for a minimum period of 5 years. The control group comprised of 15 males in the same age range (mean age 21 years), who did not train any sports. There were no motor system disorders diagnosed in either group. The protocol of the study was approved by the Local Bioethics Committee of the Poznan University of Medical Sciences (decision no. 368/0). Moreover, all participants gave their written informed consent for participating in the study.

### Measurement methods

In order to assess the degree values for spine curvatures, we used the tensometric electrogoniometer by Penny & Giles, Biometrics LTD, modified by Boocock [9], which eliminates measurement errors caused by soft tissue to bone movements. A biaxial sensor was used in the study [8,10].

The measurements covered all spine curvatures (cervical lordosis, cervical kyphosis, lumbar lordosis). The measurements were taken three times. The first time prior to therapy, the second right after completing the therapy, and the third – three months after completing the therapy. The control group was measured once. All the measurements were taken by the same investigator, in the same conditions and using a re-set electrogoniometer. The investigator performing measurements was blinded, i.e. not informed whether the subject was from the study or the control group.

The electrogoniometer test was performed according to Lewandowski [10]. The subjects stood in a relaxed position, with upper extremities hanging loosely parallel to the trunk, the weight evenly spread on both feet and the head in neutral position. The sensors of the electrogoniometer were placed on the long axis of the body, using double-sided medical tape. The measurements were performed at the same time during the day (before noon), in a room with temperature 21$^{o}$C. On the day of the measurement, the subjects did not perform any training or other sport-related physical activity. The accuracy of the measurements was verified scientifically [11, 12].

### Therapeutic methods

Subjects training kick-boxing underwent 2-week soft tissue therapy based on the methodology of Anatomy Trains by T. Myers [1]. The therapy was aimed at loosening of the myofascial superficial front line [1]. In order to achieve that, we used deep tissue massage for decreasing myofascial tension [13]. The therapeutic procedure covered, in that order: extensor digitorum longus muscle ligaments, extensor digitorum brevis muscle ligaments, tibialis anterior muscle, rectus femoris muscle, rectus abdominis muscle, sternal membrane, sternocleidomastoid muscle. During each procedure, a physical therapist worked on both right and left side of the body. Each therapeutic session took approx. 60 min and was performed by a certified physical therapist.

### Detailed therapeutic procedure:

***Extensor digitorum longus and brevis muscle ligaments:***

- Patient's position: lying on the back
- Techniques: lengthwise movement down the bridge of the foot, aggressive stretching – performed with an open fist.

***Tibialis anterior muscle:***

- Patient's position: lying on the back
- Techniques: lengthwise movement down the tibialis anterior muscle performed with an open fist; aggressive stretching with the movement of the foot (open fist); techniques: hook and stretch (intermediate phalanges).

***Rectus femoris muscle:***

- Patient's position: lying on the back
- Techniques: lengthwise movement down the rectus femoris muscle (flat part of the elbow); stimulation for stretching combined with bending the knee joint beyond the massage table (open fist); aggressive stretching combined with bending the knee joint beyond the massage table (open fist); separating inter-muscle sections (tips of the fingers).

***Rectus abdominis muscle***

- Patient's position: lying on the back
- Techniques: lengthwise movement (open hand); stimulation for stretching combined with breathing in and expanding the stomach (intermediate phalanges).

***Sternal membrane***

- Patient's position: lying on the back
- Techniques: lengthwise movement (open hand); stimulation for stretching combined with intercostal breathing in (intermediate phalanges).

***Sternocleidomastoid muscle***

- Patient's position: lying on the back
- Techniques: caudal stimulation of the chest synchronized with breathing stages; lengthwise movement down the sternocleidomastoid muscle (intermediate phalanges); stimulation for stretching combined with extending the head, bending it to the side away from the therapist and back (intermediate phalanges).

**Statistical analysis**

Statistica 10.0 by StatSoft was used for statistical analysis. The recorded data were verified for normal distribution with Shapiro-Wilk's test.

Student's t-test for independent samples was used to compare degree values for spine curvatures between the study and control groups. U-Mann-Whitney test was used to compare the variables that lacked normal distribution.

Student's t-test for dependent variables was used to compare values for each of the results of the three tests of the subjects from the study group. In order to verify the significance of differences between the results for test 1 and 2, and 2 and 3, Wilcoxon's paired samples test was used. The threshold of statistical significance was set at p≤0.05.

## RESULTS

Comparative analysis of spine curvatures among subjects training kick-boxing and the controls

Collected data underwent statistical analysis. Basic statistical characteristics were established: arithmetic means, standard deviations and maximum and minimum values for both groups (Table 1).

**Table 1.** Basic statistical characteristics for the degree values for physiological spine curvatures in the study group (determined three times) and in the controls

| | N | Mean [°] | Minimum [°] | Maximum [°] | SD [°] |
|---|---|---|---|---|---|
| CG C | 15 | 38.3 | 33.0 | 47.0 | 3.6 |
| SG C prior | 15 | 44.0 | 38.0 | 48.0 | 2.9 |
| SG C after | 15 | 40.7 | 33.0 | 44.0 | 2.9 |
| SG C after 3m | 15 | 42.0 | 35.0 | 46.0 | 3.0 |
| CG Th | 15 | 32.4 | 30.0 | 36.0 | 1.9 |
| SG Th prior | 15 | 38.8 | 33.0 | 43.0 | 2.6 |
| SG Th after | 15 | 35.9 | 30.0 | 40.0 | 2.5 |
| SG Th po 3m | 15 | 36.6 | 31.0 | 41.0 | 2.6 |
| CG L | 15 | 35.5 | 32.0 | 39.0 | 2.2 |
| SG L prior | 15 | 41.1 | 32.0 | 48.0 | 4.6 |
| SG L after | 15 | 39.0 | 30.0 | 44.0 | 4.2 |
| SG L after 3m | 15 | 39.9 | 31.0 | 45.0 | 4.0 |

SD – standard deviation, CG – control group, SG – study group, C – cervical segment (lordosis), Th – thoracic segment (kyphosis), L – lumbar segment, prior – prior to the therapy, after – immediately after the therapy, after 3m – three months after the therapy, N – number of subjects

Shapiro-Wilk's test showed that the distribution of degree values for the cervical section was not normal. Thus, in order to compare these values between the study and the control group, U-Mann-Whitney test was performed; the results showed statistically significant difference between the two studied groups (Table 2). Normal distribution for the thoracic and lumbar sections enabled the use of Student's t-test for independent samples. The t-test showed a statistically significant variation between the two studied groups (p≤0.001). The results of the t-test were confirmed by the results of U-Mann-Whitney's test (Table 2).

**Table 2.** Results of Mann-Whitney U-test conducted to compare the degree values for physiological spine curvatures of the study group and control group

| | In relation to KB variable | | | |
|---|---|---|---|---|
| | Z | p | N Group 1 | N Group 2 |
| C spinal segment | 3.567114 | 0.000361* | 15 | 15 |
| Th spinal segment | 4.355197 | 0.000013* | 15 | 15 |
| L spinal segment | 3.276767 | 0.001050* | 15 | 15 |

KB - kick-boxing, Z – result of Mann-Whitney U-test, p – statistical significance level, N – number of valid measurements, Group 1 – individuals practicing kick-boxing, Group 2 – individuals who did not train any sports, C – cervical, Th – thoracic, L – lumbar, * statistically significant difference ($p \leq 0.05$)

The result analysis showed that kick-boxers had deeper spine curvatures in all sections (cervical lordosis, cervical kyphosis, lumbar lordosis) as compared with the controls. The difference was just as visible when compared with normal values, pursuant to Lewandowski [10] (Figure 1).

## Assessment of the effects of myofascial therapy among subjects training kick-boxing

The degree values for spine curvatures from subjects training kick-boxing were taken three times: prior to the therapy, right after completing the therapy, and three months thereafter. The Wilcoxon's test results for the cervical section showed a statistically significant difference in degree values for cervical lordosis between the measurements taken prior to the therapy and right after completing the therapy, and between measurements taken right after completing the therapy and three months after completing the therapy (Tables 3 and 4).

**Table 3.** Results of Wilcoxon's paired samples test conducted to compare the degree values for physiological spine curvatures of the study group determined prior to and immediately after the therapy

| | N | Z | p |
|---|---|---|---|
| C spinal segment | 15 | 3.407771 | 0.000655* |
| Th spinal segment | 15 | 3.105692 | 0.000921* |
| L spinal segment | 15 | 2.823261 | 0.002434* |

N – number of examined subjects, Z – result of Wilcoxon's paired samples test, p – statistical significance level, C – cervical, Th – thoracic, L – lumbar,* statistically significant difference ($p \leq 0.05$)

Normal distribution of the results for the thoracic and lumbar sections allowed the use of Student's t-test, the results of which showed a statistically significant variance, in favor of the measurements prior to therapy (t-test, $p \leq 0.001$). Performing myofascial techniques significantly decreased the degree values for both cervical kyphosis and lumbar lordosis. These results were confirmed with Wilcoxon's test (Table 3). Three months after completing the therapy, the curvatures: cervical, thoracic and lumbar were deeper than right after the therapy, but still significantly shallower than prior to the therapy (Table 4).

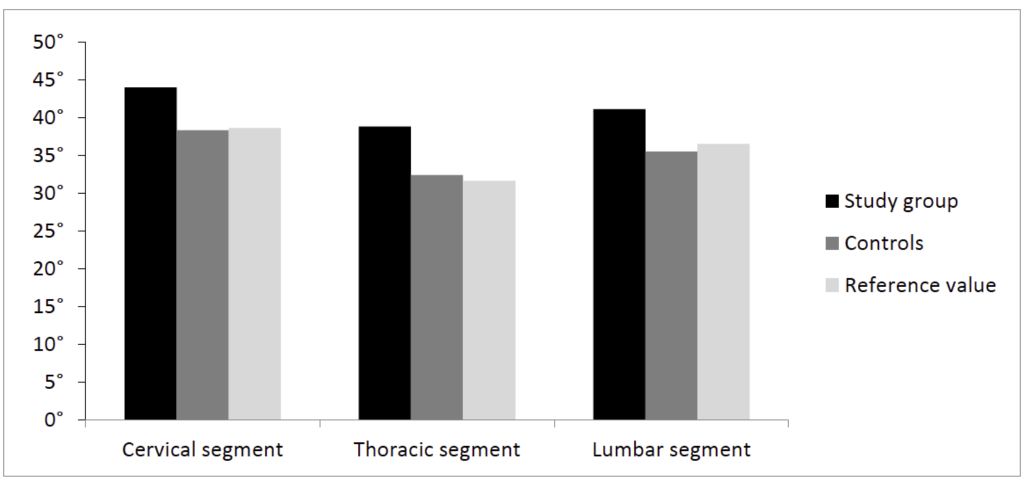


**Figure 1.** Comparative analysis of the degree values for physiological spine curvatures in the study group, controls, and respective reference values according to Lewandowski [10]

**Table 4.** Results of Wilcoxon's paired samples test conducted to compare the degree values for physiological spine curvatures of the study group determined immediately after the therapy and 3 months thereafter

| | N | Z | p |
|---|---|---|---|
| C spinal segment | 15 | 2.803060 | 0.005062* |
| Th spinal segment | 15 | 2.665570 | 0.007686* |
| L spinal segment | 15 | 2.222771 | 0.026232* |

N – number of examined subjects, Z – result of Wilcoxon's paired samples test, p – statistical significance level, C – cervical, Th – thoracic, L – lumbar,* statistically significant difference ($p \leq 0.05$)

This study showed that the therapy had significant effect – decreasing deepened spine curvatures. For the cervical section, the curvature was decreased by 3.3° (7.4%), in the thoracic by 2.9° (7.4%), and in the lumbar by 2.1° (5.0%). Unfortunately, the achieved result was not maintained, as shown by the measurements taken three months after completing the therapy. Cervical lordosis deepened by 1.3° (3.0%), cervical kyphosis by 0.7° (1.8%), lumbar lordosis by 0.9° (2.3%). It has to be stressed that the curvatures did not return to the pretreatment values (Figure 2).

## DISCUSSION

Disorders of the functional parameters of the spine are considered a sensitive indicator of pathologic changes [10,14,15]. Constant repetition of sports activities, a feature of certain sports disciplines, can increase strain within the myofascial bands. It can result in changes of the degree values of spine curvatures [4-8]. Greater or smaller deviations of these values can lead to such changes as overstraining of the vertebrae, intervertebral joints, ligaments, intervertebral discs or muscle groups. Proper degree values for spine curvatures are of key importance for balancing the weight distribution on both the spine and the entire motor system [7, 16-19].

Uetake et al. [4] stressed that sports disciplines, in which running and jumping play a significant part, can deepen spine curvatures. An increase in degree values of spine curvatures among subjects training kick-boxing, documented in this study, can point to the presence of such elements in the subjects' training program.

Kick-boxing is a sports discipline which requires the trainee to take certain positions and perform certain movements. This causes some muscle groups to be more involved than others. Even the en-guard position deepens the cervical kyphosis. This is associated with increased tension of the muscles supporting the chest (inter alia pectoralis major muscle). Lowering the head, which provides protection against strikes by the opponent, causes double-sided strain on the sternocleidomastoid muscle. In turn, taut rectus abdominis muscle provides protection for the stomach. A large number of kicks, characteristic for this discipline, requires constant activation of the hip flexors (iliopsoas, rectus femoris muscle), knee rectifiers (quadriceps femoris muscle) and tibialis anterior muscle, which take on the force of each kick. Attacks employing the upper extremities requires constant activation of the glenohumeral joint flexors, chest

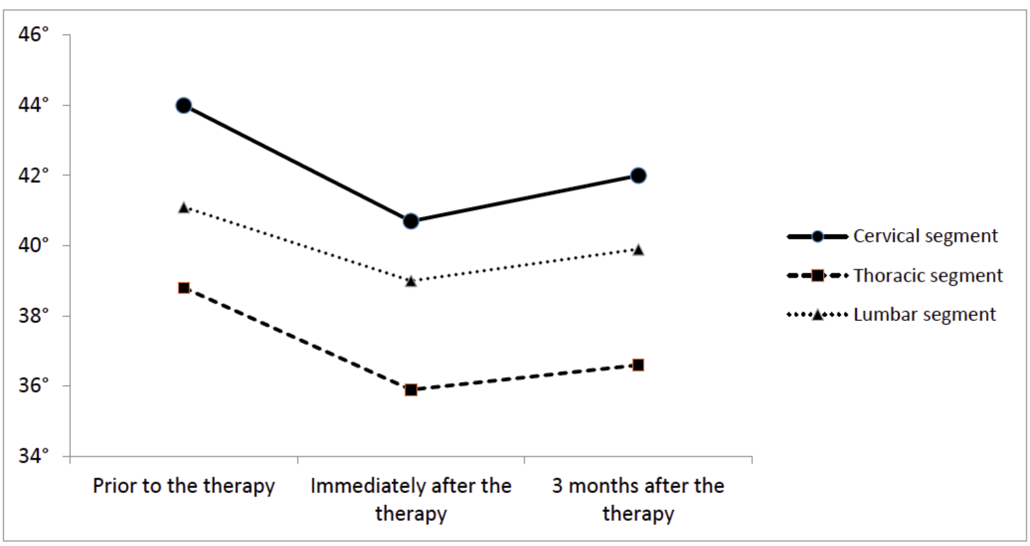


**Figure 2.** Comparative analysis of the degree values for physiological spine curvatures in the study group, determined three times: prior to the musculofascial therapy, immediately after the treatment and 3 months thereafter

and stomach muscles [20]. Thus, increased tension in the anterior part of the body, i.e. myofascial superficial front line, is particularly visible [1].

Myers [1] reported that human body may act as a tensegration construct. The term was coined by merging "tension" and "integrity." It stems from architecture and describes constructions maintaining their form and durability by maintaining constant balance between tension and compression. This balance ensures that the body is stable and functions properly. If the strain becomes too severe, the construction is damaged and not always at the spot where pressure was applied. Too great and prolonged strain (e.g. sports training) results in injuries and overstrain-related trauma. The ability to locate these overstrains, which are often far from where the symptoms occur (e.g. pain, fatigue, instability), is key for restoring balanced tension and preventing further injuries [1,2].

Correcting these changes is possible with the use of different myofascial therapies. Moore et al. [21] studied a group of professional baseball pitchers and showed that their subjects suffered from myofascial imbalance at the glenohumeral joint level. The effect of systematic activity of strong forces during throwing-movement has impinged internal rotation and horizontal adduction. The authors used Muscle Energy Techniques, which visibly restored the movement scope in the glenohumeral joint. The results of the study confirm the need for preventing myofascial tension patterns, which are characteristic for certain sports disciplines [21]. The abovementioned therapy is one of many myofascial techniques, right next to deep tissue and trigger points massage, and myofascial relaxation.

The authors of this paper stress the need for proper myofascial balance, which can affect the disorders of the degree values of spine curvatures. In the case of studied kick-boxers, cervical lordosis, cervical kyphosis, and lumbar lordosis deepened. The myofascial therapy used provided a remedy for the deepened curvatures right after the therapy and the positive effect was maintained for three months after completing the therapy. The greatest loss of the positive effect was recorded for the cervical and lumbar sections of the spine. These are the sections directly connected with taking position and using fight techniques during combat. Therefore, the authors suggest that persons training kick-boxing should use myofascial techniques aimed at loosening soft tissues, which constitute myofascial superficial front line, as part of their biological regeneration. It is noteworthy that the abovementioned methods are included in biological regeneration programs of different sports disciplines [21].

## CONCLUSIONS

Training kick-boxing can lead to an increase in degree values of spine curvatures, which in turn leads to overstrain-related changes in the motor system.

Using myofascial techniques should be an integral part of kick-boxers' biological regeneration program. The therapy should be aimed at loosening the myofascial superficial front line, which decreases the deepening of the spine curvatures.

The authors suggest further studies after a longer control period, in order to observe the degree and direction of the changes of degree values of spine curvatures. This knowledge will help to establish the effectiveness level of myofascial therapy for longer time span.

## COMPETING INTEREST

The authors declare that they have no competing interests.

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**Cite this article as:** Szulc P, Wendt M, Przydanek J et al. Evaluation of the effects of musculofascial therapy on the degree values for physiological spine curvatures, altered due to long-term kick-boxing training. Arch Budo 2015; 11: 209-215