THE INFLUENCE OF OSTEOPATHIC TREATMENT ON THE PERFORMANCE OF HOBBY RUNNERS

A COMPARATIVE STUDY USING OSTEOPATHIC TREATMENT TO ENHANCE THE PERFORMANCE OF HOBBY RUNNERS

Masterthesis – Osteopathy

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"All beginnings are difficult"…that is the common German idiom, or what it freely translates into, that I chose four months ago as the file name for what was to become my dissertation.
Nomen est omen. The idiom expressed all too well how difficult and slow my progress was with this project. Two months later I had written ten pages and lost my patience. I decided to try a psychological trick – I changed the file name to "well begun is half done"!

Surprisingly, this kind of self-hypnosis seemed to work and I began to make good progress. However, time was getting short as I was supposed to present my work in September 2004. I would now like to seize this opportunity to thank everybody who contributed to my finishing this project on time.

First of all, I would like to give very special thanks to my tutor Nick Marcer. He helped my with his vast knowledge and expertise and edited my work incredibly fast. Despite his busy schedule with extensive scientific work and preparations for the publication of his new book, he took his (night)time to monitor my work and provide feedback on my project. Without his valuable suggestions, particularly for conceptualisation, this study would not have been possible at all. It is always a pleasure for me to experience his British sense of humor. I also make a solemn promise never to present another study so late!

A talent for statistical analysis *and* osteopathic treatment does not necessarily always go together. I was therefore very glad to find an expert in Dipl. Ing. Dr. Gebhard Woisetschläger and would like to thank him for all the work and patience he put into my project.

I would also like to thank Mag. Österreicher for translating my dissertation in only two weeks. He was always available for questions and last minute changes and thus contributed to my finishing the project in the shortest time possible.

Dr. Karl Benesch, a sports scientist, provided the most important suggestions for testing procedures. I would like to thank him for the important input on testing routines and for letting me use his Tunturi ergometer.

MS. Andrea Mayrhofer is responsible for the attractive graphic design. Due to time pressure she took the work home and did the layout over the weekend.

My wife Elisabeth, who patiently supported me in this difficult and demanding phase, also deserves very special thanks. I truly admire her unshakable optimism and her believe in my perseverance. These her qualities were great inspirations for my work.

Last but not least I would like to thank all test persons for participating in the study. They all contributed substantially to the success of this study with their willingness to train regularly and observe a precisely defined regimen.

ANNEXES

1 INTRODUCTION

Osteopathic treatment usually aims at enhancing or restoring a state of health in the patient.

This clinical study is investigating an issue of indirect relevance in the conventional framework of osteopathy. The question asked in this study is whether osteopathic treatment can enhance the performance of athletes. Every practicing osteopath will be convinced that the answer to this question can only be YES, as restoring health is bound to increase athletic performance. The original inspiration to conduct this study stems from my work with hobby runners. These patients not only found relief from their aches and pains, they also claimed that my treatment increased their athletic performance.

Since I am a long distance runner myself (my time on the Marathon is 2h 59min), I was particularly interested in the question, whether osteopathic treatment could also enhance the performance of healthy individuals and whether relevant changes could be scientifically proven in the framework of a clinical case study. Another question concerns the effects of treatment on various fitness levels. It was my hypothesis that individuals with a relatively low level of fitness would benefit more from treatment than very fit athletes.

A confirmation of this hypothesis would not only be relevant for hobby runners but also provide a basis for using osteopathic methods to enhance the performance of professional athletes. Osteopathy could have a very positive effect on the performance of professional athletes by acting as a focal point for the various systems in the human body to create effective synergies for peak performance.

This would also confirm our healthy “service patients”, who return to our practices without actual problems, simply because they feel renewed and restored by our treatment, it is their conviction that osteopathy always promotes and enhances a state of health in a human being and therefore always increases performance as a positive side effect.

The main question of this study was therefore formulated as follows:

Can osteopathic methods increase the athletic performance of healthy hobby runners?

The main challenges in this study already became apparent in its conceptualisation. How could the general criterion of athletic performance, that really comprises a great number of parameters, be measured with a simple, cost effective and yet reliable GOLD-STANDARD test? After extensive investigation and countless discussions with experts I decided that the PWC 150 ergometer test, which will be described in greater detail below, was ideal for my objective.

Selecting suitable test persons proved to be even more difficult. In order to ensure a sufficient amount of finishers I required 20 individuals each for the test group and for the control group. I began to introduce my project in various runners clubs. My constant effort finally began to bear fruits and after six months and countless miles on the tracks I was able to begin the actual test series.

In addition to the objectively determinable criteria I was particularly interested in the question whether there was any correlation to be found between the test person's self assessment and their actual performance.

The surprising and interesting results to this question will be discussed at length further on. Since I was engaging in intensive research on this subject I was naturally curious to know whether any similar efforts had been made before in the field of osteopathy, physiotherapy or physical medicine.

Much to my surprise, hardly any studies had been conducted to investigate the effect of osteopathic treatment on healthy athletes.

The few research projects that had roughly similar objectives to my study will be discussed in detail and their results will be compared to those obtained in this study. This study seems to be one of the first research projects to examine the effects of comprehensive osteopathic treatment on the performance of athletes.

In my regular work as an osteopathic practitioner and in conducting this study I constantly tried to remind myself of the general objectives of osteopathy: The self-healing powers of the patient should be able to maintain, promote and continually restore a state of health in the human body. If this goal can be reached, treatment will be successful and all other positive changes are welcome side effects. In the framework of this study I examined these positive side effects and would like to present the results to the interested reader.

I hope that this study provides interesting reading and contributes to expanding osteopathy's range of application for amateur and professional sports.

2 BASICS AND PRECONDITIONS FOR THE STUDY

In the subsequent chapters I mainly refer to Zintl[1] and Martin & Coe[2].

2.1 PERFORMANCE PARAMETERS

Before I began to think about a suitable testing procedure I had to define the osteopathic, anatomical and physiological basis for improving performance in fit and healthy hobby runners through osteopathic treatment.
As a basis for treatment, we must first analyse the parameters that need to be improved in order to achieve athletic endurance. According to Zintl[1], endurance sports involve the organ systems of the musculoskeletal system, circulatory system, respiratory system, and the entire nervous system.
According to Weineck[3], these organ systems can be attributed to three main functional areas. The first involves the storage and supply of energy in the runner's body. The second group contains all the parameters relevant for efficient energy transfer to the ground. The third aspect includes psychological factors that influence performance.
The runner's full potential can only be realized if each and every one of these aspects is improved.

2.1.1 ENERGY STORAGE AND ENERGY SUPPLY

In the subsequent chapter I mainly refer to Hollmann and Hettinger, 2000[4].

Training leads to a variety of adaptive changes in the athlete's body that improve fitness and running performance.

[1] Zintl, 1997
[2] Martin & Coe, 1995
[3] Weineck, 1990
[4] Hollmann, Hettinger, 2000

These are the most important points for enhancing performance:

1.According to Martin & Coe[2] the biochemical processes of adaptation at a cellular level lead to an increase in the concentration and size of mitochondria and to higher enzyme activity, which in turn increases the synthesis of glycogen.

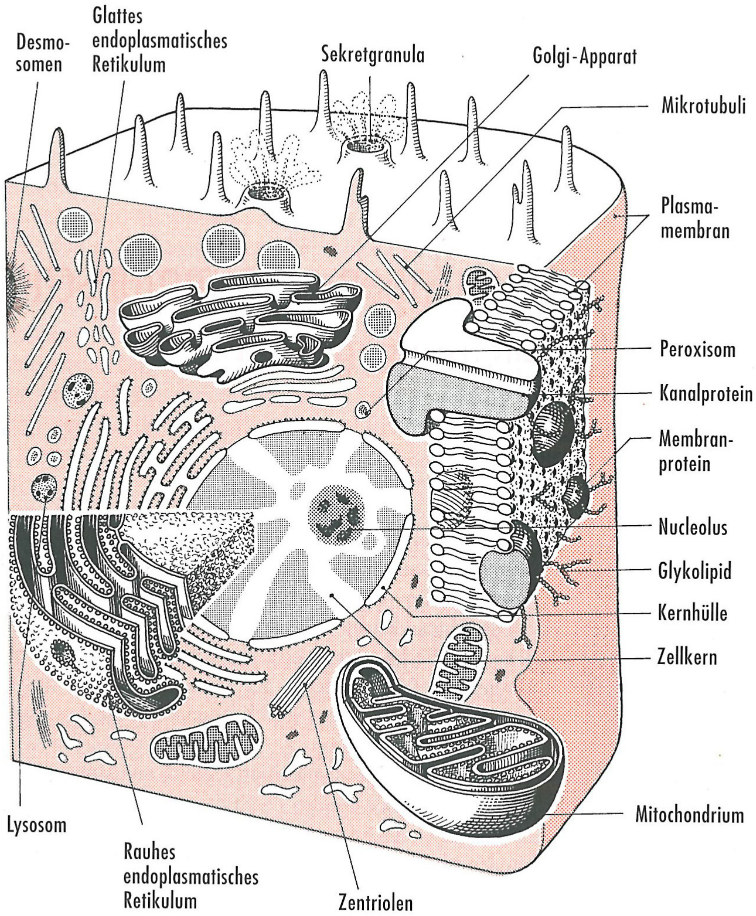

Illustration1: Structure of a cell

Energy is produced in the cells through the release of chemically stored energy. In this process, the chemical substance adenosine triphosphate (=ATP) is converted into adenosine diphosphate (=ADP) by releasing phosphate. Releasing energy by breaking up ATP into ADP is the universal form of energy production in the human body. All vital functions of the body (maintaining a constant temperature, membranous functions, maintaining cell structures, mechanism of active transport, etc.) depend on the availability of ATP. In the muscle cell, this energy is used predominantly for muscle contraction. During a regular day of work we use up approximately 25-30% of available energy for muscle activity.

[2] Martin & Coe, 1995

Depending on requirements, energy can be made available in a variety of ways but is always based on breaking down ATP. The illustration below shows different muscle reactions depending on the required type of performance, namely short term peak performance, prolonged high intensity or long term low intensity.

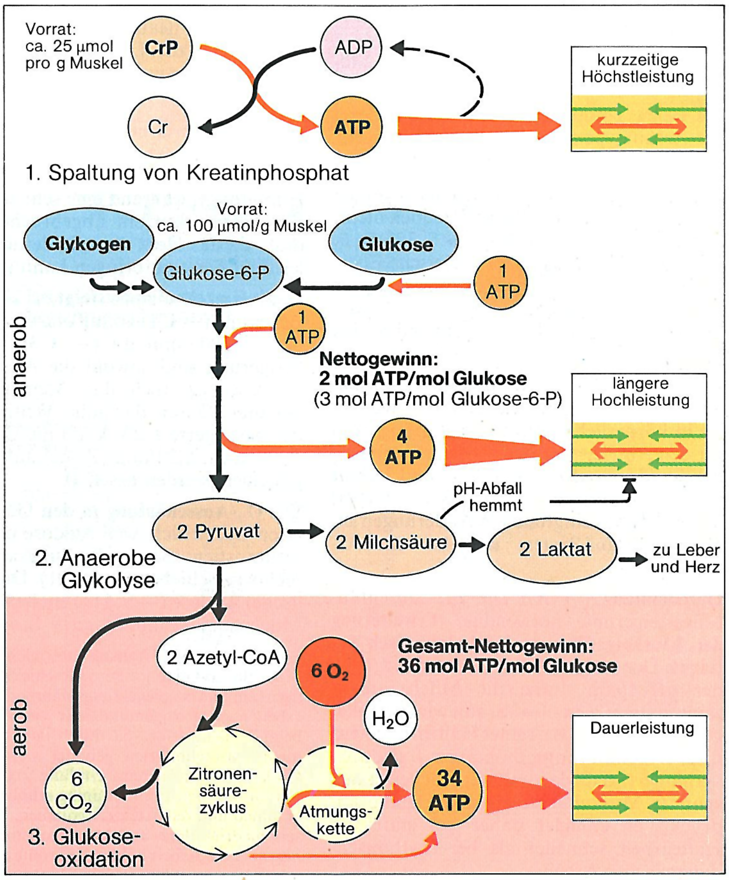

Illustration 2: Short term peak performance, prolonged high intensity and long term low intensity

This illustration shows how creatine phosphate stored in the cell is broken down to create ATP without the help of oxygen (O_2) for short term peak performance. This anaerobic energy production can be maintained for a maximum of 20 seconds of muscular contraction.

The largest part of energy is produced by breaking down glycogen stored in the cell in the process of glycolysis. Glycogen is composed of several molecules of glucose (= dextrose). Energy can be released from glucose both in anaerobic as well as in aerobic (oxidation) reactions. See illustration 2.

2. Biochemical adaptations of the entire metabolism are expressed mainly in hypertrophy of the hormone producing endocrine glands and in increased sensitivity towards hormone concentration in the blood. The body of a trained athlete therefore responds better to a certain type of hormone concentration than that of an untrained person[5]. Zintl mentions the following relevant hormones:

- Somatotropin (STH) from the hypophysis
- Thyroxin (T3/T4) from the thyroid gland
- noradrenaline and adrenaline from the adrenal medulla and the ganglia of the sympathetic trunk
- aldosterone and cortisol from the adrenal cortex
- Insulin from the pancreas

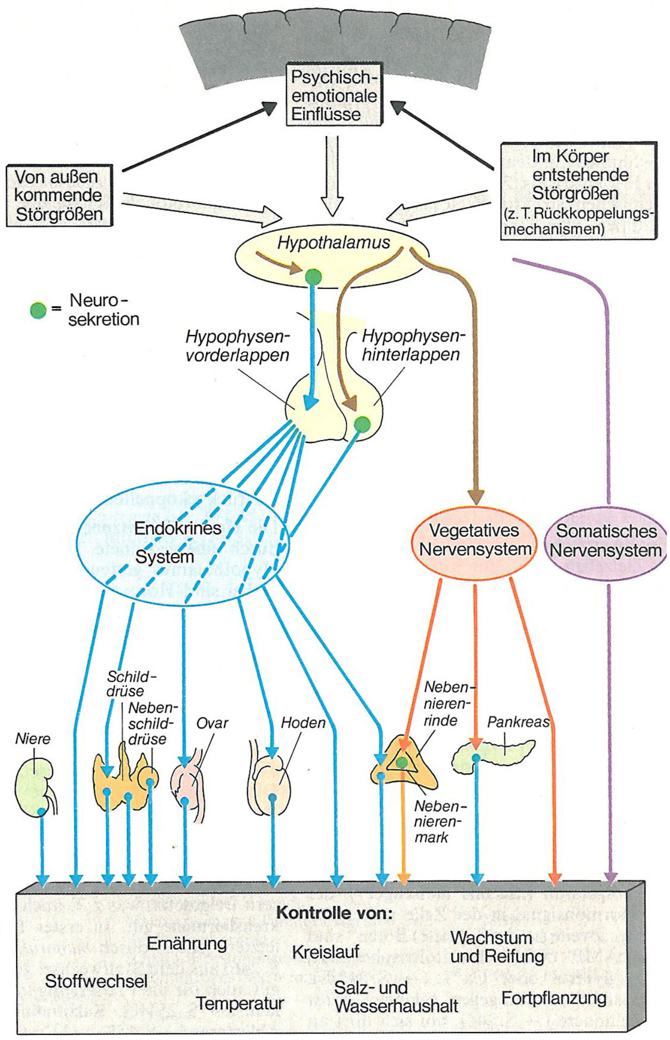

Illustration 3: control of vegetative functions

[5] Zintl, 1997

3. Adaptations of the cardiovascular system improve gas exchange in the lungs, increase cardiac output, regulate oxygen transport in the blood and enlarge the capillary bed in the intersticial tissues. In order to evaluate gas exchange in the lungs of athletes, sports science measures maximal oxygen uptake (VO2 max) in unit time. According to Haber[6], untrained individuals aged between 20 and 30 years typically reach VO2 max values around 3 l/min. This value can be raised through conditioning and reach up to 7 l/min in top athletes!

Endurance training of sufficient intensity and duration can produce an "athlete's heart". The athlete's heart is characterized by increased cavity dimensions and heart wall thickness (hypertrophy of the heart walls).[7] The critical heart weight of approximately 500g is, however, never exceeded as this would threaten proper blood supply of the myocardium. The heart of untrained individuals typically weighs between 250 and 300g. Heart volume can be increased through training from 700 to 800ml to a maximum of 1600ml in extreme cases. Based on these factors, Haber[8] describes a possible increase in cardiac output from a normal value of 4.5 l/min up to 20l/min, i.e. by the factor 4.5.

Enhanced oxygen transport is achieved in endurance athletes through an increase in absolute blood volume. According to Hollmann & Hettinger[9], absolute blood volume in athletes reaches up to 8.3 l compared to an average of 5-6 l in untrained individuals.

Capillarisation of skeletal musculature increases significantly in endurance athletes.[10] Local blood supply to the musculature increases during exercise by the factor 15 to 20 compared to values at rest. Training also leads to improved regulation of blood flow. [11]

2.1.2 ENERGY TRANSFER TO THE GROUND SURFACE

An efficient running technique plays a major role in energy transfer. This factor was, however, not directly assessed in this study. Full range of motion in all articulations of the lower extremity, the pelvic girdle and vertebral column are a precondition for

[6] Haber, 2001
[7] Neumann & Schüler, 1994
[8] Haber, 1978
[9] Hollmann & Hettinger, 2000
[10] Martin & Coe, 1995
[11] Strauzenberg & Schwidtmann, 1976

efficient energy transfer to the ground surface thus optimising the locomotive force. Releasing dysfunctions in these areas should lead to a more balanced energy transfer and therefore optimise running technique.

2.1.3 PSYCHOLOGICAL FACTORS

The motivation to train hard up to maximum intensity plays an important role, particularly for professional athletes. In the case of amateur athletes and in the framework of this study I was interested whether the test persons experienced any positive stimulus from participating in the study. The statistical evaluation of the questionnaire should also provide insights with regards to this factor.

3 COMPARISON WITH OTHER STUDIES ON ENHANCING PERFORMANCE IN HEALTHY ATHLETES WITH THERAPEUTIC MEASURES

3.1 OSTEOPATHIC STUDIES

Many osteopathic studies are dedicated to treating athletes. Some of these studies focus on running and examine topics such as “Pulmonary Function Alterations Subsequent to Running a Marathon“[12], or “Recovery of Heart Rate after Running and Skiing“[13] from an osteopathic point of view. In 1990, a team of the American Osteopathic Academy of Sports Medicine even looked after the participants of the Boston Marathon[14]. During my research I discovered two papers by teachers of the British College of Naturopathy and Osteopathy in London who investigated therapeutic and passive measures to increase muscle strength. The question is, however, up to which degree these studies can be attributed to the field of osteopathy. Since there are no osteopathic papers on the general improvement of performance in healthy athletes, I would like to present these two studies.

Tanya Lipman and Nick Waters conducted a clinical study in 2002 to investigate the effect of hydrotherapy with hot and cold water on the contractility of the biceps brachii

[12] Doerr & Miles, 1984
[13] Friedmann, 1987
[14] Collins, 1991

muscle.[15] Their hypothesis was that hydrotherapy could enhance the physiological function of this muscle. This expected improvement was evaluated by measuring muscle strength. 40 test persons participated in the study (20 men and 20 women). The test persons were divided in two groups of 20 individuals each. The members of the test group were treated with compresses that were applied to the biceps. Hot (3 min) and cold (1 min) compresses were applied alternately during a total of 12 minutes. The control group was not treated and rested for 12 minutes. Before and after each 12 minute period, both groups were tested with a Cybex Norm Isokinetic Dynamometer (60 and 120 degrees per second). The maximum torque (Nm) and acceleration up to the defined dynamometer speed were measured. Comparison of test results showed a significant increase in maximum torque (0=88%) for the test group after treatment, both at 60° and at 120° per second. The control group exhibited a significant (>0.5) decrease of maximum torque (0=94%) at 60° and (0=95%) at 120°. The acceleration rates also increased in the test group after treatment. Hydrotherapy therefore offset the effect of fatigue measured in the control group and even led to improved performance in the second test, not only in maximum torque but also in acceleration. This test provides evidence for the hypothesis that hydrotherapy can enhance muscle function through changes in muscle metabolism.

In a follow-up study, Sweatal Shah and Nick Waters[16] examined the effects of soft tissue techniques and hydrotherapy on muscle functions of the biceps brachii muscle. The same setup was used for the test. The only difference was that only a single speed protocol was used with 60° per second. 15 test persons participated in the study, both as members of the test group and the control group. The strength of the biceps brachii muscle was measured three times before and after soft tissue treatment (effleurage, kneading and hacking) and hydrotherapy (as in the first study). The control group took a 12 minute rest between the first and the second test. This time only maximum torque was measured. Both hydrotherapy and soft tissue techniques significantly increased ($p<0.05$) maximum strength of the biceps in the second test. Soft tissue techniques and hydrotherapy led to an average increase in strength of 9%. The control group showed a non-significant decrease in maximum

[15] Lipman & Waters, 2002
[16] Shah & Waters, 2003

strength of – 7%. This study confirms the results on an increase in maximum strength through hydrotherapeutic treatment obtained earlier by Lipman and Waters[17]. It also confirmed that therapeutic treatment may create an increase in maximal performance of a muscle.

3.2 OTHER STUDIES

In my search for studies that investigated the effects of passive physical therapies on the athletic performance of test persons I could identify two main areas in sports medicine.

The first examines the effects of pre-cooling treatments on athletes. Whereas the two osteopathic studies presented earlier examined the effects of passive hot and cold treatments, these studies focus on kryotherapy.

Dae Taek Lee and Emily Haymes[18] examined the effects of whole body pre-cooling on the performance of 14 trained male runners. The runners were tested twice on a treadmill, once after a cooling phase of approximately 33 minutes and another time after a rest of 30 minutes at normal room temperature. The temperature during cool down was 5°C. The mean interval between the end of the rest period and the beginning of the exercise was 10.5 min for the normal condition and 16.1 min for the hypothermic condition (transient period). After the transient period the subjects mounted a treadmill and ran at 82 % VO2 max in 24°C air to exhaustion. Beside many measured changes in metabolism, the average exercise duration in hypothermic condition was significantly longer at 26.2 min. ($p<0.01$) than under normothermic conditions (average exercise duration 22.4min).

D. Kay et al.[19] investigated the impact of whole-body pre-cooling during self-paced cycling performance in warm humid conditions. Seven moderately trained cyclists (males) performed a 30 min. self-paced cycling trial on two separate occasions. The first test was for control purposes while in the second test whole body pre-cooling by water immersion was used to reduce skin temperature during rest by 5 – 6°C. The results showed that heat storage increased from an average of 84 $W.m^{-2}$ to an

[17] Lipman & Waters, 2002
[18] Lee & Haymes, 1995
[19] Kay et al., 1999

average of 153 $W.m^{-2}$. The distance cycled during the 30 min test time increased from 14.9 km to 15.8 km ($p<0.05$).

In a similar study with cyclists, D. Marsh and G. Sleivert[20] examined the influence of pre-cooling on high intensity cycling performance. Thirteen male cyclists who competed at national and international levels were tested in random order after 30 min. of pre-cooling by cold water immersion during 30 minutes and a second time under control conditions (without pre-cooling). The protocol consisted of a 10 min. warm up at 60 % of VO_2 max. After three minutes of stretching, a 70 sec. power test was taken on a standard road bicycle set up as a stationary ergometer. The results showed a significant increased in performance ($p<0.05$) of 3.3 % from 581 Watt to 603 Watt.

J. Schniepp et al.[21], however, could not confirm the results of the previous study with their experimental design. They tested ten well-trained cyclists on an ergometer . All participants were tested both under control and experimental conditions. The test persons had to perform two maximum effort sprints for approximately 30 seconds. For test purposes they were then immersed in water with a temperature of 12° up to the iliac crest during 15 minutes while for control purposes they took a 15 minute quiet sitting rest. Maximum and average power showed a significant (p0.001) decline by 9.5 % for the experimental condition, whereas the control condition declined by 2.3 %.

The second important area of passive performance enhancement is in the biomechanical and physiological effects of oscillating mechanical stimulation. The use of mechanical vibrations to increase performance was introduced by V.T. Nasarov & G. Spivak[22] in 1987. In this manuscript they describe the positive effects of such treatment on strength, circulatory system, coordination, and articular mobility. Manual vibration is also used in osteopathy. Bernhard Ligner[23], for instance, recommends vibration to treat reduced range of motion of the shoulder and hip joint.

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20 Marsh & Sleivert, 1999
21 Schniepp et al., 2002
22 Nasarov & Spivak, 1987
23 Ligner, 2004

He also uses vibration in the area of the inferior thoracic aperture to release tension of the diaphragm.

In a study conducted in 2002, C. Delecluse et al.[24] describe an increase in strength after whole body vibrations (WBV) in resistance training of human knee-extensors. Sixty seven untrained females participated in the study during a 12-week period, and were divided into three groups. The WBV-group performed static and dynamic knee extensor exercises on a vibration platform. The placebo group performed the same exercises but received much lower vibrations. The resistance training group worked their knee extensors with a dynamic leg-press and leg extension exercises. Measurements taken with a motor driven dynamometer showed significantly increased strength in isometric and dynamic knee extension exercises for the WBV-group and the resistance training group (WBV-group in average +10.8 % and +3.2 %, resistance training group in average +5.3 % an +6.2 %).

J. Künnemeyer & D. Schmidtbleicher[25] examined whether vibrations on the pectoralis major muscle could improve the mobility of the shoulder joint. 112 fit and healthy hobby athletes were divided into three groups for this study. The first group received rhythmical vibration treatment in the area of the pectoralis major muscle. The second group performed a conventional stretching programme of the pectoralis major muscle, while the third group was used as the control group. In both test groups the range of motion increased by highly significant values. Group one showed an average increase in mobility of +5° while the second group, who performed stretching exercises, increased its mobility by +3.7%.

In a study by C. Bosco et al.[26] designed to investigate the hormonal responses to whole body vibrations, 14 male subjects were treated with 10 min. of WBV. Before and after treatment the subjects performed a test consisting of counter-movement jumps and maximal dynamic leg presses on a slide machine. Apart from hormonal changes similar to the reaction to explosive power training, the average Watt output

[24] Delecluse et al., 2002
[25] Künnemeyer & Schmidtbleicher, 1997
[26] Bosco et al., 2000

on the slide machine increased significantly by 7 % and the jumps showed a significant improvement of 4.9 % in average height.

V. B. Issurin et al.[27] tested vibratory stimulation on target muscles. Twenty-eight male athletes were divided into three groups and trained three times a week for three weeks under following conditions: the first group did conventional exercises for strength of the arms and vibratory stretching exercises for the legs. The second group performed vibratory stimulated strength exercises for the arms and conventional stretching exercises for the legs, whereas the third group performed irrelevant training (control group). The vibratory stimulation strength training yielded an average increase in isotonic maximal strength of 49.8 %, compared with an average gain of 16% with conventional training.

In an extensive review of biomechanical and physiological effects of oscillating mechanical stimulation, Haas et al.[28] also mention a number of studies which do not show any improvement or even a decrease of strength. In their summary these authors draw the conclusion that the results of these studies do not provide any clear indication of the effectiveness of WBV.

[27] Issurin et al., 1994
[28] Haas et al., 2004

4 OSTEOPATHIC TREATMENT

In this chapter I would like to introduce the definition of osteopathy according to H. M. Wright[29]:

"Osteopathy is at the same time philosophy, science and an art. Its philosophy is expressed in the concept of union of structure and function of the body, in health as well as in illness. Its science comprises the chemical, physical and biological sciences that help promote health as well as prevent, cure and alleviate illnesses. Its art is the application of philosophy and science in practical osteopathic work."

4.1 OSTEOPATHIC PRINCIPLES

Dr. Andrew Taylor Still, the founder of osteopathy, originally chose the name for his method of treatment because through the examination of bony structures he was able to detect undue tension in the tissues of the body, which he tried to relieve trough his therapeutic work.

He defined the principles of osteopathy that form the basis of osteopathic work.

1. Life is Movement.

Movement is the basis and the fundamental expression of life. Movement must be possible at all levels of the human body, from initial cell fusion until the end of life.

Movement is expressed in a variety of ways: it is present in each and every cell, each nerve stimulation is caused by moving ions, each organ has its peculiar form of movement (motility). The absence of movement is always a cause of disease.

2. Structure and Function Influence Each Other.

The mutual influence of structure and function is present at all levels of the human body.

- At a cellular level between the cells and the surrounding interstitium.
- At a biochemical, hormonal and electrophysiological level between tissues and organs.

[29] Wright, 1976, 7

- At a neurological level in information transfer through peripheral and central nerve tracts.
- In circulatory movements of blood and lymphatic vessels as well as in the CSF due to the course of all these fluids.
- At a membranous level through fascial-ligamentous relationships between the organs and tissues.
- And finally on a mechanical level between articulations, muscles and bones.

A change in function caused by undue strain, for instance, can lead to deformation of the structure affected, and degenerative structural damage will lead to restricted function.

3. The Body is a Unit of Function.

Osteopathy considers all parts of the physical body, the mind and the spirit to be interconnected and interdependent. All cells, tissues and organs work together and must be considered an organic unit, in health as well as in illness. Therefore, each osteopathic intervention that concerns an organ or organ system always influences the entire body and contributes to harmonizing all areas of the body.

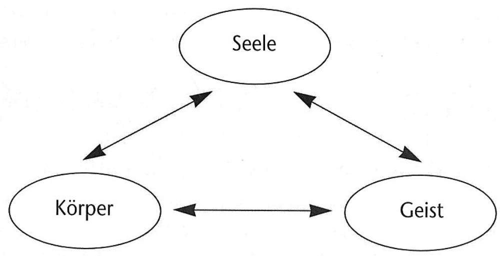

Illustration 4: Interdependance of body, soul and spirit

4. The Law of the Artery.

The uninhibited transport of all body fluids (blood, lymph and CSF) is a precondition for health. Any restriction of circulation damages tissues in two ways. Firstly, the restriction results in decreased supply with nutrients and oxygen. And secondly, the blockage inhibits proper drainage of metabolic by-products that can result in intoxication.

5. Mechanisms of Self Healing

Our body has at its disposal a large repertoire of regenerative measures.
These powers of self healing are expressed in:

- the automatic regulation of the organism's entire biological functions
- in the immune functions of the body that eliminate pathogens (bacteria, viruses, and fungi)
- in repairing damaged tissues
- in correcting damages caused by external mechanical influences
- in mechanisms of compensation in the case of irreparable damage
- also with regards to psychological functions when trauma is processed ("time heals wounds")

The efficiency of these self healing powers depends on genetic and environmental factors, diet, lifestyle, and particularly on a positive attitude to life[30]. Osteopathic treatment supports the organism's self healing powers and promotes mechanisms of compensation in the case of irreparable damage so that the body is able to heal itself.

4.2 OSTEOPATHIC DYSFUNCTION

My hypothesis, that osteopathic treatment of healthy hobby runners could increase their performance capability, is based on the concept of osteopathic (or somatic) dysfunction. This definition was derived from the concept of the osteopathic lesion.
Although Still never spoke of osteopathic lesions, this term has been used since the early years of osteopathy. In the 1960's it was recognized that this term referred too specifically to a certain region of the body and neglected the patient as a complex organism.
It also indicates the presence of ill tissue with all resulting consequences (swelling, reddening, raised temperature, pain, restricted function).
Osteopathic somatic dysfunction, however, indicates structural abnormity that does not necessarily cause pain but may result in reduced performance. Often there is no

[30] Sammut & Searle-Barnes, 2000

perceptible change in the general condition of the patient. This changes the physiological relationships within a tissue or between various organ structures.

Structural abnormity may be caused by a number of endogenous or exogenous factors.

For instance, according to Liem[31] trauma, intrauterine influences, effects of serious illnesses, surgery, vaccinations, scars, dental surgery, psychological shock, diet are all possible factors.

An osteopathic lesion can become manifest

- in all areas of the musculoskeletal system
- in fasciae, meninges, diaphragms
- and in all organs.

After the acute symptoms are relieved, the tissue may remain restricted in its mobility which often goes unnoticed by the patient. Without directly causing symptoms, these dysfunctions may influence other tissues and lead to problems in totally different areas of the body.

Still describes these correlations in his autobiography with the following words:

"Cause and effect are perpetual. Cause may not be as large in the beginning in some cases as in others, but time adds to the effect until the effect overbalances cause, and the end is death. Death is the end or the sum total of effects.“ [32]

The most commonly known of such lesion chains are the effects of inversion trauma of the ankle, as Liem[33] describes it. If the right ankle joint is affected, this trauma can cause the right fibula to shift caudally and anteriorly. This puts tension on the biceps femoris muscle, which in turn causes the pelvis to tip over posteriorly via the right ischial tuberosity. This can cause tension on the right side at the psoas and quadratus femoris muscle. Prolonged hypertonus of these muscles can cause scoliosis of the lumbar spine. The sacrospinous and sacrotuberous ligaments may also be stretched, which influences the mobility of the sacrum. Altered biomechanics of the pelvis may cause a variety of problems over time ranging from bladder dysfunction to indigestion and, naturally, trouble in the area of the lumbar spine.

[31] Liem, 1998
[32] Still, 2001, 202
[33] Liem, 1998

The various dysfunctions are named as follows according to the tissue of origin and the direction of the lesion chain:

- Somato-somatic dysfunctions
- Somato-visceral dysfunctions
- Viscero-somatic dysfunctions
- Viscero-visceral dysfunctions

In his book “The Cranial Bowl”, Sutherland[34] already describes osseous and membranous lesions of the cranium. Magoun[35] mentioned fluid, membranous and osseous dysfunctions on the craniosacral level in 1966.

<u>Fluid Dysfunctions</u>

The term fluid dysfunctions denotes pathological alterations of the cerebrospinal fluid concerning its rhythm, composition and volume.

<u>Membranous Dysfunctions</u>

Membranous dysfunctions comprise pathological changes of membranous structures in the craniosacral system, such as the brain and spinal meninges, as well as the dural sheaths of the cranial and spinal nerves.

<u>Osseous Dysfunctions</u>

The term osseous dysfunctions is used to describe all pathological dysfunctions that concern the osseous skull and the sacrum. This condition may affect the position, structure and physiological mobility of each individual bone in the cranial system. Osseous dysfunctions can affect the cranial nerves, the vascular system of the brain, the brain itself and particularly the pituitary gland. The pituitary gland has a central influence on the endocrine system. The endocrine system is of particular importance for athletes.

In view of these preconditions, the presence of osteopathic dysfunctions could also result in reduced performance in otherwise healthy athletes. Conversely, a healthy athlete should be able to make better use of his or her potential after resolving osteopathic dysfunctions. As an osteopathic practitioner I now tried to identify those

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[34] Sutherland, 1939
[35] Magoun, 1966

dysfunctions responsible for reduced performance in runners so that I could then treat them in order to increase the runner's athletic performance. According to chapter 2.1 there would be two main functional areas to correct.

4.2.1 DYSFUNCTIONS THAT CONCERN STORAGE AND AVAILABILITY OF ENERGY

The objective of my osteopathic work in this area was first and foremost to enhance oxygen uptake, transport and release in the body.

Oxygen uptake:

Oxygen (O_2) is absorbed in the lungs through ventilation and distribution of the air we breathe and by diffusion of oxygen through the alveolar walls into arterial blood vessels.

Osteopathic treatment of the following structures can enhance oxygen uptake in the case of dysfunctions:

- Mobility and motility of the lungs and the visceral pleura
- Mobility and motility of the diaphragm and the pleural attachment
- Mobility of the osseous thoracic cage and the parietal pleura
- Mobility of the cervical spine and thoracic spine

Oxygen Transport

My next considerations were how I could osteopathically improve oxygen uptake and thus also blood transport. Obviously, the main factor for good O_2 transport was the stroke volume of the heart. I asked myself through which structures I could influence the function of the heart.

Osteopathic methods for testing and correcting heart function can be found on various levels:

- Pericardial ligaments and fasciae
- Diaphragm
- Sympathetic trunk and the corresponding segments of the vertebral column
- Parasympathetic system – course of the vagus nerve at the jugular foramen

The following illustration shows how all the fascias are tightly interconnected especially in the area of the chest.

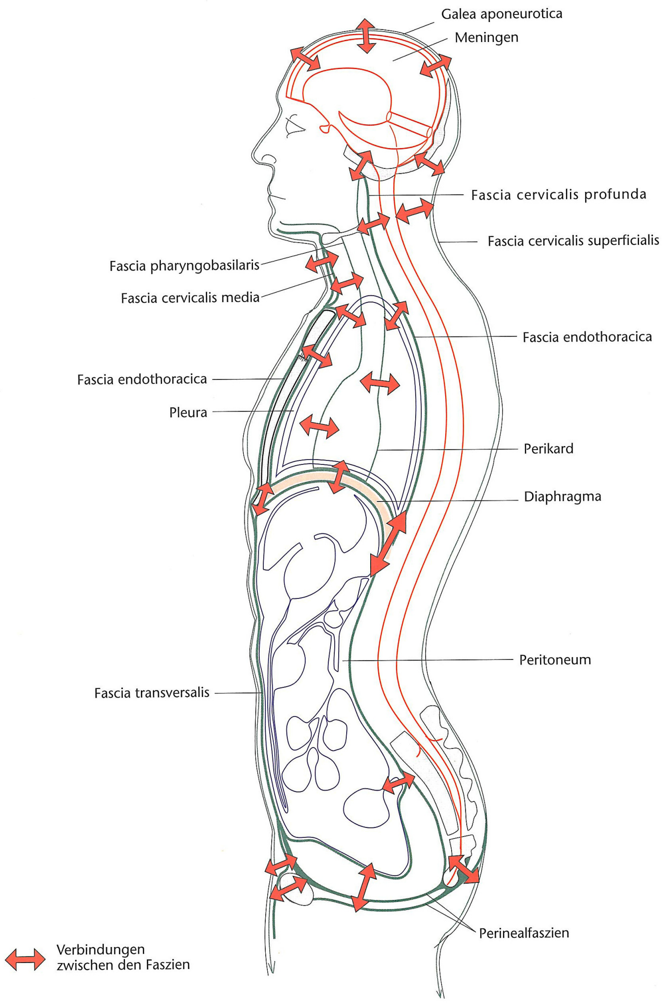

Illustration 5: Connections of fascia

Oxygen Release to the Muscles

This function can be improved mainly through reducing tension in the muscle tissue. Increased muscle tone always reduces blood supply (capillarisation), which reduces oxygen diffusion into the muscle cells.

4.2.2 DYSFUNCTIONS CONCERNING ENERGY TRANSFER TO THE GROUND SURFACE

This category comprises all osteopathic dysfunctions that concern the length of stride, support and weight distribution on the soles of the feet, mobility of the pelvic ring and the mobility of the thorax upon the lumbar spine.

The following areas were tested and treated if necessary:

- all articulations of the lower extremity
- muscle tone
- sacroiliac joint and pubic symphysis
- thoraco-lumbar transition and the segments of the lumbar spine
- fasciae of the lower extremities, the pelvis and the lumbar spine
- the mobility of the nervous system in the lower extremities

5 METHODOLOGY

5.1 STUDY DESIGN

The members of the test group received osteopathic treatment three times at intervals of 14 days. Before each treatment, their personal fitness level was assessed by means of a PWC 150 ergometer test with a **Tunturi T6 – Alpha 300 bicycle** ergometer. The heart rate was measured with a Polar heart rate monitor and displayed on the Alpha 300 computer. The tests were conducted at room temperature between 22 and 24°C. The test persons performed the test in running shoes and were strapped to the pedals of the ergometer. The saddle height used in the first test was recorded for each test person and the same adjustment was used for all following tests. One month after the third treatment, the ergometer test was repeated in order to check the sustained effect of the treatment.
The performance of the control group was measured in the same way and at the same intervals as that of the test group. However, the members of the control group did not receive osteopathic treatment. Tests and treatment were performed by the author of this study.

<u>Intervals Between Treatments and Duration of the Study</u>
The interval of 14 days between treatments was chosen for practical reasons. I was not sure whether two week or three week intervals were more effective. On average, I usually treat chronic illnesses at intervals of three weeks, whereas patients suffering from acute illnesses receive treatment once a week. The interval of 14 days was

chosen to keep the duration of the study as short as possible for each participant in order to reduce the possibility of subjects withdrawing from the study.
The subjective duration of the study was two months for each participant. The largest part of tests and treatments were performed between the middle of September 2003 and the end of November 2003. Four participants had to postpone their initial test so that they did not finish the entire test program until December 2003.

5.2 GROUP FORMATION

As required in a clinical study, a test group and a control group was recruited. They were recruited from hobby runners of various running clubs and by word of mouth among friends and patients. The groups represented a balanced mix with regards to age and fitness level.

As a basic assessment of fitness, the test person's own measured or estimated running performance was used (see questionnaire in the appendix). The basis for this evaluation was the last Marathon or Half Marathon finishing time. Among male participants, the first group had finishing times of up to three hours. The second group was formed by runners with a finishing time between three and four hours. All other runners were assigned to the third group. The female participants also formed three groups with their finishing times exceeding those of the male group by 30 minutes. In the case of those few participants who had finishing times for the Half Marathon, the requirements were reduced by 50%. The minimum number of test persons required by the Vienna School of Osteopathy was ten individuals per group. In order to obtain a sufficient number of participants who would actually finish the entire testing procedure, the study was started with 20 hobby runners for each group.

Three persons dropped out of the test group and six persons left the control group before the end of the study. The reasons for dropping out were health problems (respiratory disorders common at this time of the year) and professional obligations that interfered with training programs. The test group therefore comprised 17 individuals (10 men and 7 women) and the control group 14 (10 men and 4 women).

5.2.1 CRITERIA FOR INCLUSION

- healthy hobby runners, female and male
- regular running training, at least once a week for a minimum duration of 60 minutes
- **observing a constant training program of their own choice throughout the entire duration of the study (very important)**
- age between 20 and 45 years
- no change of diet during the study

At the beginning of the tests, the amount of training chosen by the participants was recorded (see annex 5) and a disclaimer (see annex 4) was signed to make sure that all participants had understood the objectives of the study and would maintain their chosen training regimen throughout the entire period of the study. The participants also confirmed that they felt physically fit and healthy and promised not to change their diet during the study.

5.2.2 GENERAL CRITERIA FOR EXCLUSION

The criteria for exclusion were defined in order to reduce external influences to a minimum and to keep the group as homogenous as possible.

- professional runners were excluded. Professional runners were defined as athletes who were no longer able to work full time, due to the amount of time they dedicated to training.
- participants were only accepted if they did not suffer from cardiac or pulmonary diseases at the beginning of the study.
- participants had to agree not to undergo any other form of treatment for the entire duration of the study. Furthermore, they were not allowed to use any dietary supplements or to follow any special diets.

5.2.3 CRITERIA FOR EXCLUSION DURING THE STUDY

The following criteria for exclusion were defined in order to ensure consistency in training and avoid erroneous test results:

- illnesses and
- injuries

that interrupted the regimen, changed the amount of training or its intensity.

5.3 OBJECTIVE PERFORMANCE DIAGNOSIS

The aim of objective diagnosis was to evaluate the test person's performance as independently as possible of subjective influences such as personal readiness for performance, and external factors such as race course, weather conditions and outside temperature.

Therefore, a Cooper Test, that involves 12 minutes of running, was not considered a suitable method[36]. This test means running for 12 minutes as fast as possible, to achieve a very long running distance. The measured distance should show the performance capability of the tested subject. The Conconi Test is also a running test and fairly reliable for determining an athlete's performance capability[37]. However, this test requires an all out effort from the athlete and was therefore not acceptable without any medical supervision.

Finally, the PWC 150 ergometer test (PWC = physical work capacity) was chosen as a suitable method, particularly to measure the general performance readiness under exclusion of external and personal influences.

5.3.1 BASICS OF ERGOMETRY

Ergometry is a method of measuring performance. The result expresses the endurance of an organism. Depending on the form of energy generation in the muscle cell (see chapter 2.1.1.) both anaerobic and aerobic endurance can be tested by ergometry. In the case of hobby runners only aerobic endurance is relevant.

In order to test general endurance, a device must be used that requires the athlete to use at least one sixth of his or her entire muscle mass. This device must allow calibration and provide exact measurements in Watts. Apart from special types of ergometers such as rowing, cross country skiing or canoe ergometers, the devices

[36] Cooper, 1984
[37] Conconi, 1982

most commonly used in the USA and Europe are treadmills and cycle ergometers. For Haber[38] this type of movement required by these machines is not specific, the result is meaningful with regards to general endurance and only influenced by the quality and amount of endurance training. The test measures adaptive reactions of the circulatory system to this type of training.[39]

In his standard work on ergometry, Mellerowicz[40] describes the method as follows: "Ergometry is a safe method of assessing physical performance capability. The test fulfils the requirements of being objective, safe for test persons and providing reproducible results."

5.3.2 PWC 150 ERGOMETRY TEST

The PWC 150/170 test is recommended by the WHO, not only as the standard test for measuring the physical condition and endurance of athletes but also for general testing of the cardiovascular system (exercise test).[41] The test uses increasing load steps. The general protocol contains a series of rectangular steps (increasing resistance) without a pause in between steps. This resistance is measured in Watts, the internationally used unit to measure power. Over time, various methods were developed for load duration per step and for increasing resistance in Watts per step.

The following diagram is a graphic representation of the step test. The x-axis shows step duration and the y-axis Watts per step.

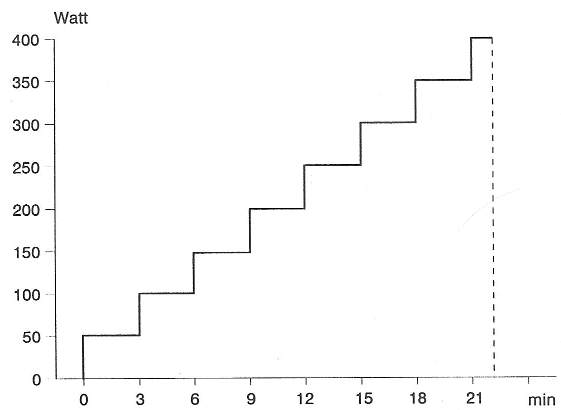

Illustration 6: Step Test for well trained athletes

[38] Haber, 2001
[39] Haber et al., 1978
[40] Mellerowicz, 1979
[41] Neumann & Schüler, 1994

Testing Procedures

The initial resistance depends on individual fitness level and usually ranges between 25 and 50 Watt. Every two to three minutes, resistance is raised by 25 to 50 Watts. The heart rate is then measured at the end of each step. Resistance is raised until the predetermined heart rate is exceeded. It is this maximum heart rate that the test names, PWC 130, PWC 150 or PWC 170, refer to.

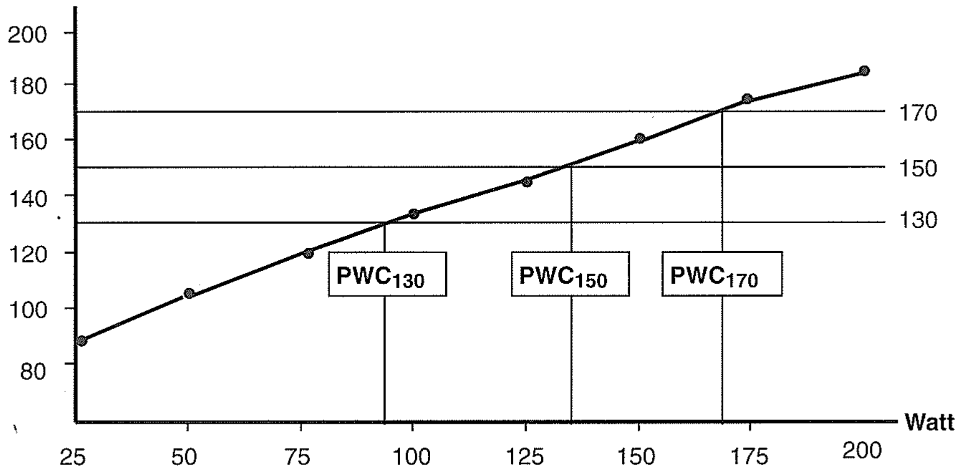

Illustration 7: Physical Work Capacity at a heart rate of 130, 150 and 170

The graph of the heart rate in a step test is more or less linear according to Neumann & Schüler[42] up to a heart rate of 180 beats per minute.

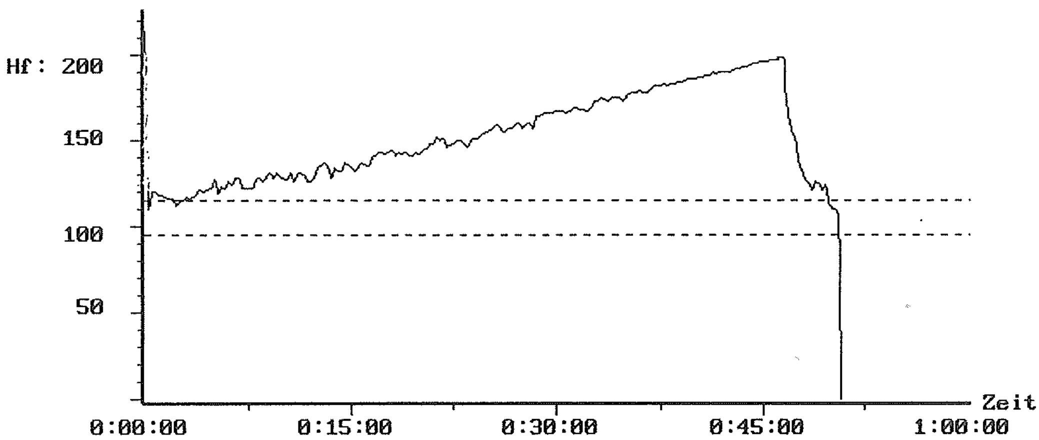

Illustration 8: Regulation of the heart rate (measurement each 5 seconds) during ergometry. The test started at 120 W, duration 4 min, load 30 W

[42] Neumann & Schüler, 1994

This permits calculating the theoretical Watts value for 130, 150, or 170 beats per minute by interpolation of the next lower and next higher frequency. The heart rate value calculated in the PWC 150 test therefore expresses the amount of working energy in Watts put out at a heart rate of 150 beats per minute. The higher the runner's fitness level, the higher his or her output in Watts or, in other words, the more adaptation has occurred in the cardiovascular system. Osteopathic treatment should enhance these adaptive reactions despite an unchanged training regimen.

This value is then divided by the patient's body weight. The resulting Watt/kg provide a physical value that is very suitable for comparing individual test persons as well as for intrasubjective comparisons.

A 35-year-old runner with a body weight of 84 kg, for instance, can pedal against a resistance of 140 Watts at a heart rate of 150 bpm. These 140 Watts output are divided by the bodyweight of 84 kg. The result is 1.66 Watts/kg. According to the table "Achievement groups based on performance" (page 39), this value corresponds to the average performance capability of a 35-year-old.

The test of choice for this study is the PWC 150 since no doctor was present and the danger of unforeseen complications (e.g. circulatory collapse) is significantly higher in a PWC 170 test.

Duration of Load Steps

The typical duration of load steps quoted in specialized literature is between two and three minutes. A regulatory state of balance between heart rate, blood pressure and oxygen uptake (steady state) is reached after an average of two to six minutes. Since the test should not take too long, many authors (Arndt, Neumann & Schüler, Haber) recommend load steps of three minutes.

Increasing Load

All authors recommend an initial load of 50 Watts for healthy test persons. Individuals with a low fitness level or risk patients should begin with 25 Watts. According to Arndt[43], Haber[44] and Neumann & Schüler[45], load increase per step should be

[43] Arndt, 1998
[44] Haber, 2001
[45] Neumann & Schüller, 1994

between 25 and 50 Watts depending on the physical condition of test persons. In this range measured values show no differences in the linear rise of heart rate. Hollmann & Hettinger[46] and Löllgen & Erdmann[47] generally recommends steps of 25 Watts. According to Neumann steps should not be too large for average hobby athletes to avoid reaching the maximum too early.

Cadence

A cadence of 70-80 rotations per minute is generally recommended in specialized literature. This cadence was accurately maintained throughout the tests.

Step Protocol

The following protocol was chosen from recommended options for the PWC 150 test:

- Duration of load steps: three minutes
- initial load step: 50 Watts
- load increase per step: 30 Watts

At each graduation the frequency was noted and marked on a chart. (see annex 6)

5.3.3 VALIDITY AND RELIABILITY

As Neumann & Schüler show, the PWC 150 is the standard test recommended by the WHO to measure the general endurance of athletes.[48] The test is very reliable since testing procedures are simple, the ergometer is calibrated and factors such as weather conditions or the test person's personal motivation are eliminated. All tests and treatments were performed by the same person (the author of this study).

5.4 SUBJECTIVE PERFORMANCE MEASURE

A four dimensional questionnaire was used for both test and control group based on a questionnaire developed at the "Bremer Institut für Präventionsforschung und Sozialmedizin" (BIPS) (see annex 6). Participants used this questionnaire for a self assessment of their own fitness level. Before each test, these questionnaires had to

46 Hollmann & Hettinger, 2000
47 Löllgen & Erdmann, 2000
48 Neumann & Schüler, 1994

be answered according to the subjective evaluation of participants. The fundamental question was whether the participants were able to accurately self evaluate changes in performance capability occurring between individual tests. Additionally, the members of the test group were questioned on the subjective effects of osteopathic treatment on their performance capability. This should reveal whether the treatment and personal relationship with the therapist influenced the training of the test group compared to the control group.

5.5 OSTEOPATHIC TREATMENTS

As explained above, the members of the test group received three osteopathic treatments at intervals of 14 days.

Particular attention was paid to a detailed case history of each participant before the first treatment. Since all participants were healthy hobby runners, none had any specific complaints. Therefore, it was even more important to find out about previous lesions that had probably led to chronic dysfunctions and compensatory mechanisms that the patients were not aware of.

All previous fractures, traumas, surgical interventions and pregnancies were recorded and put into chronological order. Operations and caesaran sections often leave behind internal and external scars that can affect organ systems and thus reduce performance.

Furthermore, all grave illnesses were recorded (e.g. pneumonia) and the function of all visceral systems (e.g. bowel motion, bladder function, menstrual disorders) was examined.

The patients were asked whether they were taking any medication and whether there was any relative contraindication (hormone releasing intrauterine device, cysts, myoma, adenoma, diverticulosis). General information on the quality of sleep, diet and a family history rounded off the first impression.

After the interview, all structures relevant for runners were examined as described in chapter 4.2. Additionally, all visceral organs and the craniosacral system was tested.

Two important lesion chains were identified in these tests. Tension of the diaphragm was often transferred to the cervical spine via the pericardium and the pericardial bands, and through the left and right crura of the diaphragm this dysfunction continued to the psoas muscles. This condition often led to reduced hip extension and shortening of the rectus femoris muscle. Both factors reduce the runner's length of stride. In many cases, abnormal tension of the liver ligaments was also diagnosed which reduces the mobility of this organ. This tension is often caused by inappropriate diet and stress factors. Dysfunctions of the liver or the liver capsule can aggravate tension of the diaphragm or psoas muscle. In the dorsal area, there is often a lesion chain that leads from dysfunctions of the thoraco-lumbar transition via the lumbar spine and sacrum to a hypertonicity of the hamstring muscles.

About three quarters (!) of all treated patients had dysfunctions of the ankle joints due to inversion trauma from sports injuries. In four patients, lesion chains were found to cause imbalances of the pelvis and lumbar spine.

Careful examination of the spine revealed that whenever a blockage was present in any segment, restrictions were also found in the area of the thoracic segments between T2 and T5. According to the model of John Littlejohn the area of T3/2 is particularly prone to lesions since it is here that the fascial triangles of the upper and lower spine meet.[49] Bernard Ligner[50] and Gez Lamb[51] also adhere to this model in their work. In my treatment I always tried to resolve lesions between T2 and T5 first and then correct other segments if necessary. The following treatments showed that very good results were obtained with this approach.

The tests of pulmonary function and mobility of the rib cage showed that restrictions were caused primarily by tension of the diaphragm and the bands of the pleural dome. The mobility of the ribs was generally good. The condition of the pericardial bands proved to be of particular importance in the area of the thoracic cage. Tension could be reduced effectively by working on the sternopericardial, vertebropericardial and cervicopericardial ligaments.

The general approach to treating the test group after the first thorough test was to correct first and foremost structural dysfunctions and then, if necessary, visceral dysfunctions.

Before the second treatment the tests were repeated with particular focus on the fasciae. The craniosacral system was also checked again, particularly the tension of the sphenobasilar synchondrosis (SBS) and pituitary gland, and treated if necessary. Membranous torsion at the cranial base can restrict the diameter of the infundibulum

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[49] Liem & Dobler, 2002
[50] Ligner, 2003
[51] Lamb, 2004

and affect the supply of vessels. SBS fixation in flexion can increase tension at the diaphragma sella via the tentorium cerebelli, which may according to Sue Turner[52] change the function of the pituitary gland. After checking the corrected dysfunctions, the third treatment focused on the craniosacral system. The objective was to stabilize the body's midline by harmonizing the central nervous system, membranes and distribution of CSF, in order to further enhance a sustained effect of treatment. James Jealous[53] described the midline as a bioelectric force responsible for the orientation of structure and form. The movements of all osseous structures, the RTM and the fluctuation of the CSF are oriented around this spatial midline. A functioning midline promotes health and supports the body's self healing powers.

Treatment of all test persons was ended with the CV4 technique (compression of the fourth ventricle) to kickstart the entire craniosacral system, as described by Rolin Becker[54].

[52] Turner, 1980
[53] Jealous, 2000
[54] Becker, 1977

6 RESULTS

Statistical Analysis of Data

The results of the performance tests (W) were calculated for a heart rate of 150 bpm by linear interpolation both for the test group and the control group. The measured performance was then put in relation to body weight.

These results together with those obtained from questionnaires were then processed in computer aided statistical analysis (WinStat 3.1). All exact results are shown in annex 3.

A truly thorough statistical analysis was, however, not possible due to the small number of test persons. Nonetheless, numerous statistical tests were performed in order pave the way for possible further studies on the topic.

6.1 GENERAL DATA

Both groups comprised a total of 31 individuals, among them 20 men and 11 women.
Gender specific differences between control group and test group are statistically not relevant despite a marked difference in percentage.

Gender	Test Group		Control Group	
	Frequency	Percentage	Frequency	Percentage
M	10	58.8	10	71.4
F	7	41.2	4	28.6

Gender of test- and control group

Age: Both medium value and standard variation are comparable. In the control group the average age and dispersion around the mean value are slightly higher.

Age (in years)	Test Group	Control Group
Cases	17	14
Mean Value	37.1	38.1
Standard Deviation	5.01	6.21
Minimum	28	25
Maximum	44	45
Median	38.0	39.0

Average age: mean value and standard deviation 1

		Age (in years)				
Group	Gender	Mean Alter	Std. dev.	Min.	Max.	Median
Control group	m	37.5	6.7	25	45	39
	w	39.5	5.2	33	45	40
Test group	m	36.8	4.9	29	42	38
	w	37.6	5.5	28	44	38

Average age: mean value and standard deviation 2

With regards to gender, both men and women of the test group were younger than in the control group. However, no statistically relevant difference (T-test) can be deduced from this fact due to dispersion around the mean value.

Body Mass (kg)	Control Group		*Test Group*	
	m	f	m	f
Mean Value	74.7	59.8	72.8	63.1
Standard Deviation	7.5	6.9	9.8	5.4
Minimum	65.0	55.0	56.0	58.0
Maximum	90.0	70.0	84.0	72.0
Median	72.5	57.0	71.0	62.0
Cases (subjects:n)	10	4	10	7

Body mass: mean value and standard deviation

Average body weight of male participants in the control group exceeds that of the test group by 2 kg, whereas the average weight of women is 3 kg lower in the control group. (T-test: statistically insignificant differences)

The performance per kg body weight compared to the amount of training shows a correlation.
The amount of training in both groups shows statistically significant differences (T-test), particularly with regards to male participants.
Since all participants agreed to keep the amount of training constant throughout the study, the percentage of change without the influence of training duration can be calculated by comparing the results of the first test (W/kg at a heart rate of 150 bpm) with those obtained from the following tests.
This influence could be further reduced by dividing participants into groups based on their performance measured in W/kg. This table was compiled according to Rost and Hollman[55].

Men		**AG1**	**AG2**	**AG3**	**AG4**	**AG5**
Age (in years)		very poor	poor	normal	good	very good
-30	W/kg	<1	>1.0>1.5	>1.5>2.0	>2.0<3.0	>3.0
-35	W/kg	<0.95	>0.95<1.42	>1.42<1.9	>1.9<2.85	>2.85
-40	W/kg	<0.9	>0.9<1.35	>1.35<1.8	>1.8<2.7	>2.7
-45	W/kg	<0.85	>0.85<1.27	>1.27<1.7	>1.7<2.55	>2.55
Women		**AG1**	**AG2**	**AG3**	**AG4**	**AG5**
Age (years)		very poor	poor	normal	good	very good
-30	W/kg	<0.8	>0.8<1.2	>1.2<1.6	>1.6<2.4	>2.4
-35	W/kg	<0.76	>0.76<1.14	>1.14<1.52	>1.52<2.28	>2.28
-40	W/kg	<0.72	>0.72<1.08	>1.08<1.44	>1.44<2.16	>2.16
-45	W/kg	<0.68	>0.68<1.02	>1.02<1.36	>1.36<2.04	>2.04

Achievement groups based on performance measured by W/kg

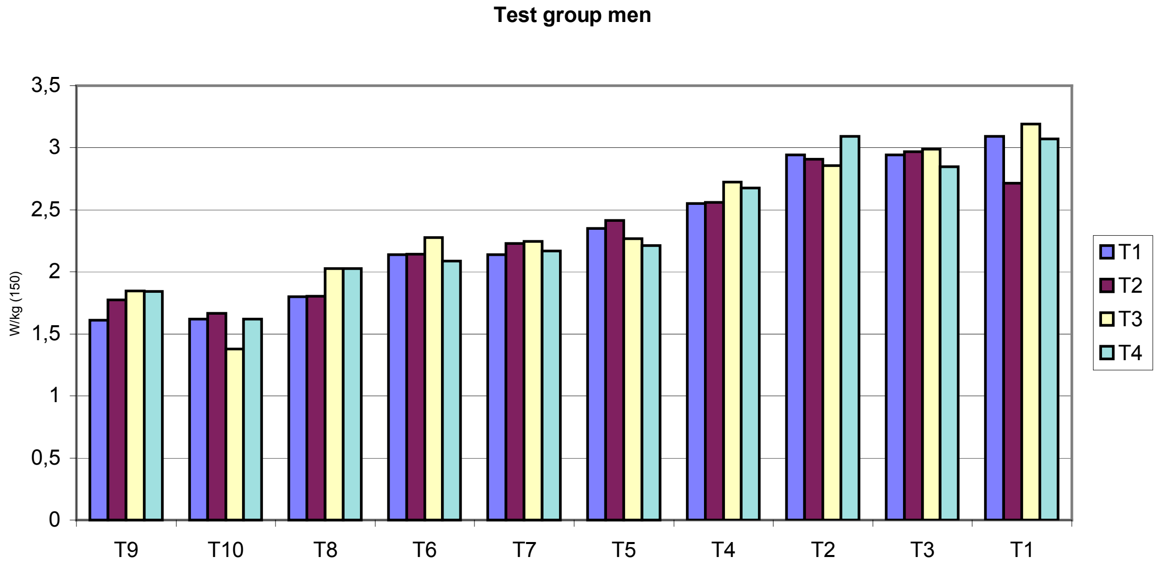
As explained in greater detail further on, the data obtained from the various achievement groups was processed together and this wider framework conditions were used for statistical analysis. As mentioned above, the general

[55] Rost & Hollman, 1982

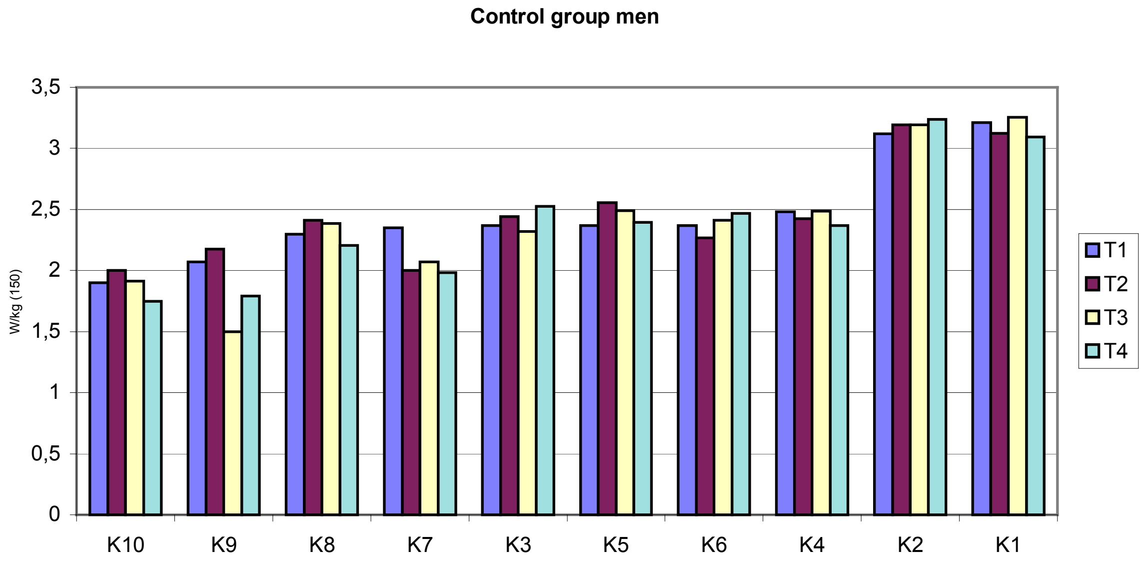
conditions for a meaningful statistical evaluation could not be fulfilled despite of using the data from all groups.

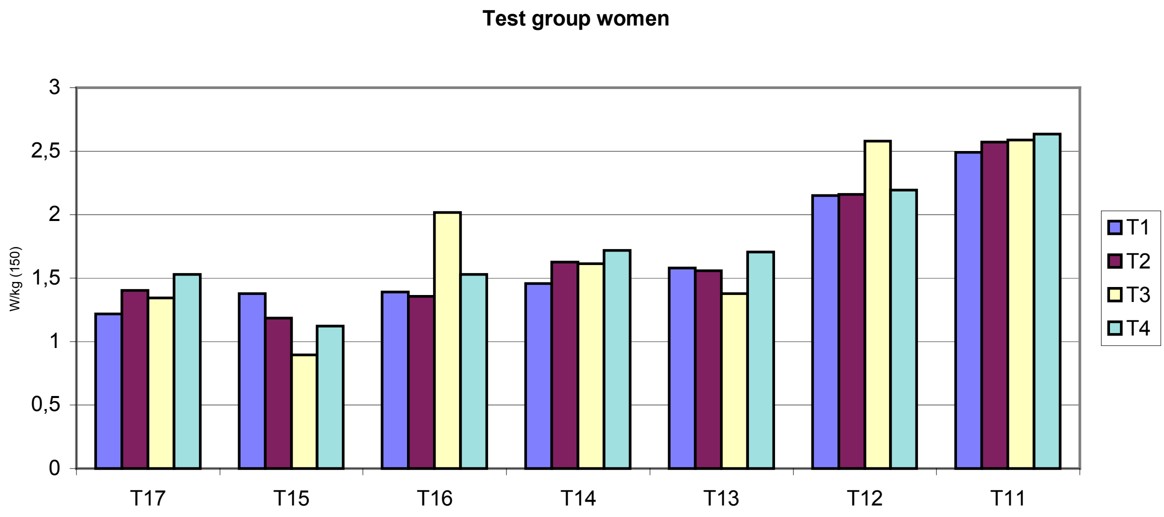
6.2 SUMMARY OF INDIVIDUAL TEST RESULTS

The following graphs show the individual performance of participants in the four tests according to achievement group (AG) and gender. The order corresponds to rising performance levels (expressed in W/kg body weight at a heart rate of 150 bpm) in the first test (T1, blue coloumns):

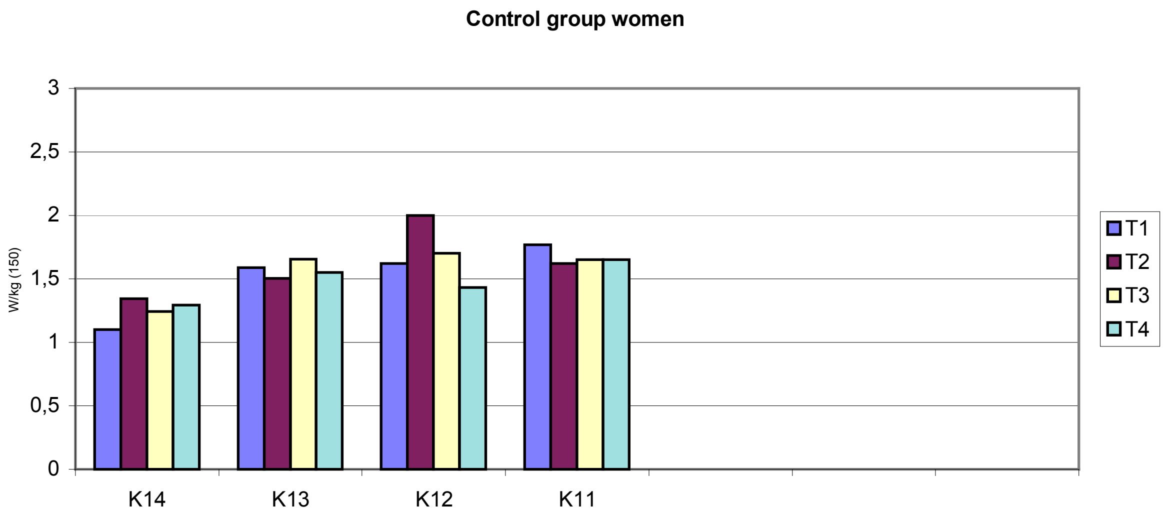


Individual performances: Test group men (above), Control group men (below)





Test group women: individual performance

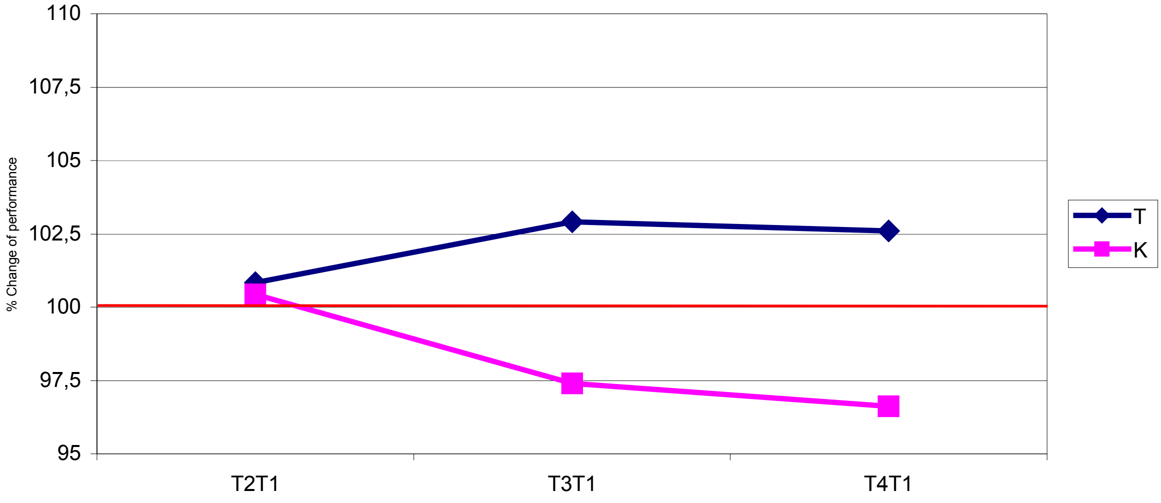


Control group women: individual performance

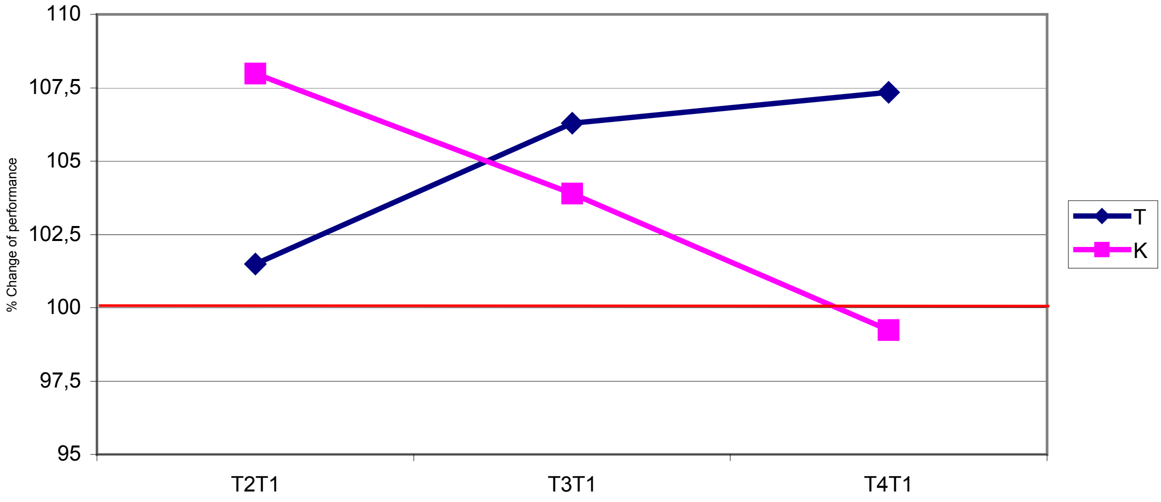
These graphs are meant as an overview over the performances of the individual persons taking part in this study, the accurate changes in performance are described in chapter 6.3.

6.3 RELATIVE CHANGES IN PERFORMANCE COMPARED TO THE FIRST TEST

The quotient of performance in W/kg obtained from tests 2, 3 and 4 and the result in W/kg from the first test is expressed in the following graph of mean values. The mean initial situation in the first test is therefore set at 100%.

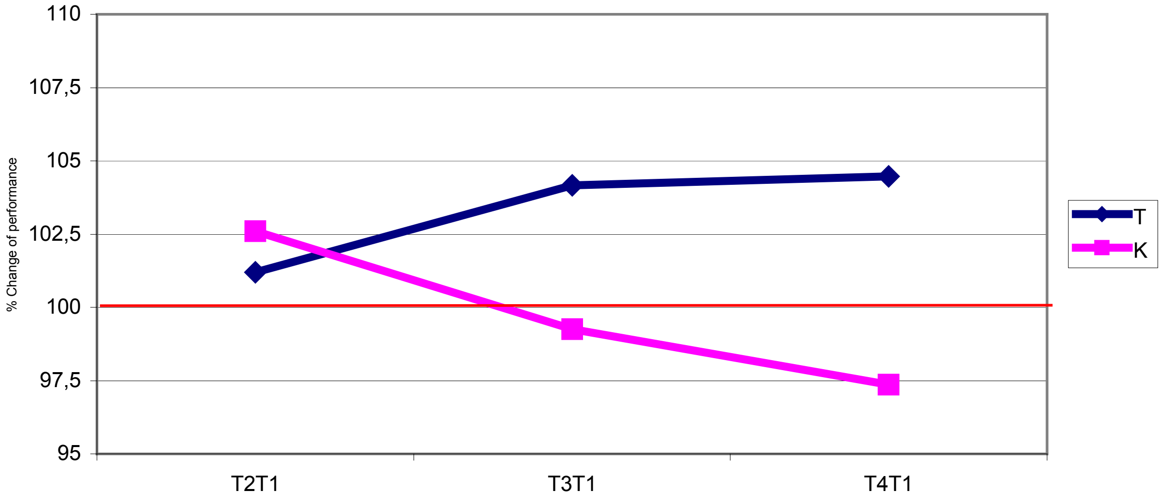


Men: Percental change of average performance (W/kg at pulse 150) at the tests 2, 3 and 4 relative to test 1 (T2T1, T3T1, T4T1)



Women: Percental change of average performance (W/kg at pulse 150) at the tests 2, 3 and 4 relative to test 1 (T2T1, T3T1, T4T1)

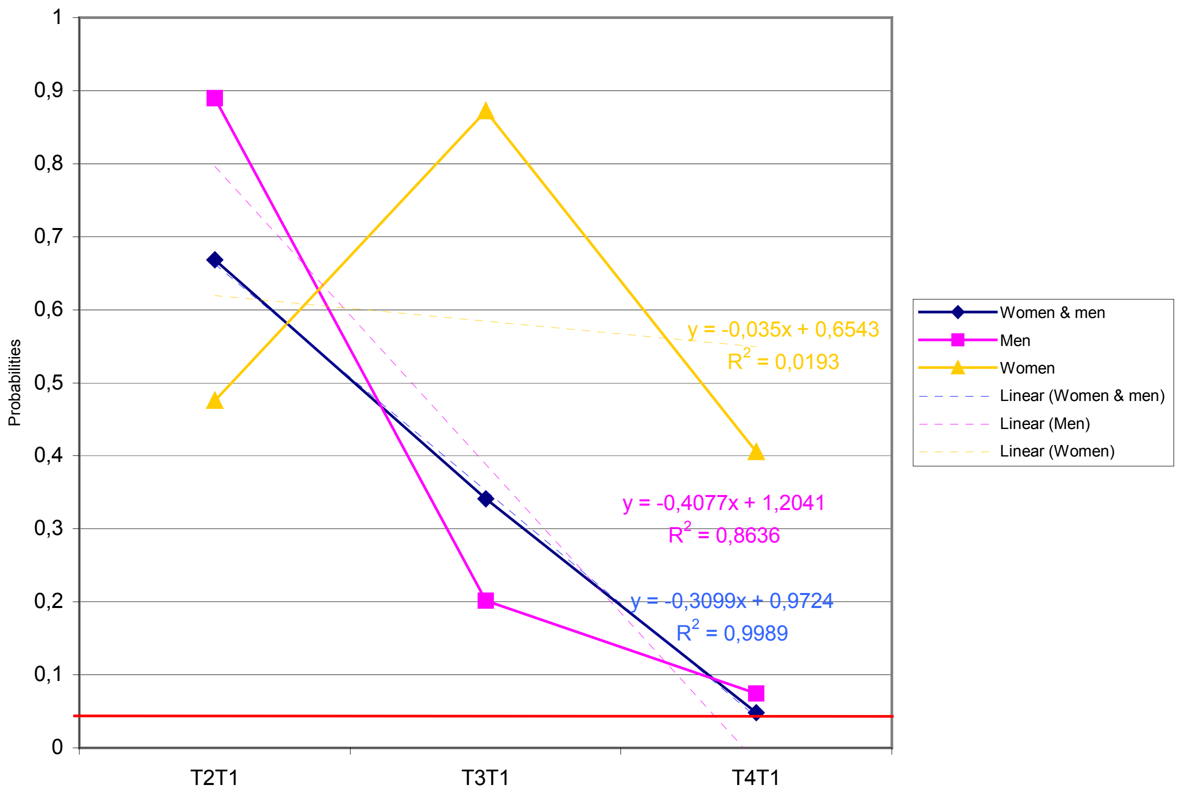
The mean value of all women shows the most significant increase in performance compared to the control group.



Women and men: Percental change of average performance (W/kg at pulse 150) at the tests 2, 3 and 4 relative to test 1 (T2T1, T3T1, T4T1)

The individual results were statistically evaluated. The level of significance of differences between test and control group increased with each test (approximately linear) and the probability that these differences could be attributed to chance reached a level of significance of 0.05 at T4T1. Despite the limited statistical validity we may assume that these increases in performance capability were an effect of osteopathic treatment, not only for the entire test group but also in case of the male participants. No significant differences could be found among the female test persons.

The following illustration shows these probabilities for the individual tests:



Probablities for non-rejecting the null hypothesis (no statistical difference between test group and control group)

The diagram of mean values and probability shows that the men already had slightly raised performance capability after the second test (initial situation in the first test = 100%). In the third test, the men of the control group reached performance levels app. 2.5% lower than those of the first test, while the average results of the osteopathically treated group had risen by app. 3%. The following drop in performance is also more pronounced in the control group than in the study group. Measured performance increased by an average of 5.5% among male test persons compared to the control group.

Among the women, the situation can be described as follows: Both groups increased performance in the second test with results of the control being an average of 7% above those of the test group. In the following two tests, the test group increased performance up to app. 7.5% in the fourth test, whereas performance of the control group drops to a mean value below that of the initial

test. Measured performance increased by an average of 8% among female test persons compared to the control group.
The overall curve of participants is similar to that of the women, with mean values of the control group already dropping below the initial level in the third test.

6.4 CLASSIFICATION ACCORDING TO ACHIEVEMENT GROUPS AND SUSTAINABILITY OF TREATMENT

Another interesting question in the framework of this study concerns the effect of osteopathic treatment on the various performance levels and how long possible positive effects last.

The available data both from achievement groups as well as according to the amount of training is insufficient (no normal distribution) and dispersion is too great for statistical evaluation. I have tried to put the data in order and summarize the results according to the following criteria in an attempt to compensate for this shortcoming.

The men were divided into three classes and the women into two based on the measured performance levels and according to the table page 39. (Achievement groups based on performance)

<table>
<tr><th>Original Achievement Group</th><th>Men (summary)</th><th>Women (summary)</th></tr>
<tr><td>AG 1</td><td>-</td><td>-</td></tr>
<tr><td>AG 2</td><td rowspan="2">AG 2 + AG 3 (2/1)</td><td>-</td></tr>
<tr><td>AG 3</td><td>AG 3 + (3/1)</td></tr>
<tr><td>AG 4</td><td>AG 4 + (5/7)</td><td rowspan="2">AG 4 + AG 5 (4/3)</td></tr>
<tr><td>AG 5</td><td>AG 5 + (3/2)</td></tr>
</table>

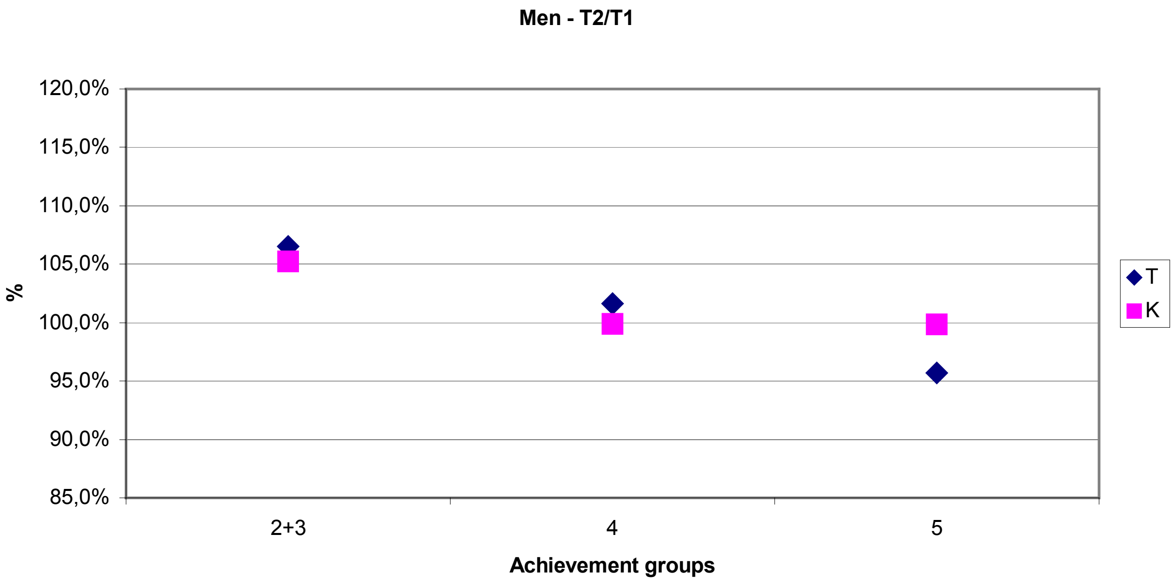
Achievement groups: Men and women

The number put in brackets (first digit = members of the test group, second digit members of control group) shows that this data does not allow general conclusions but tries to indicate trends in the framework of this study.

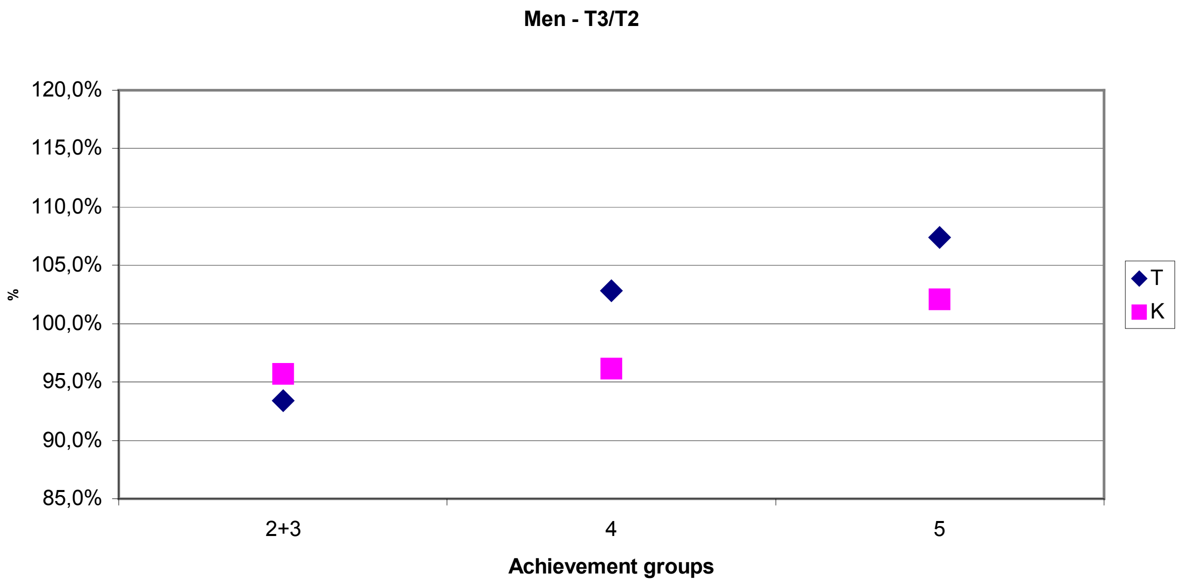
The relative changes compared to the first test were then examined for these achievement groups or training groups respectively. The following graph of mean values provides an overview. Further statistical evaluations were not considered useful.

6.4.1 MEN

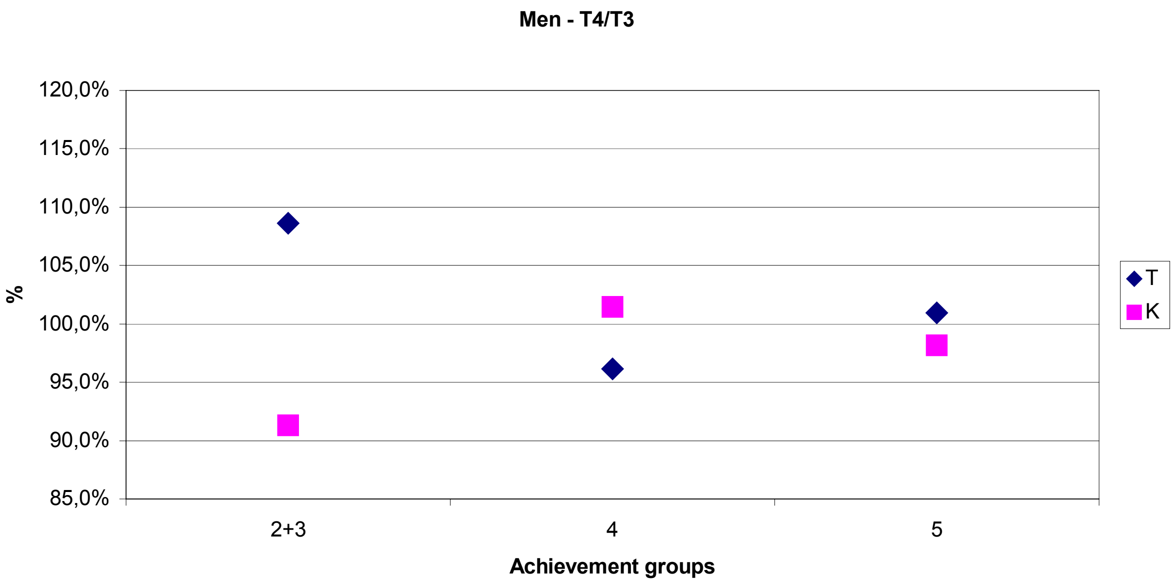
The changes in performance measured in W/kg body weight were expressed in percentage and put into chronological order. For instance: T2/T1 is the change in performance capability at a heart rate of 150 between the first and the second test.



Men: performance change of the achievement groups T2/T1



Men: performance change of the achievement groups T3/T2



Men: performance change of the achievement groups T4/T3

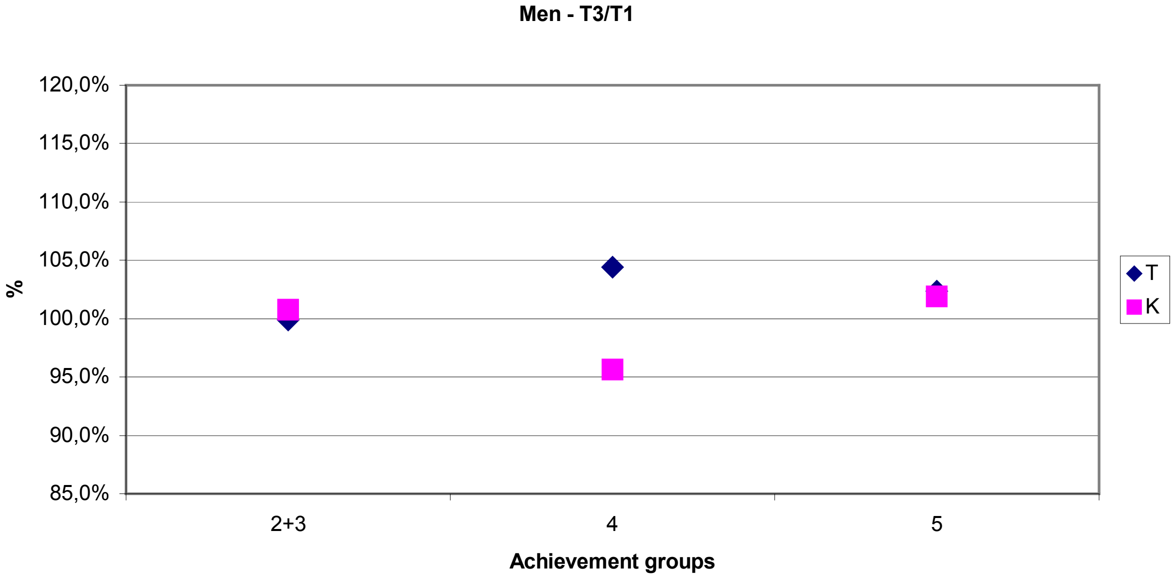
Compared to the initial situation, the lower achievement groups improved more in the second test with improvements being generally higher in the treated test group. In levels four and five of the control group performance is more or less stagnant, whereas in the test group it increases in level four and drops in level five.

In the third test, level four of the osteopathically treated group has the best results, only level four of the control group drops in performance. The values of the study group are below those of the control group in the low achievement levels, whereas those of level five are higher than in the control group.
In test number four, the low achievement levels two and three again show the highest improvement compared to the initial test, the values of AG 5, however, are also an average of 3.5% above the initial value.
A closer examination of changes occurred between tests one and two, two and three, and three and four reveals that in the osteopathically treated group the levels AG 2 and AG 3 benefited most of the first and third treatment, whereas levels AG 4 and AG 5 gained most from the second treatment.

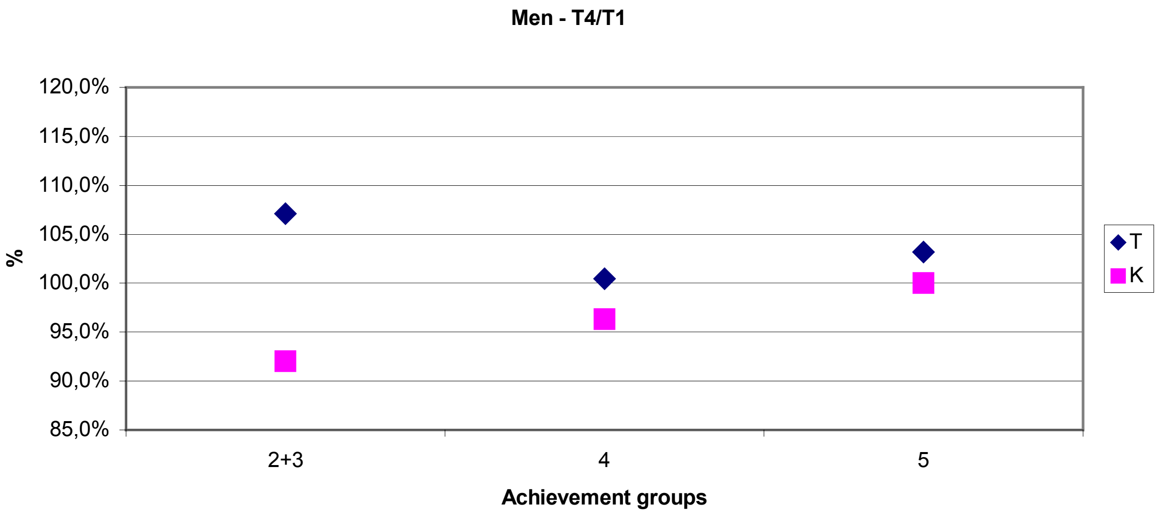
6.4.2 SUSTAINABILITY OF TREATMENT - MEN

While the intervals between individual treatments was approximately two weeks, the last test was performed one month after the last treatment to provide clues on a possible sustained effect of the osteopathic input.
The comparison of tests 3/1 and tests 4/1 revealed an increase of 7% in AG 2&3 of the test group and an increase of 1% in AG 5 of that group.
Achievement group four reduced its performance to value close to the initial value.
In the control group, the performance level of the third tests could not be maintained in any of the achievement groups.

Examination of the treatment's effect on the various achievement groups revealed that levels AG 2&3 of the test group, i.e. individuals with a relatively low level of performance, gained most from treatment.



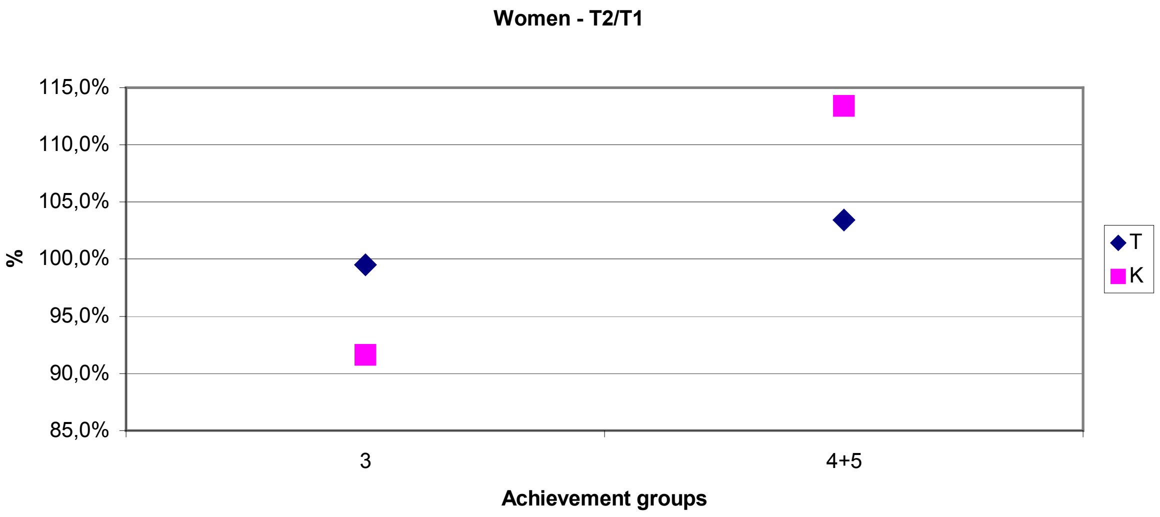
Men: performance change of the achievement groups T3/T1



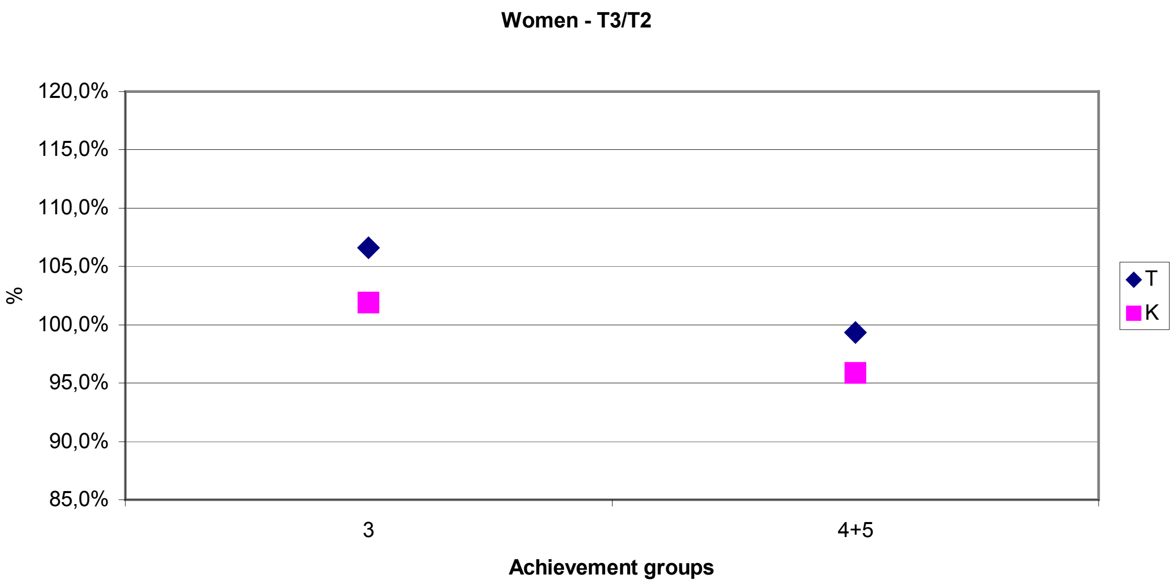
Men: performance change of the achievement groups T4/T1

6.4.3 WOMEN

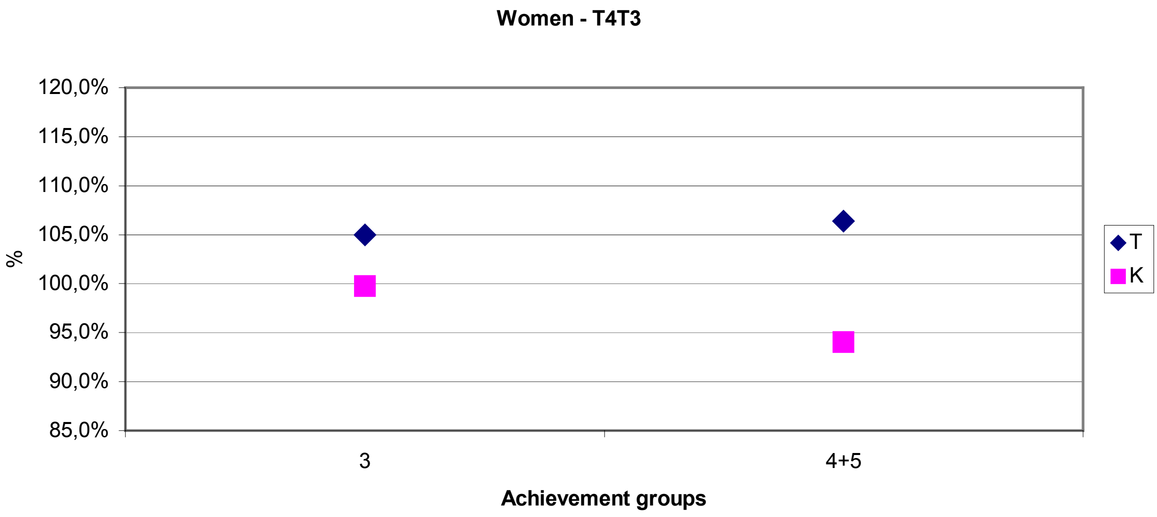
The changes in performance capability measured in W/kg body weight were expressed in percentage and put into chronological order.



Women: performance change of the achievement groups T2/T1



Women: performance change of the achievement groups T3/T2



Women: performance change of the achievement groups T4/T3

The changes measured in the second test is relatively low in both achievement levels of the treated group, levels AG 4&5 of the control group obtained clearly better results.

Test two produced a performance increase of 13% compared to the initial value. Test four, however, revealed a marked drop in performance level.

The results obtained from AG 4&5 of the test group were the exact opposite.

It was not until test four that a marked increase in performance capability could be measured in the female members of the treated group.

AG 3 of treated women benefited most from the second treatment.

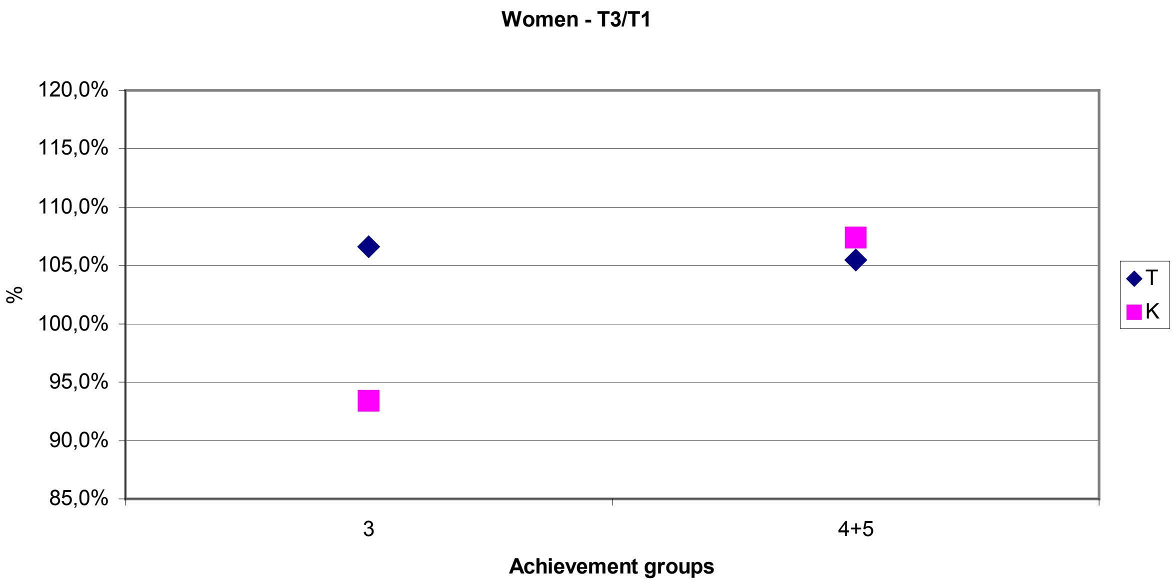
6.4.4 SUSTAINABILITY OF TREATMENT - WOMEN

In the third test, both achievement groups of treated women showed an increase between 5% and 6% compared to the initial test.

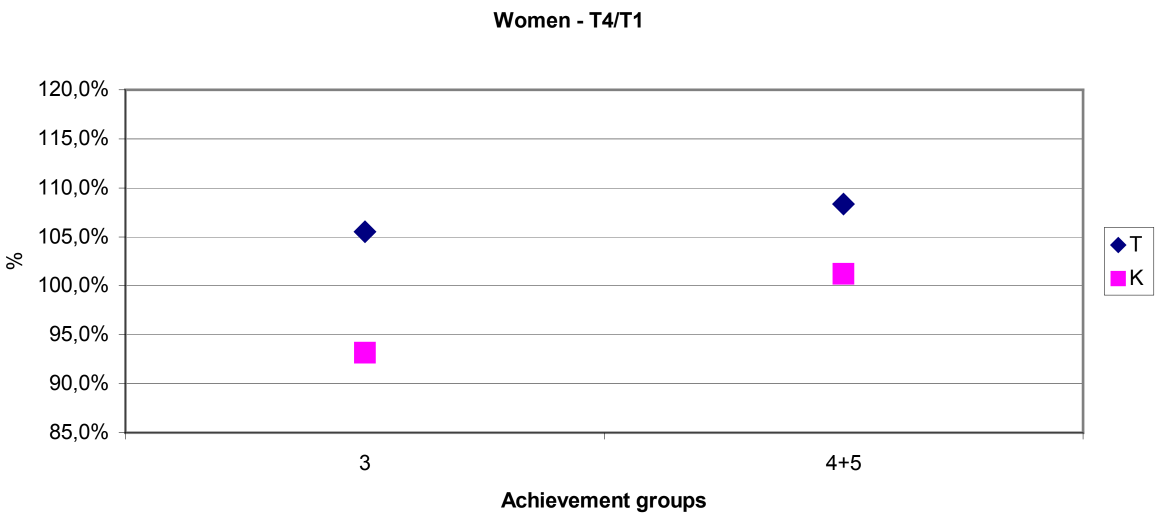
One month later, the fourth test revealed that the AG 3 had dropped in performance by 1%, whereas AG 4&5 further improved by 3%.

The members of the control group retained a level of approximately 94%, whereas levels 4&5 dropped by approximately 7% to a value close to that of the first test.

Among the women of the test group, levels 4&5 again benefited most from treatment with a rise in performance of 8%.



Women: performance change of the achievement groups T3/T1



Women: performance change of the achievement groups T4/T1

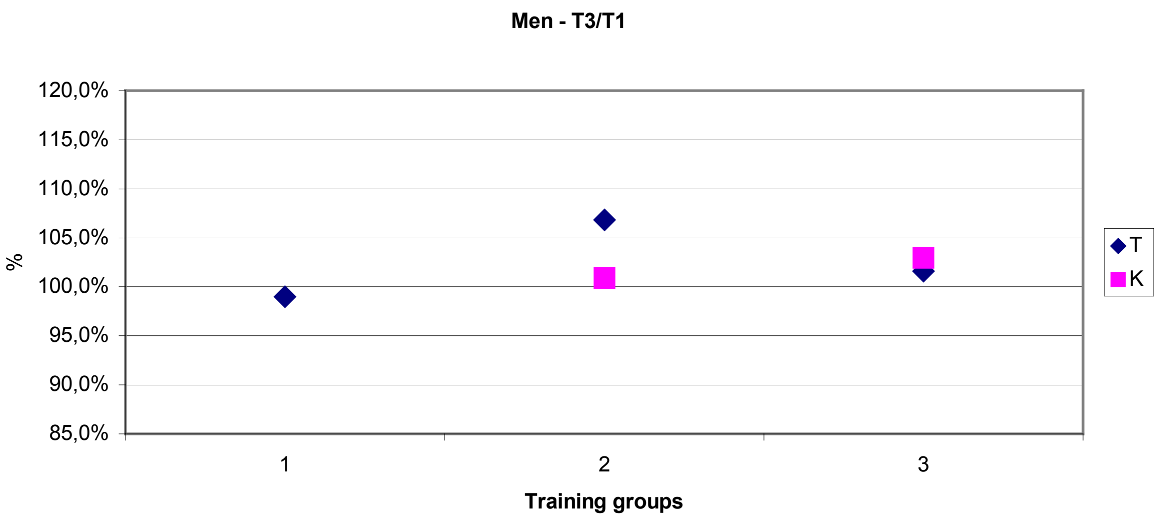
6.5 CHANGES ACCORDING TO TRAINING GROUPS

	Men	T/C	Women	T/C
Training Group	min/week	n	min/week	n
TG1	<150	3/2	<140	5/1
TG2	150-285	4/5	>140	2/3
TG3	>285	3/3		

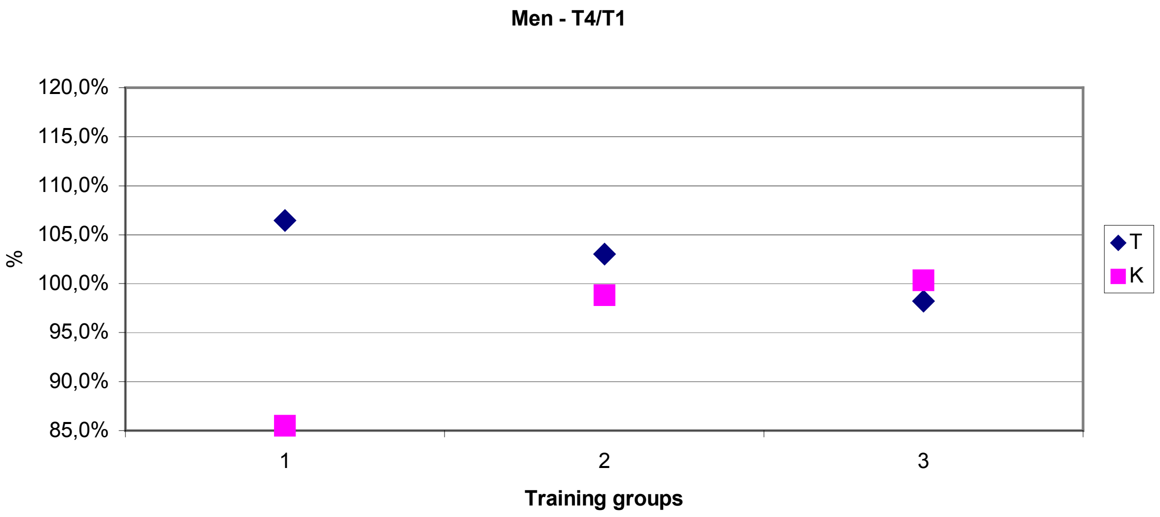
Training groups: women and men

The data used here are sum values, training intervals and intensity of the training could not be considered in the framework of this study.

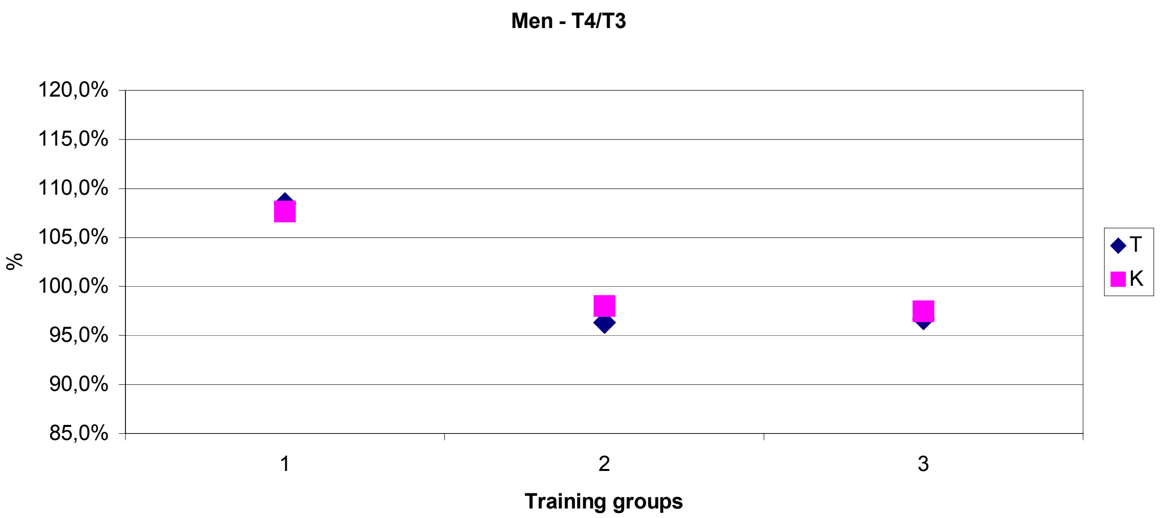
6.5.1 MEN



Men: performance change according to training groups T3/T1



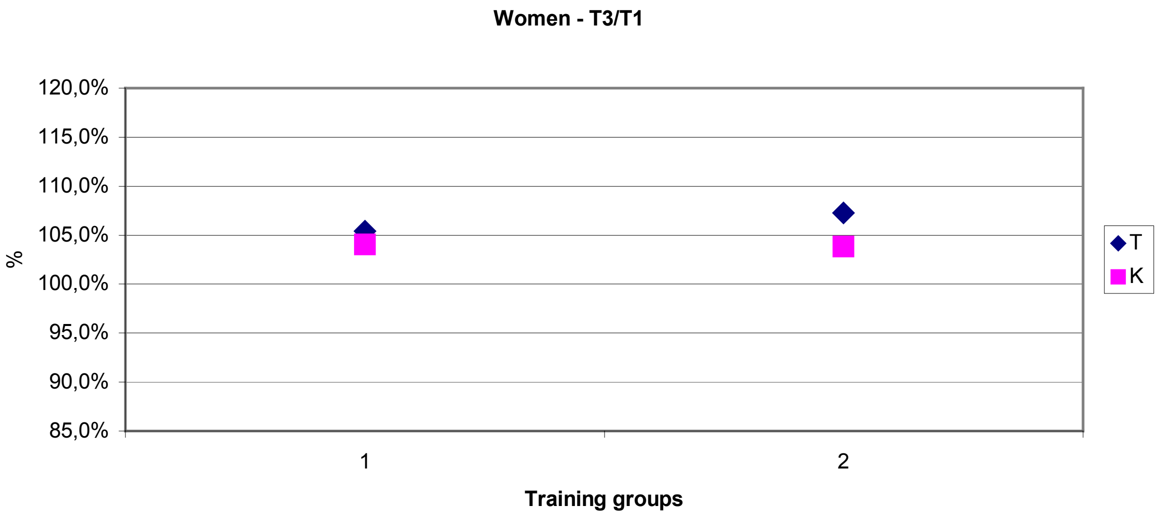
Men: performance change according to training groups T4/T1



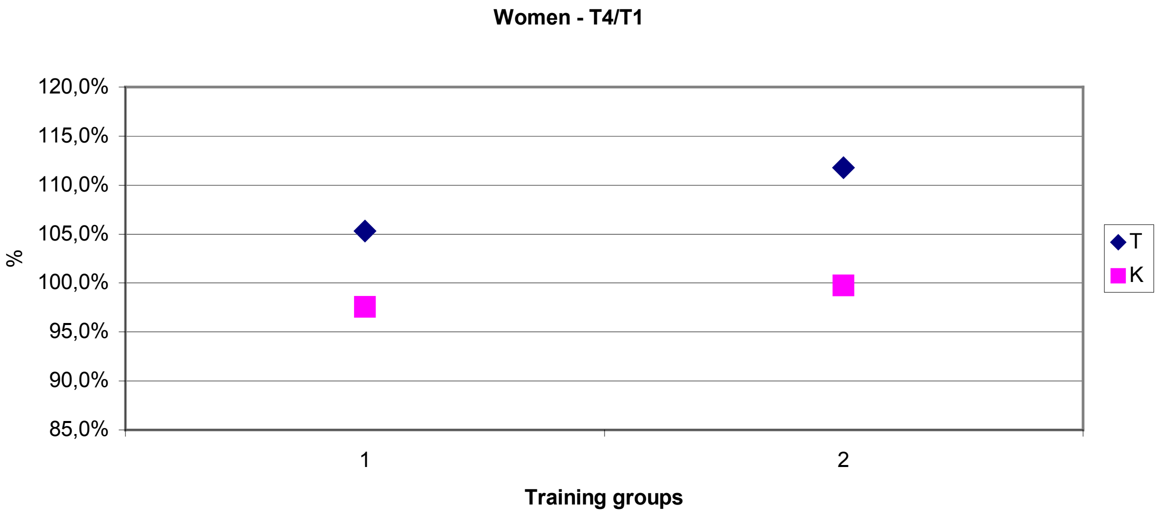
Men: performance change according to training groups T4/T3

In the treated group, the changes were most significant in the group with the lowest amount of training (training group 1 or TG1) after the third test. Ultimately, TG4 as well as the control group remained unchanged compared to initial values, whereas TG1&2 improved performance, with TG1 gaining most from treatment.

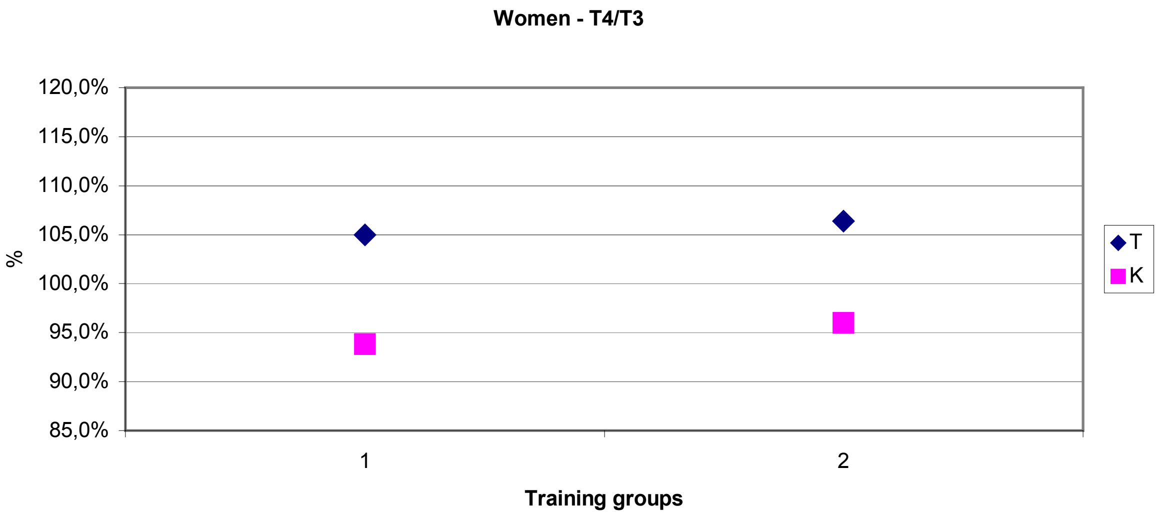
6.5.2 WOMEN



Women: performance change according to training groups T3/T1



Women: performance change according to training groups T4/T1



Women: performance change according to training groups T4/T3

Women showed higher percentages of improvement in both training groups compared to the control group. Unlike male participants, women who trained more also improved more.

6.6 SUBJECTIVE SELF EVALUATION OF INDIVIDUAL PERFORMANCE

In addition to the objectively measurable changes, participants also had to self evaluate their performance capability with the help of questionnaires. The questionnaire BIPS 80 was developed for this purpose (see annex 6) and focuses on two main points.

Firstly, each test person subjectively decided whether his or her performance capability had increased or decreased since the last treatment.

And secondly, they had to evaluate their performance capability by choosing suitable adjectives from the following four pairs of opposites: weak – strong, exhausted – energetic, tired – recovered, trained – untrained.

Statistical Questions for Processing Data

The following problems arose in comparing the test results with the self evaluation from the questionnaires answered before the tests:
1. The precise results of the performance tests with their low range were to be compared with a rough scale used for self evaluation.

2. The scale of self evaluation was not used to its full extent. Maximum values were never chosen, therefore maximum values of change obtained from performance tests cannot be compared with possible maximum values of subjective self evaluation (+9 or –9).

3. While the questionnaires permitted the classification “unchanged” (i.e. in two consecutive tests the same self evaluation could be chosen), this was not possible in the objective tests due to the calculated values. We are therefore confronted with the problem of defining this classification arbitrarily.

4. When the values obtained from objective tests are put in relation to those of the questionnaires, the null point shifts to positive or negative values.
(e.g. Self evaluation maximum value: 4, minimal value –1, calculated values maximum 120% of preceding test, minimum 90% of preceding test; values between 90-95% would correspond to –1, values between 95-100% to 0, and between 100-105% to 1,…).

5. Even if improvements (values >100% or >0) and deteriorations (values >100% or >0) were considered separately, the example under point 4 would still not provide meaningful data and retain the problem of an arbitrarily defined null point.

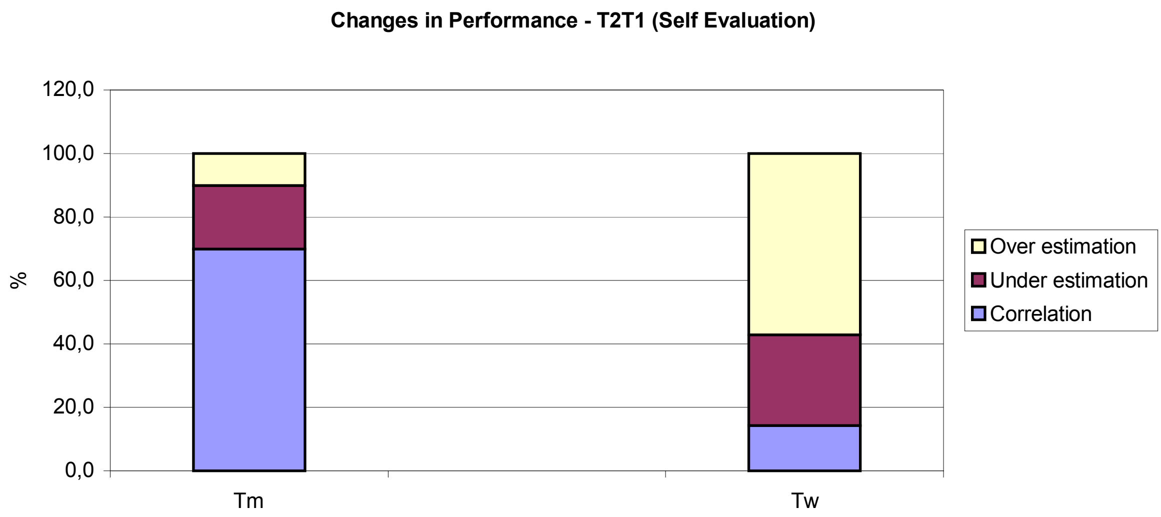
The following arbitrary limits would be drawn accordingly:

- Noticeable improvement: Self evaluation >0, or calculated values >102.5% respectively
- Noticeable deterioration: Self evaluation <0, or calculated values <97.5% respectively

- Predominantly unchanged: Self evaluation 0, calculated values ≥ 97.5% and ≤ 102.5%

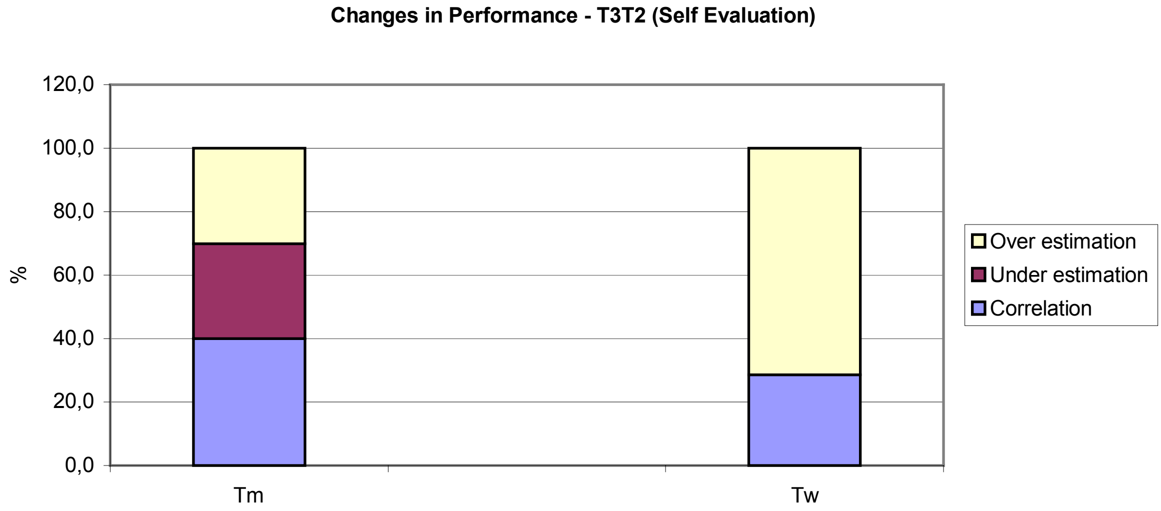
The threshold of +/- 2.5% change that was labelled unnoticeable is based on an adaptation of overall intervals of self evaluation and measured values.
In tests 1&2, for instance, the question on physical condition produced the following extreme values. Minimum: 0.92, maximum: 1.23.
The interval is therefore 31%. Therefore, 17.5% of the overall interval (5% of these 31%) are attributed to the category "predominantly unchanged".
The extreme values of calculated change from self evaluation in the same category are at 0 and 6. Accordingly, there are seven categories, one of which is "predominantly unchanged". 1/7 equals 14.3%, which is a slightly smaller interval.
The overall mean of all questionnaire categories prove that this 2.5% threshold best reflects this problem.

6.6.1 SELF EVALUATION OF CHANGES IN PERFORMANCE CAPABILITY



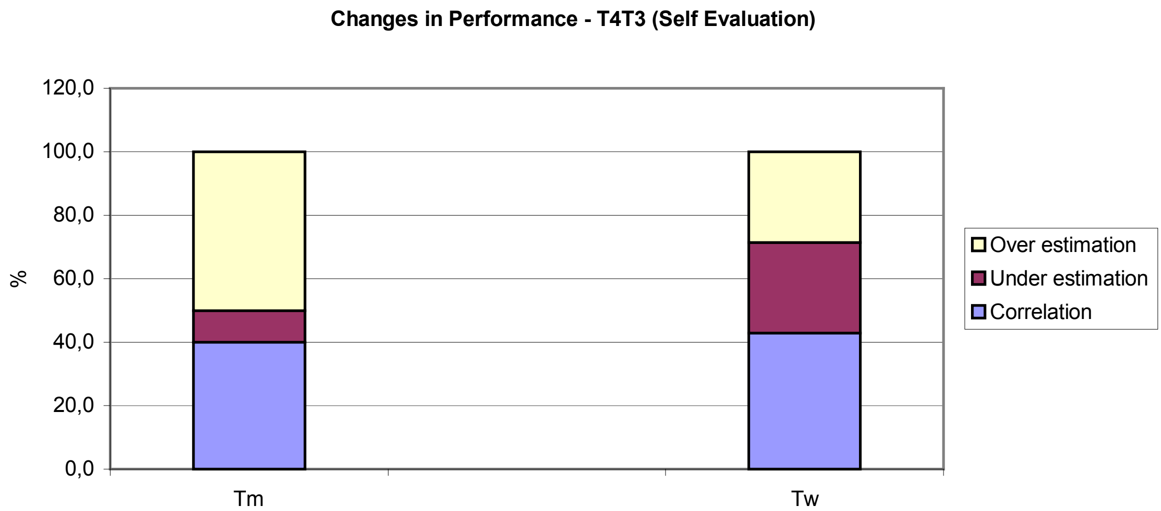
Self evaluation of the members of the test group of changes in performance capability (T2/T1, Tm…men, Tw… women)

Test 2 – Test 1: Among male test persons, perceived change corresponds better to test results than among women. More than 50% of female participants are wrong in their self evaluation of perceived change.



Self evaluation of the members of the test group of changes in performance capability (T3/T2, Tm…men, Tw… women)

Test 3 – Test 2: Distribution of negative and positive self evaluation is even among men and predominantly positive among women. The percentage of correct self evaluation is relatively low compared to wrong assessment among both gender groups.



Self evaluation of the members of the test group of changes in performance capability (T4/T3, Tm…men, Tw… women)

Test 4 – Test 3: Self evaluation in this phase is predominantly positive among male test persons. More women than men provide accurate self evaluations here, yet more than 50% of female test persons are also wrong in their assessment.

6.6.2 EVALUATION OF STRENGTH, ENERGY LEVEL, PERCEIVED FATIGUE AND ALERTNESS, AND EVALUATION OF PHYSICAL CONDITION

The results of self evaluations obtained from two consecutive tests were subtracted (e.g. strength Test 2 – strength test 1) and classified as described above. The result was compared to the category obtained from measured data and the percentage of concordance, overestimation and underestimation was calculated (see tables under Basics for diagrams, table of men and women).
To complete the picture, the percentages of achievement groups are also given in this calculation (see annex 3). However, this data provides no comparable results and therefore permits no general conclusions.

7 DISCUSSION

Comparison of the entire study group shows that the test group improved its performance capability by an average of 4.5% compared to the control group and reaches a level of significance of 0.05, whereas the control group finished approximately 2.5% below their performance at the first test. Measured performance increased by an average of 8% among female and 5.5% among male test persons compared to the control group.

The differences in sustained effects of treatment were particularly pronounced. In the final test performed one month after the last treatment, three out of five achievement groups from the test group had further improved, whereas four groups of the control group decreased performance and only the male members of AG 4 increased by 1%.
As there is no standard of the best available treatment for runners in the literature, these results indicate that the structure of treatment, from releasing structural dysfunctions to treating and correcting the craniosacral system, can be considered effective. About three quarters (!) of all treated patients had dysfunctions of the ankle joints due to inversion trauma. The hypothesis that individuals with a low level of performance capability would benefit most from treatment could not be confirmed.

Subjective self evaluation revealed that participants of both gender groups find accurate self assessment very difficult. No significant trends could be identified here.
The additional question whether performance capability had increased since the last osteopathic treatment produced interesting differences in self evaluation between men and women. Initially, two thirds of male participants were able to accurately assess changes, whereas in the third test, half of the men overestimated the effect of osteopathic treatment. Approximately two thirds of women overestimated their change in performance in the first and second test, whereas in the third test overestimation and underestimation were balanced at approximately one third.
These results of personal self evaluation after osteopathic treatment did not correspond at all with actually measured changes.
These results permit the conclusion that the relationship between therapist and test person (which often develops very positively) does not influence the motivation of the test group.
The statistical evaluation of test results indicates that increases in performance capability measured in the test group are not coincidental but the result of osteopathic treatment.
This confirmed the working hypothesis that osteopathic treatment can improve the performance of hobby runners.
<u>The following critical observations must be made in evaluating the study:</u>

1. Due to the small number of participants, the validity of statistical evaluations and conclusions drawn from the study is limited. In order to obtain more meaningful results, the number of test persons should be at least ten times as high as in this study. This scale went far beyond the limited resources available for this study.
Both tests and treatment were performed by the same person (the author of this study). It was not possible to have the tests performed by a different person due to the amount of work (140 tests at very different hours, during the day as well as at night), and the limited resources available for this study. The question may be asked whether test persons may have subconsciously trained more or harder out of sympathy or gratitude. A treatment fee was charged to avoid such an effect resulting from free treatment. The subjective self evaluation of performance capability after osteopathic treatment also shows no significance in relation to actually measured values.

2. Dispersion with regards to age and performance capability is marked in both groups. As initially described, it was not easy to recruit the necessary number of participants. This is also due to the fact that international Marathon events are distributed over the year and many hobby runners are in a build up phase that does not permit a constant and unchanged training regimen over a period of two months. Criteria for inclusion therefore could not be too stringent.

3. Participants agreed to strictly observe their regular training regimen. The author was not able to verify how strictly participants adhered to their training plan.

4. The study was conducted between mid September 2003 and December 2003. Predominantly cold weather in this time of the year led to adverse conditions for training.

In comparing this study with projects introduced in chapter three, particularly attention must be drawn on one study that was not presented until 2003 at the ICAOR in London, so that it could not be considered in my research and conceptualisation of my own project. Shah & Waters[56] of the British College of Osteopathic Medicine are the only authors who measured the influence of direct THERAPEUTIC TREATMENT on the performance capability of an organ (=muscle).
This paper confirms that therapeutic treatment can enhance the performance of a single muscle.
Since Shah and Waters used pre-cooling, it was also interesting to research how passive methods of sports medicine could be used to enhance performance. The results of these methods are promising and they will probably be used in competitive sports in the future.
It was only in researching specialized literature that I discovered that the effectiveness of vibration techniques on performance capability had already been proven. However, other results are so divergent that further research will be required until valid conclusions may be drawn. Personally, I have used vibration techniques during the study to treat tension of the diaphragm in the area of the inferior thoracic aperture. The complex approach I have chosen does not permit any conclusions on

[56] Shah & Waters, 2003

the effectiveness of individual techniques for enhancing the patient's performance rather more focussing on a global osteopathic approach.

In spite of all these critical observations, this study indicates that osteopathic treatment is able to enhance the performance of hobby runners. The study design could be a good basis for a more comprehensive work on the effects of osteopathic treatment on athletes. A larger number of participants would, for instance, permit a more differentiated classification in groups.

For instance: male amateur marathon runners between 25 and 35 years who finished a Marathon in the previous year and are in the transition period to the next Marathon during the study. Performance could be measured by a initial PWC – Test, and participants could than be classified in achievement groups to shape more homogenous groups.

Personally, I really enjoyed working with hobby athletes. Since I was working with healthy individuals I was able to focus directly on the causes of dysfunctions. At the same time, many test persons had not made previous experiences with osteopathy and participated with great interest and pleasure.

My impressions at the end of the study take me right back to the beginning: Osteopathy should always place the human being and its health at the centre of attention. Performance capability is an expression of this state of health. If we focus on health we have reached our goal and all other positive reactions are welcome effects of our work.

8 SUMMARY

The hobby runners I treated in my osteopathic practice reported that my treatment not only relieved their aches and pains, but also increased their athletic performance. These impressions led to the question whether this subjective perception could also be objectively measured by performance tests.

Research revealed that at that point of time no papers had been published on the effects of therapeutic treatment on the performance capability of athletes. The first study on this subject was published in April 2003 at the International Conference on Advances in Osteopathy.

In order to obtain a valid result, a study design was chosen that eliminated external factors such as weather conditions, temperature and race course or subjective readiness for performance. A total of 31 male and female individuals participated in the study. The members of the test group (n=17) were osteopathically treated three times at intervals of 14 days. Before each treatment, their performance capability was measured in a PWC 150 ergometer test. One month after the treatment series, a follow-up PWC 150 test was performed. The control group (n=14) was tested at the same intervals but did not receive any treatment.

The PWC 150 ergometer test was performed with a Tunturi cycle ergometer and Polar heart rate monitor. The test measures resistance on the pedals in Watts at a heart rate of 150 beats per minute. The result is divided by body weight and produces a value in W/kg suitable for comparison.

During the treatment period of two months, all participants observed a constant, individual training program which they had already been following for a minimum of one month before the study was launched.

Additionally to the objective tests, participants had to self evaluate their perceived level of fitness with the help of a four dimensional questionnaire. The members of the test group were also asked to evaluate the effects of osteopathic treatment on their athletic performance.

The results revealed a significant improvement in performance capability in the test group with an average of 4.5%. The control group finished approximately 2.5% below the performance of the first test. Measured performance increased by an average of 8% among female and 5.5% among male test persons compared to the control group.
The question of a sustained effect of treatment was particularly interesting. In the test group, three out of five achievement groups improved during the treatment free period between the third and the final test, whereas in the control group only one achievement group increased performance. The hypothesis that individuals with a low level of performance capability would benefit most from treatment could not be confirmed.

Evaluation of questionnaires showed that participants found it very difficult to accurately evaluate their performance capability. Self evaluation of the influence of osteopathic treatment neither produced significant results.

Despite limited validity of results due to the low number of participants, the study permits the conclusion that osteopathic treatment is able to increase performance of hobby runners, and improves the sustained effects of training. Therefore the results confirm the initial hypothesis of this study.

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ANNEX 1

TABLE OF ILLUSTRATION

TABLE OF ILLUSTRATIONS

ANNEX 2

CONCEPT FOR DIPLOMATHESIS

A comparative Study using Osteopathic Treatment to Enhance the Performance of Hobby Runners

Student: Franz Josef Haberl
Tutor: Nick Marcer

Introduction

In my practice I have the possibility to treat many hobby runners. As I am a long distance runner too (marathon time 2:59), I am very interested in this sport.
My patients tell me, that their performance increases after my treatment.
So I am very interested to search, if there is a significant difference in the performance of hobby runners after my treatments in comparison with a control group.

Research Question:
Does Osteopathic treatment influence the performance of hobby runners?

Null Hypothesis:
Osteopathic treatment does not influence the performance of hobby runners.

Hypothesis:
Osteopathic treatment does increase the performance of hobby runners.

Inclusion criteria:

Hobby runners: male and female
age between 20 and 45
training one hour or more a week

Exclusion criteria:

no lung or cardiac diseases
no professional runners
no other forms of treatment during the study
no symptoms of infections during the study
no injuries during the study

Number of subjects:

10 to 15 subjects in each group, study and control (n= 20 to 30)
Methodology:

- Two comparative groups of 10 to 15 subjects.

- Each individual subject will be required to maintain their constant training throughout the course of the study. They will be informed that any variance of their normal training programme may invalidate the study! (see appendix A)

- The test group will receive three osteopathic treatments at intervals of 12 to 14 days. Before each treatment the PWC 150 Test will be carried out on the Ergometer, which shows performance in Watt of the subject at the pulse frequency of 150.
  This test will be carried out again one month after the last treatment to show the
.
  efficiency of the treatment during a longer period of time.

- The control group will be tested in the same manner as the test group, but will not receive treatment.

Measurements

Objective:
This will be made using a „Tunturi Ergometer" in order to give a measurement of Watt output of energy at a pulse rate of 150 beats per minute.
It is achieved by initially setting a resistance of 50 Watts and the subject maintaining a speed of between 70-80 revolutions per minute. The resistance is increased every three minutes for 30 Watts until a pulse of 150 is exceeded.
At each gradation, the frequency is noted and marked on a chart. By extrapolation of the line on the chart the Wattage may be read at the 150 pulse line.
(See chart sample appendix B)

The wattage is then divided by the subjects weight to give a relative figure of Watt/Kg which is comparative for all subjects.

The pulse will be measured using a Polar pulseclock and chestbelt.

Subjective:
For both groups there will be a questionnaire asking about the self-assessment of the fitness of the subject, which should be filled out before each test.
(See appendix C)

Duration of the study

The duration of the study for each subject will be two months.

Validity and reliability

The PWC 150 is a WHO recommended standard test to measure the condition and performance of athletes and is highly reliable to show the endurance of hobby runners. This test is not influenced by weather conditions or the personal ambition of a subject.
All tests and treatments will be executed through the same person (myself).

Results and presentation of data:

CD-Rom using Microsoft Word and Microsoft Excel on pdf file. The data will be presented graphically and in table format.

Previous work

As far as I could research this would be the first study using Osteopathy to increase the performance of hobby runners.

Further Work

Positive results could provide the groundwork for a larger study including far more subjects than this pilot study. There could be a splitting of the subjects into different groups, e.g. male/female or marathon hobby runners.

Definitions:

My treatment will include an exact test of the musculoskeletal, visceral and craniosacral system. Osteopathic lesions will be treated as required by the patient.
I will note the Osteopathic treatment of each patient and on which level I have worked. If there should be any technique shown to be more effective than others it will be presented and discussed.

Franz Josef Haberl DPt

ANNEX 3

STATISTICAL DATA SHEET

Measured Data

ID	Gender	Age	kg	W 150 T1	W p kg T1	Lg T1	W 150 T2	W p kg T2	W 150 T3	W p kg T3	W 150 T4	W p kg T4	Amount of Training
T01	m	36	70	216,15	3,09	5	190,00	2,71	223,33	3,19	215,00	3,07	420
T02	m	33	70	206,00	2,94	5	203,53	2,91	200,00	2,86	216,36	3,09	124
T03	m	29	56	164,55	2,94	4	166,25	2,97	167,39	2,99	159,41	2,85	370
T04	m	40	68	173,53	2,55	5	174,00	2,56	185,00	2,72	182,00	2,68	200
T05	m	41	82	192,50	2,35	4	197,86	2,41	186,00	2,27	181,25	2,21	420
T06	m	42	83	177,50	2,14	4	178,00	2,14	188,95	2,28	173,33	2,09	240
T07	m	42	72	153,75	2,14	4	160,40	2,23	161,82	2,25	156,00	2,17	320
T08	m	40	61	110,00	1,80	4	110,00	1,80	123,64	2,03	123,64	2,03	240
T09	m	30	82	132,11	1,61	3	145,45	1,77	151,54	1,85	150,91	1,84	135
T10	m	35	84	136,00	1,62	3	140,00	1,67	115,63	1,38	136,00	1,62	150
T11	w	38	63	156,67	2,49	5	162,00	2,57	163,08	2,59	166,00	2,63	600
T12	w	40	62	133,33	2,15	5	134,00	2,16	160,00	2,58	135,91	2,19	120
T13	w	35	58	91,84	1,58	4	90,34	1,56	80,00	1,38	98,95	1,71	120
T14	w	43	69	100,87	1,46	4	112,14	1,63	111,43	1,61	118,57	1,72	180
T15	w	28	58	80,00	1,38	3	68,75	1,19	51,88	0,89	65,00	1,12	140
T16	w	35	60	83,60	1,39	3	81,30	1,36	120,91	2,02	91,79	1,53	60
T17	w	44	72	87,89	1,22	3	101,11	1,40	96,67	1,34	110,00	1,53	60
K01	m	45	70	224,38	3,21	5	218,75	3,13	227,86	3,26	216,50	3,09	300
K02	m	38	72	224,55	3,12	5	230,00	3,19	230,00	3,19	233,00	3,24	175
K03	m	43	90	213,64	2,37	4	220,00	2,44	209,00	2,32	227,50	2,53	150
K04	m	34	73	180,71	2,48	4	176,92	2,42	181,54	2,49	172,73	2,37	180
K05	m	39	71	168,00	2,37	4	181,54	2,56	176,92	2,49	170,00	2,39	210
K06	m	39	75	177,89	2,37	4	170,00	2,27	181,05	2,41	185,00	2,47	160
K07	m	45	85	200,00	2,35	4	170,00	2,00	176,00	2,07	168,50	1,98	60
K08	m	25	65	149,60	2,30	4	156,67	2,41	155,00	2,38	143,53	2,21	150
K09	m	39	76	157,14	2,07	4	165,38	2,18	114,00	1,50	136,25	1,79	140
K10	m	28	70	133,33	1,90	3	140,00	2,00	134,00	1,91	122,35	1,75	180
K11	w	38	70	123,75	1,77	4	113,53	1,62	115,71	1,65	115,45	1,65	180
K12	w	33	55	89,13	1,62	4	110,00	2,00	93,64	1,70	78,80	1,43	150
K13	w	42	58	92,00	1,59	4	87,20	1,50	95,94	1,65	90,00	1,55	140
K14	w	45	56	61,54	1,10	3	75,31	1,34	69,66	1,24	72,50	1,29	150

Men

Experimental Group Men

Mean Value	36,80	72,80	166,21	2,32	4,10	166,55	2,32	170,33	2,38	169,39	2,36	261,90
Standard Deviation	4,92	9,77	33,90	0,55	0,74	28,81	0,47	33,51	0,56	30,61	0,52	114,25

Control Group Men

Mean Value	37,50	74,70	182,92	2,45	4,10	182,93	2,46	178,54	2,40	177,54	2,38	170,50
Standard Deviation	6,74	7,48	31,93	0,41	0,57	29,97	0,41	37,62	0,53	38,32	0,49	60,21

Women

Experimental Group Women

Mean Value	37,57	63,14	104,89	1,67	3,86	107,09	1,69	111,99	1,77	112,32	1,78	182,86
Standard Deviation	5,50	5,43	28,98	0,47	0,90	32,19	0,49	40,55	0,65	32,46	0,50	188,83

Control Group Women

Mean Value	39,50	59,75	91,61	1,52	3,75	96,51	1,62	93,74	1,56	89,19	1,48	155,00
Standard Deviation	5,20	6,95	25,45	0,29	0,50	18,33	0,28	18,87	0,21	18,95	0,15	17,32

Men and Women

Experimental Group Men and Women

Mean Value	37,12	68,82	140,96	2,05	4,00	142,07	2,06	146,31	2,13	145,89	2,12	229,35
Standard Deviation	5,01	9,42	43,92	0,60	0,79	42,01	0,56	46,09	0,65	41,96	0,58	149,41

Control Group Men and Women

Mean Value	38,07	70,43	156,83	2,19	4,00	158,24	2,22	154,31	2,16	152,29	2,12	166,07
Standard Deviation	6,21	9,95	51,85	0,57	0,55	48,38	0,54	51,40	0,60	53,05	0,59	51,30

Performance change

ID	Gender	W p kg T1	Lg T1	W p kg T2	W p kg T3	W p kg T4	Amout of Training	T2T1	T3T1	T4T1	T3T2	T4T3
T01	m	3,09	5	2,71	3,19	3,07	420	87,84	103,25	99,40	117,54	96,27
T02	m	2,94	5	2,91	2,86	3,09	124	98,90	97,18	105,13	98,27	108,18
T03	m	2,94	4	2,97	2,99	2,85	370	100,98	101,67	96,82	100,69	95,23
T04	m	2,55	5	2,56	2,72	2,68	200	100,35	106,69	104,96	106,32	98,38
T05	m	2,35	4	2,41	2,27	2,21	420	102,68	96,52	94,06	94,01	97,45
T06	m	2,14	4	2,14	2,28	2,09	240	100,21	106,38	97,59	106,15	91,74
T07	m	2,14	4	2,23	2,25	2,17	320	104,10	105,02	101,25	100,88	96,40
T08	m	1,80	4	1,80	2,03	2,03	240	100,18	112,60	112,60	112,40	100,00
T09	m	1,61	3	1,77	1,85	1,84	135	110,18	114,78	114,31	104,18	99,58
T10	m	1,62	3	1,67	1,38	1,62	150	102,88	84,97	99,94	82,59	117,62
T11	w	2,49	5	2,57	2,59	2,63	600	103,27	103,96	105,82	100,66	101,79
T12	w	2,15	5	2,16	2,58	2,19	120	100,53	120,03	101,96	119,40	84,94
T13	w	1,58	4	1,56	1,38	1,71	120	98,59	87,30	107,97	88,55	123,68
T14	w	1,46	4	1,63	1,61	1,72	180	111,32	110,61	117,70	99,36	106,41
T15	w	1,38	3	1,19	0,89	1,12	140	85,89	64,81	81,21	75,45	125,30
T16	w	1,39	3	1,36	2,02	1,53	60	97,49	144,97	110,05	148,71	75,91
T17	w	1,22	3	1,40	1,34	1,53	60	115,11	110,05	125,23	95,60	113,79
K01	m	3,21	5	3,13	3,26	3,09	300	97,35	101,41	96,35	104,16	95,02
K02	m	3,12	5	3,19	3,19	3,24	175	102,39	102,39	103,72	100,00	101,30
K03	m	2,37	4	2,44	2,32	2,53	150	103,14	97,98	106,66	95,00	108,85
K04	m	2,48	4	2,42	2,49	2,37	180	97,73	100,28	95,41	102,61	95,15
K05	m	2,37	4	2,56	2,49	2,39	210	107,89	105,14	101,03	97,46	96,09
K06	m	2,37	4	2,27	2,41	2,47	160	95,64	101,86	104,08	106,50	102,18
K07	m	2,35	4	2,00	2,07	1,98	60	85,11	88,11	84,36	103,53	95,74
K08	m	2,30	4	2,41	2,38	2,21	150	104,79	103,68	96,01	98,94	92,60
K09	m	2,07	4	2,18	1,50	1,79	140	105,13	72,46	86,61	68,93	119,52
K10	m	1,90	3	2,00	1,91	1,75	180	105,26	100,75	91,99	95,71	91,31
K11	w	1,77	4	1,62	1,65	1,65	180	91,63	93,39	93,18	101,92	99,78
K12	w	1,62	4	2,00	1,70	1,43	150	123,46	105,09	88,44	85,12	84,16
K13	w	1,59	4	1,50	1,65	1,55	140	94,56	104,03	97,59	110,02	93,81
K14	w	1,10	3	1,34	1,24	1,29	150	122,26	113,08	117,69	92,49	104,08

Men

Experimental Group Men

Mean Value	2,32	4,10	2,32	2,38	2,36	261,90	100,83	102,91	102,61	102,30	100,09
Standard Deviatio	0,55	0,74	0,47	0,56	0,52	114,25	5,57	8,58	6,66	9,70	7,49

Control Group Men

Mean Value	2,45	4,10	2,46	2,40	2,38	170,50	100,44	97,41	96,62	97,28	99,77
Standard Deviatio	0,41	0,57	0,41	0,53	0,49	60,21	6,71	9,93	7,46	10,65	8,68
Probability-p							**0,89**	**0,20**	**0,07**		

Women

Experimental Group Women

Mean Value	1,67	3,86	1,69	1,77	1,78	182,86	101,74	105,96	107,13	103,96	104,55
Standard Deviatio	0,47	0,90	0,49	0,65	0,50	188,83	9,60	25,18	13,84	23,78	18,70

Control Group Women

Mean Value	1,52	3,75	1,62	1,56	1,48	155,00	107,98	103,90	99,23	97,39	95,46
Standard Deviatio	0,29	0,50	0,28	0,21	0,15	17,32	17,23	8,08	12,87	10,87	8,63
Probability-p							**0.48**	**0.87**	**0,41**		

Men and Women

Experimental Group Men and Women

Mean Value	2,05	4,00	2,06	2,13	2,12	229,35	101,20	104,16	104,47	102,99	101,92
Standard Deviatio	0,60	0,79	0,56	0,65	0,58	149,41	7,23	16,78	10,10	16,30	12,95

Control Group Men and Women

Mean Value	2,19	4,00	2,22	2,16	2,12	166,07	102,59	99,26	97,37	97,31	98,54
Standard Deviatio	0,57	0,55	0,54	0,60	0,59	51,30	10,59	9,63	8,84	10,29	8,57
Probability-p							**0,67**	**0,34**	**0,05**		

Selfevaluation

ID	Gender	AD T1	Strength S T1	Strength S T2	Strength S T3	Strength S T4	ELevel S T1	ELevel S T2	ELevel S T3	ELevel S T4	Fatigue S T1	Fatigue S T2	Fatigue S T3	Fatigue S T4	Fatigue S T1	Condition S T2	Condition S T3	Condition S T4	Change S T2	Change S T3	Change S T4
T01	m	5	7	5	7	7	6	4	7	6	6	5	7	5	8	6	8	8	1	3	3
T02	m	5	7	6	7	7	5	7	6	6	4	5	4	5	6	6	6	6	0	3	0
T03	m	4	8	8	6	5	8	8	6	5	8	9	7	4	7	6	7	5	0	0	1
T04	m	5	8	9	9	10	8	10	10	10	10	10	10	10	8	8	8	10	1	1	1
T05	m	4	7	5	5	6	7	6	5	6	5	6	6	5	8	9	8	7	3	0	1
T06	m	4	9	9	9	9	9	9	9	10	9	9	8	8	7	7	9	9	1	0	0
T07	m	4	8	8	8	9	8	8	7	8	7	7	7	8	7	8	7	8	0	0	0
T08	m	4	7	4	6	4	8	5	6	5	5	5	6	5	8	5	6	5	0	2	-1
T09	m	3	5	7	4	6	3	7	3	5	3	6	3	7	3	4	2	5	3	-2	0
T10	m	3	5	7	4	8	4	7	4	8	4	7	4	9	7	8	8	8	0	3	2
T11	w	5	10	10	10	10	10	10	8	10	9	10	10	10	10	10	10	10	4	5	1
T12	w	5	8	4	8	7	7	3	7	7	9	5	9	8	5	7	9	6	2	3	1
T13	w	4	5	7	7	3	5	7	7	4	5	7	7	3	7	8	7	5	2	3	0
T14	w	4	8	4	7	5	8	4	6	4	10	3	7	3	9	4	8	7	-1	3	3
T15	w	3	7	8	6	8	5	8	8	8	4	8	7	6	6	8	5	8	0	0	3
T16	w	3	2	8	4	4	2	5	4	3	3	5	4	3	3	4	3	5	1	2	1
T17	w	3	4	6	7	3	3	6	7	3	4	5	4	3	2	5	4	2	1	2	-2
K01	m	5	5	4	6	7	5	4	7	5	6	3	7	7	5	5	7	8	0	0	0
K02	m	5	8	5	4	4	7	5	3	4	7	5	4	5	6	4	6	4	0	0	0
K03	m	4	7	5	6	7	7	6	7	5	6	4	8	6	7	8	6	6	0	0	0
K04	m	4	7	4	7	7	7	4	7	5	5	5	8	4	7	5	8	5	0	0	0
K05	m	4	8	8	7	5	8	8	6	5	4	9	6	4	5	7	7	6	0	0	0
K06	m	4	7		6	4	7		5	4	6		5	4	5		3	3	0	0	0
K07	m	4	6	3	8	4	5	3	8	3	4	4	8	3	7	6	7	4	0	0	0
K08	m	4	5	6	7	9	5	4	7	9	5	4	7	8	5	7	3	7	0	0	0
K09	m	4	5	6	7	5	5	6	7	4	5	5	6	4	7	6	6	4	0	0	0
K10	m	3	3	3	4	5	3	5	3	6	3	5	4	5	3	6	3	4	0	0	0
K11	w	4	4	8	3	3	4	8	4	2	5	8	5	7	6	6	4	5	0	0	0
K12	w	4	5	2	5	4	5	3	6	4	5	4	5	5	2	4	5	4	0	0	0
K13	w	4	6	7	8	8	7	7	8	7	6	6	9	5	7	7	8	7	0	0	0
K14	w	3	5	5	8	3	5	5	9	3	5	8	9	5	1	7	6	3	0	0	0

Men

Experimental Group Men

Mean Valeu	4,10	7,10	6,80	6,50	7,10	6,60	7,10	6,30	6,90	6,10	6,90	6,20	6,60	6,90	6,70	6,90	7,10	0,90	1,00	0,70
Standard Deviation	0,74	1,29	1,75	1,84	1,91	2,01	1,79	2,11	1,97	2,33	1,85	2,10	2,07	1,52	1,57	1,97	1,79	1,20	1,70	1,16

Control Group Men

Mean Value	4,10	6,10	4,89	6,20	5,70	5,90	5,00	6,00	5,00	5,10	4,89	6,30	5,00	5,70	6,00	5,60	5,10	0,00	0,00	0,00
Standard Deviation	0,57	1,60	1,62	1,32	1,70	1,52	1,50	1,76	1,63	1,20	1,69	1,57	1,56	1,34	1,22	1,90	1,60	0,00	0,00	0,00

Women

Experimental Group Women

Mean Value	3,86	6,29	6,71	7,00	5,71	5,71	6,14	6,71	5,57	6,29	6,14	6,86	5,14	6,00	6,57	6,57	6,14	1,29	2,57	1,00
Standard Deviation	0,90	2,75	2,21	1,83	2,69	2,81	2,41	1,38	2,76	2,93	2,34	2,27	2,91	2,94	2,30	2,64	2,54	1,60	1,51	1,73

Kontrollgruppe weiblich

Mean Value	3,75	5,00	5,50	6,00	4,50	5,25	5,75	6,75	4,00	5,25	6,50	7,00	5,50	4,00	6,00	5,75	4,75	0,00	0,00	0,00
Standard Deviation	0,50	0,82	2,65	2,45	2,38	1,26	2,22	2,22	2,16	0,50	1,91	2,31	1,00	2,94	1,41	1,71	1,71	0,00	0,00	0,00

Men and Women

Experimental Group Men and Women

Mean Value	4,00	6,76	6,76	6,71	6,53	6,24	6,71	6,47	6,35	6,18	6,59	6,47	6,00	6,53	6,65	6,76	6,71	1,06	1,65	0,82
Standard Deviation	0,79	1,99	1,89	1,79	2,29	2,33	2,05	1,81	2,34	2,51	2,03	2,12	2,47	2,18	1,84	2,19	2,11	1,34	1,77	1,38

Control Group Men and Women

Mean Value	4,00	5,79	5,08	6,14	5,36	5,71	5,23	6,21	4,71	5,14	5,38	6,50	5,14	5,21	6,00	5,64	5,00	0,00	0,00	0,00
Standard Deviation	0,55	1,48	1,89	1,61	1,91	1,44	1,69	1,85	1,77	1,03	1,85	1,74	1,41	1,97	1,22	1,78	1,57	0,00	0,00	0,00

Selfevaluation osteopathic treatment - Men

Change		Men T2/T1						Men T3/T2						Men T4/T3					
		Experimental Group			Control Group			Experimental Group			Control Group			Experimental Group			Control Group		
Achievement	Number	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimation
3	n	1	1	0	-	-	-	0	1	1	-	-	-	2	0	0	-	-	-
	%	50	50	0	-	-	-	0	50	50	-	-	-	100	0	0	-	-	-
4	n	4	1	0	-	-	-	3	1	1	-	-	-	1	0	4	-	-	-
	%	80	20	0	-	-	-	60	20	20	-	-	-	20	0	80	-	-	-
5	n	2	0	1	-	-	-	1	1	1	-	-	-	1	1	1	-	-	-
	%	66,7	0,0	33,3	-	-	-	33,3	33,3	33,3	-	-	-	33,3	33,3	33,3	-	-	-
Total	%	70	20	10				40	30	30				40	10	50			

Strength		Men T2/T1						Men T3/T2						Men T4/T3					
		Experimental Group			Control Group			Experimental Group			Control Group			Experimental Group			Control Group		
Achievement	Number	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimation
3	n	2	0	0	0	1	0	1	1	0	0	0	1	1	0	1	0	0	1
	%	100	0	0	0	100	0	50	50	0	0	0	100	50	0	50	0	0	100
4	n	2	3	0	1	5	1	2	2	1	3	1	3	0	1	4	2	3	2
	%	40	60	0	14,3	71,4	14,3	40	40	20	42,9	14,3	42,9	0	20	80	28,6	42,9	28,6
5	n	3	0	0	0	1	1	2	1	0	2	0	0	1	1	1	1	0	1
	%	100	0	0	0	50	50	66,7	33,3	0	100	0	0	33,3	33,3	33,3	50	0	50
Total	%	70	30	0	10	70	20	50	40	10	50	10	40	20	20	60	30	30	40

Energy		Men T2/T1						Men T3/T2						Men T4/T3					
		Experimental Group			Control Group			Experimental Group			Control Group			Experimental Group			Control Group		
Achievement	Number	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimation
3	n	2	0	0	1	0	0	1	1	0	1	0	0	1	0	1	0	0	1
	%	100	0	0	100	0	0	50	50	0	100	0	0	50	0	50	0	0	100
4	n	2	3	0	1	5	1	1	3	1	3	1	3	1	0	4	3	2	2
	%	40	60	0	14,3	71,4	14,3	20	60	20	42,9	14,3	42,9	20	0	80	42,9	28,6	28,6
5	n	1	0	2	0	1	1	2	1	0	1	1	0	1	1	1	2	0	0
	%	33,3	0	66,7	0	50	50	66,7	33,3	0	50	50	0	33,3	33,3	33,3	100	0	0
Total	%	50	30	20	20	60	20	40	50	10	50	20	30	30	10	60	50	20	30

Fatigue		Men T2/T1						Men T3/T2						Men T4/T3					
		Experimental Group			Control Group			Experimental Group			Control Group			Experimental Group			Control Group		
Achievement	Number	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimation
3	n	2	0	0	1	0	0	1	1	0	0	0	1	1	0	1	0	0	1
	%	100	0	0	100	0	0	50	50	0	0	0	100	50	0	50	0	0	100
4	n	3	2	0	2	3	2	1	3	1	3	1	3	2	0	3	4	2	1
	%	60	40	0	28,6	42,9	28,6	20	60	20	42,9	14,3	42,9	40	0	60	57,1	28,6	14,3
5	n	2	0	1	1	1	0	2	1	0	2	0	0	2	1	0	1	0	1
	%	66,7	0	33,3	50	50	0	66,7	33,3	0	100	0	0	66,7	33,3	0	50	0	50
Total	%	70	20	10	40	40	20	40	50	10	50	10	40	50	10	40	50	20	30

Ph. Condition		Men T2/T1						Men T3/T2						Men T4/T3					
		Experimental Group			Control Group			Experimental Group			Control Group			Experimental Group			Control Group		
Achievement	Number	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimation
3	n	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1
	%	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100
4	n	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2
	%	42,9	28,6	28,6	42,9	28,6	28,6	42,9	28,6	28,6	42,9	28,6	28,6	42,9	28,6	28,6	42,9	28,6	28,6
5	n	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1	0	1	1
	%	0	50	50	0	50	50	0	50	50	0	50	50	0	50	50	0	50	50
Total	%	30	30	40	30	30	40	30	30	40	30	30	40	30	30	40	30	30	40

Mean from 4 Questions		Men T2/T1						Men T3/T2						Men T4/T3					
		Experimental Group			Control Group			Experimental Group			Control Group			Experimental Group			Control Group		
Achievement	Number	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimation
3	%	75	0	25	50	25	25	38	38	25	25	0	75	38	0	63	0	0	100
4	%	46	47	7	25	54	21	31	47	22	43	18	39	26	12	62	43	32	25
5	%	50	13	38	13	50	38	50	38	13	63	25	13	33	38	29	50	13	38

Mean Value		Men Mean Value aus T2/T1, T3/T2, T4/T3					
		Experimental Group			Control Group		
Achievement	Number	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimation	Overestimation
3	%	50	13	38	25	8	67
4	%	34	35	30	37	35	29
5	%	44	29	26	42	29	29

Selfevaluation osteopathic treatment - Women

Change		Woman T2/T1						Women T3/T2						Women T4/T3					
		Experimental Group			Control Group			Experimental Group			Control Group			Experimental Group			Control Group		
Achievment	Number	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimation
3	n	0	1	2	-	-	-	1	0	2	-	-	-	1	1	1	-	-	-
	%	0	33,3	66,7	-	-	-	33,3	0	66,7	-	-	-	33,3	33,3	33,3	-	-	-
4	n	0	1	1	-	-	-	0	0	2	-	-	-	1	1	0	-	-	-
	%	0	50	50	-	-	-	0	0	100	-	-	-	50	50	0	-	-	-
5	n	1	0	1	-	-	-	1	0	1	-	-	-	1	0	1	-	-	-
	%	50	0	50	-	-	-	50	0	50	-	-	-	50	0	50	-	-	-
Total	%	14	29	57	-	-	-	29	0	71	-	-	-	43	29	29	-	-	-

Strength		Woman T2/T1						Women T3/T2						Women T4/T3					
		Experimental Group			Control Group			Experimental Group			Control Group			Experimental Group			Control Group		
Achievment	Number	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimation
3	n	1	0	2	0	1	0	1	1	1	0	0	1	1	1	1	0	0	1
	%	33,3	0,0	66,7	0	100	0	33,3	33,3	33,3	0	0	100	33,3	33,3	33,3	0	0	100
4	n	0	1	1	0	1	2	0	0	2	0	2	1	0	2	0	0	2	1
	%	0	50,0	50,0	0	33,3	66,7	0	0	100	0	66,7	33,3	0	100	0	0	66,7	33,3
5	n	0	2	0	-	-	-	2	0	0	-	-	-	1	0	1	-	-	-
	%	0	100,0	0	-	-	-	100	0	0	-	-	-	50	0	50	-	-	-
Total	%	14	43	43	0	50	50	43	14	43	0	50	50	29	43	29	0	50	50

Energy		Woman T2/T1						Women T3/T2						Women T4/T3					
		Experimental Group			Control Group			Experimental Group			Control Group			Experimental Group			Control Group		
Achievment	Number	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimation
3	n	1	0	2	0	1	0	0	1	2	0	0	1	0	2	1	0	1	0
	%	33,3	0	66,7	0	100	0	0	33,3	66,7	0	0	100	0	66,7	33,3	0	100	0
4	n	0	1	1	0	1	2	0	0	2	0	2	1	0	2	0	1	1	1
	%	0	50	50	0	33,3	66,7	0	0	100	0	66,7	33,3	0	100	0	33,3	33,3	33,3
5	n	0	2	0	-	-	-	1	1	0	-	-	-	0	0	2	-	-	-
	%	0	100	0	-	-	-	50	50	0	-	-	-	0	0	100	-	-	-
Total	%	14	43	43	0	50	50	14	29	57	0	50	50	0	57	43	25	50	25

Fatigue		Woman T2/T1						Women T3/T2						Women T4/T3					
		Experimental Group			Control Group			Experimental Group			Control Group			Experimental Group			Control Group		
Achievment	Number	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimation
3	n	0	1	2	1	0	0	0	1	2	0	0	1	0	2	1	0	1	0
	%	0	33,3	66,7	100	0	0	0	33,3	66,7	0	0	100	0	66,7	33,3	0	100	0
4	n	0	1	1	0	1	2	0	0	2	1	1	1	0	2	0	1	0	2
	%	0	50	50	0	33,3	66,7	0	0	100	33,3	33,3	33,3	0	100	0	33,3	0	66,7
5	n	0	2	0	-	-	-	2	0	0	-	-	-	1	0	1	-	-	-
	%	0	100	0	-	-	-	100	0	0	-	-	-	50	0	50	-	-	-
Total	%	0	57	43	25	25	50	29	14	57	25	25	50	14	57	29	25	25	50

Ph. Condition		Woman T2/T1						Women T3/T2						Women T4/T3					
		Test Group			Control Group			Experimental Group			Control Group			Experimental Group			Control Group		
Achievment	Number	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimation
3	n	1	0	2	1	0	0	1	1	1	0	0	1	1	1	1	0	1	0
	%	33,3	0	66,7	100	0	0	33,3	33,3	33,3	0	0	100	33,3	33,3	33,3	0	100	0
4	n	1	1	0	1	0	2	0	0	2	0	2	1	0	2	0	1	0	2
	%	50	50	0	33,3	0	66,7	0	0	100	0	66,7	33,3	0,0	100,0	0,0	33,3	0	66,7
5	n	0	1	1	-	-	-	2	0	0	-	-	-	2	0	0	-	-	-
	%	0	50	50	-	-	-	100	0	0	-	-	-	100	0	0	-	-	-
Gesamt	%	29	29	43	50	0	50	43	14	43	0	50	50	43	43	14	25	25	50

Mean from 4 Questions		Women T2/T1						Women T3/T2						Women T4/T3					
		Experimental Group			Control Group			Experimental Group			Control Group			Experimental Group			Control Group		
Achievment	Number	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimatio	Accurate Ev.	Underestimat	Overestimation
3	%	25,0	8,3	66,7	50,0	50,0	0,0	16,7	33,3	50,0	0,0	0,0	100,0	16,7	50,0	33,3	0,0	75,0	25,0
4	%	12,5	50,0	37,5	8,3	25,0	66,7	0,0	0,0	100,0	8,3	58,3	33,3	0,0	100,0	0,0	25,0	25,0	50,0
5	%	0,0	87,5	12,5	-	-	-	87,5	12,5	0,0	-	-	-	50,0	0,0	50,0	-	-	-

Mean Value		Women Mean Value T2/T1, T3/T2, T4/T3					
		Experimental Group			Control Group		
Achievement	Number	Accurate Ev.	Underestimation	Overestimation	Accurate Ev.	Underestimation	Overestimation
3	%	19,4	30,6	50,0	16,7	41,7	41,7
4	%	4,2	50,0	45,8	13,9	36,1	50,0
5	%	45,8	33,3	20,8	-	-	-

ANNEX 4

CONSENT FORM

<u>CONSENT FORM</u>

<u>TITLE OF THESIS</u>**:**

A comparative study using osteopathic treatment to enhance the performance of hobby runners.

<u>Name of Student:</u> Franz Josef Haberl

I,..., born ...., do declare that I am fully prepared to willingly take part in the above named study.

I have been informed, that I must maintain my constant training programme through-out the whole course of the study.

I understand, that any variance of the normal training programme may invalidate the study!

I am in a full state of health.

Throughout the whole course of the study I will not receive any other treatments to increase my performance.

I will not change my regular diet during the study, because this would influence my personal performance.

I am aware, that I may withdraw of the study at any time without the need for giving a reason.

I am fully aware of what my participation of this study involves.

***Signed*______________________________**

***Date*__________________**

ANNEX 5

GENERAL QUESTIONAIRE

GENERAL QUESTIONAIRE

<u>THESIS:</u> A comparative Study using Osteopathic Treatment to Enhance the Performance of Hobby Runners

Student: Franz Josef Haberl

<u>Dear Participant!</u>

At the beginning of this study I would like ask you to answer the following questionaire.
Thank you for your cooperation!

<u>Name:</u> ________________________________ <u>Date of birh:</u> _______________

<u>Age:</u> **Date:**_______________

<u>Member of the:</u>

<u>EXPERIMENTAL GROUP</u> **<u>CONTROL GROUP</u>**

State of health

<u>Did you ever suffer from cardiac or lung diseases?</u>

YES **NO**

If YES, which kind of diseases:

GENERAL QUESTIONAIRE

Name:______________________________

Are you:

HOBBYRUNNER PROFESSIONAL RUNNER

Amount of training per week during the course of the study:

1x 2x 3x 4x 5x 6x 7x

Time in minutes for each training:

Other individual scheme:

Personal running performance:

Marathon:______________________ Date:__________

Halfmarathon:__________________ Date:__________

10.000 Meter:___________________ Date:__________

5.000 Meter:___________________ Date:__________

ANNEX 6

SELF-ASSESSMENT OF THE FITNESS

SELF-ASSESSMENT OF THE FITNESS

Name:______________________ Date of Birth:______________

Test Number: I one I two I three I four I

DATE OF TEST:______________ Date of previous Test: _____________

Dear participant of the study!

Before we start testing Your personal endurance on the ergometer, I would like to ask You to assess Your fitness and to fill in this questionnaire.
Please mark the number which corresponds with Your personal feeling.

Thank You for Your cooperation!

Today I feel:

WEAK I 1 I 2 I 3 I 4 I 5 I 6 I 7 I 8 I 9 I 10 I STRONG

EXHAUSTED I 1 I 2 I 3 I 4 I 5 I 6 I 7 I 8 I 9 I 10 I FULL OF ENERGY

TIRED I 1 I 2 I 3 I 4 I 5 I 6 I 7 I 8 I 9 I 10 I RESTED

UNTRAINED I 1 I 2 I 3 I 4 I 5 I 6 I 7 I 8 I 9 I 10 I WELL TRAINED

Since my last osteopathic treatment my running performance has:

DETORIATED I 5 I 4 I 3 I 2 I 1 I 0 I 1 I 2 I 3 I 4 I 5 I IMPROVED

--

Abstract

THE INFLUENCE OF OSTEOPATHIC TREATMENT ON THE PERFORMANCE OF HOBBY RUNNERS

A Comparative, Clinical Study Using Osteopathic Treatment to Enhance the Performance of Hobby Runners

by Franz Josef Haberl

Purpose: Osteopathic treatment usually aims at enhancing or restoring a state of health in the patient. This study investigates whether osteopathic treatment can be used to increase the athletic performance of healthy hobby runners.

Study Design: retrospective, comparative, statistically evaluated clinical case study

Method: Two comparative groups with a defined age limit (test group n=17, control group n=14) followed a constant individual training regimen over a period of two months. During this period, the test group received three osteopathic treatments at regular intervals of two weeks. Before each treatment, the personal fitness level was assessed by means of a PWC 150 ergometer test. One month after the third treatment, the ergometer test was repeated in order to assess a possible sustained effect of treatment. The performance of the control group was measured in the same routine and at similar intervals as that of the test group.
Additionally, a questionnaire was answered by all participants for subjective self evaluation of fitness levels before each test.

Results: The results of the two groups are graphically presented for comparison.

Conclusion: Compared to the control group, the osteopathically treated test group showed a statistically significant increase in performance capability. The experimental group was able to increase performance capability by an average of approximately 4.5%. Measured performance increased by an average of 8% among female and 5.5% among male test persons compared to the control group. Treatment showed a sustained effect in three out of five achievement groups, with a further increase in performance levels between the third and the fourth test. One achievement group of the control group also increased performance in this period.
Evaluation of questionnaires proved that neither of the two groups was able to accurately self evaluate their performance capability.
Apart from the low number of participants, the results confirmed that osteopathic treatment is able to enhance performance capability and improves the sustained effect of training.

Key words: Osteopathy, running, sports, PWC-150 Test, ergometer, performance increase.