ORIGINAL RESEARCH

# Athletic Performance and Physiological Measures in Baseball Players Following Upper Cervical Chiropractic Care: A pilot study

*Jon Schwartzbauer, D.C., Jason Kolber, Mitzi Schwartzbauer, D.C., John Hart, D.C., John Zhang, M.D., Ph.D.*

**Abstract** — Changes in athletic performance and physiological measures in university baseball players was assessed before, during and after a specific duration of upper cervical chiropractic care. Each athlete's performance was evaluated through assessment of the vertical jump, broad jump specified, standing broad jump, and muscle strength. Physiological measures including blood pressure, pulse rate, microcirculation (capillary counts), and treadmill stress testing were also evaluated. Twenty one male baseball players, assigned randomly to either a control or chiropractic (adjustment) group, completed the study. The subjects were required to complete three sessions of athletic ability and physiological tests. The first session was administered before commencing chiropractic care. The second and third sessions were administered after the initiation of chiropractic care at five and fourteen weeks, respectively. Only those subjects in the adjustment group received chiropractic care. The results showed significant improvement at fourteen weeks in muscle strength and long jump distance in the group receiving adjustments. Moreover, this same group showed significant improvement in capillary counts at five and fourteen weeks of chiropractic care. Trends in decreased or increased performance in other physical and physiological measures were accompanied by either moderate or large effect sizes within both the chiropractic group and control group. Evaluation of these trends in the group receiving chiropractic care revealed decreases in resting blood pressure and pulse rate as well as pulse rate following tread mill activity. By comparison, trends in these same measures showed increases within the control group.

*Key words: Athletic performance, chiropractic, vertebral subluxation, cardiovascular system.*

## Introduction

The central tenet of subluxation-based chiropractic care is the existence of vertebral subluxation and its detrimental consequences on the health of the individual.[1] Subluxation theory describes how misalignment of any of the movable components of the spinal column has the potential to interfere with the normal functioning of the nervous system, thereby effecting the body's ability to respond or adapt to the environment. While the misalignment component of vertebral subluxation is easily demonstrable, more challenging is the demonstration of nervous interference and its consequence on the proper functioning of the body.[1]

Vertebral subluxation theory was founded on the careful observations of D.D. Palmer and B.J. Palmer and has accumulated a wealth of anecdotal evidence over the last century. Although B.J. Palmer began testing this theory with greater scientific stringency, this process has only recently escalated within the profession.[2] One of the inherent difficulties of vertebral subluxation research is a direct consequence of the complexity of the nervous system; namely, one cannot predict the effect of any one vertebral subluxation on bodily function. As a consequence, most research is directed to observing the association between chiropractic care and changes in individual body systems on a case by case basis, or quantifying the effects of chiropractic care on the overall fitness and health in large groups of people.

In this regard, the current resurgent interest in chiropractic research is generating a growing body of evidence supportive of vertebral subluxation theory. For example, numerous reports of improved immunological function following chiropractic adjustments have recently appeared.[3-6] Such findings support the more subjective observations of field chiropractors who have long found that patients under care are chronically ill less often than those not under care. The link between the immune system and the nervous system suggested by these reports is made more compelling given the recent histological finding of a direct communication between the two systems.[7]

Athletes are a particularly interesting group in which to study the putative relationship between vertebral subluxation and physical and physiological function since they are constantly stressing their bodies to achieve maximum performance. However, this characteristic also presents a measurement problem. Since even

*Address reprint requests to:* John Q. Zhang, MD, Ph.D., Department of Research, Sherman College of Straight Chiropractic, 2020 Springfield Road, Spartanburg, SC 29304.

small changes in overall function and adaptability of an athlete can have a significant effect on his or her performance, it may be difficult to quantitatively record the subtle changes which manifest in profound changes in levels of performance. The present study was conducted to ascertain the extent of this phenomenon, and in doing so to evaluate the utility of measuring physical and physiological functions as outcomes associated with chiropractic care administered for the correction of vertebral subluxation.

Unfortunately, the intense competition that pervades many sports has prompted some athletes to use illegal drugs to boost performance, with often severe long term consequences to their bodies.[8] Therefore, it is important to discover a variety of assessments which document the efficacy of chiropractic in the improvement of human performance since its methods offer a non-therapeutic and drugless means for athletes to attain optimal physical expression of their abilities. For example, Grimston and co-workers demonstrated an eighty-three percent increase in training mileage in eighteen female long distance runners while receiving chiropractic manipulation.[9] Bonci and colleagues showed immediate strength improvement in biceps and trunk erector muscle following chiropractic manipulation.[10,11] Chiropractic care may also be beneficial in the recovery of chronically injured athletes.[12-15] Lauro and Mouch[16] observed similar improvements in athletic ability following correction of vertebral subluxation in their subjects, but could only speculate on the mechanism by which athletic performance was improved.

Employing a number of the assessments evaluated by Lauro and Mouch, the present pilot study investigated the feasibility and sensitivity of detecting changes in physical and physiological measures in athletes before, during, and after a specified duration of chiropractic care. In addition, the present study examined the plausibility of measuring effects of chiropractic adjustments on certain physiological parameters to advance the knowledge base related to athletic performance.

## Materials and Methods

*Subjects*

Twenty-eight male university baseball players (ages 19 - 23 years) were recruited for the study which was conducted for fourteen weeks between January 1 - April 15, 1996. Only players that were free of physical injury were selected for the study. Consent was obtained from all players according to the Human Subjects Protocol of Sherman College. Only data from players that remained free from physical injury throughout the study were used in the final analyses. Twenty-eight players, all of whom had the same workout regimen (since they participated in the same sport) were randomly assigned to either a control or chiropractic group. Twenty one players completed the study; nine in the chiropractic group and twelve in the control group.

*Study Design*

The pilot study was a longitudinal design with all athletes evaluated through the same performance and physiologic measures at the beginning of the study, at five weeks, and at fourteen weeks duration of chiropractic care. The two groups were treated identically, except that the control group never received chiropractic adjustments. Chiropractic assessments were made on both groups during the first week of the study using radiographic analysis and thermographic profiling of the spine. Before adjustments were administered, a baseline profile of athletic ability and physiological function was compiled for each athlete using the tests described below. Following commencement of care in the chiropractic group, all athletes were re-evaluated at five and fourteen weeks of the study.

*Chiropractic Analysis*

Prior to initiating chiropractic adjustments, all players received a specific radiographic examination of the cervical spine to identify the misalignment component of upper cervical vertebral subluxation. Neutral lateral and anterior to posterior (A-P) open mouth views were routinely taken. When necessary, to achieve better visualization of relationships between vertebrae, nasium views were obtained. Vertebral relationships were identified using the Palmer System of Analysis, with particular emphasis given to the "point wedge" formed by the atlas plane line and occiput condyle plane lines.[17]

Paraspinal thermographic profiles of the cervical regions of each athlete were taken on a weekly basis using the Accolade III system (STI, Inc., New York), a dual probe infrared detection devise. The Accolade with a single probe infrared sensor was also used to measure atlas fossa temperature differentials. Paraspinal thermographic profiles were taken with the athlete seated in a posture constant chair with a face resting plate for accurate graphing.[18] At least two similar graph patterns were established prior to administration of an adjustment in the chiropractic group. The persistence of a thermographic pattern was used as the major criterion for determining when to administer an adjustment. The specific segmental level for the adjustment was determined by radiographic findings coupled with motion and static muscle and bony palpation. Adjustments for cervical vertebral subluxation were given by a licensed chiropractor using the Palmer toggle-recoil thrust in the side posture position, employing a drop head piece.[19] All methods employed were representative of methods employed in the Health Center of Sherman College of Straight Chiropractic. Subjects were rested at least ten minutes following the adjustment. All controls were examined by the same procedure but received no adjustments.

## Athletic Performance Tests

*Vertical Jump Test*

This tests measured vertical jumping ability. Athletes were instructed to jump as high as possible from a squatting position while maintaining contact with the wall. The athlete was allotted three attempts with the average value recorded for data analysis.

*Broad Jump Specified (Horizontal Linear Space Test)*

In this test, the subject was shown a focal spot on a 120 inch fiberglass tape measure fixed to the floor. The athlete was then blindfolded, paused for ten seconds and then asked to jump to where the spot was located, lining up the back of the heel up with the focal spot. Three attempts were allowed and an average distance from jump to spot was then calculated .

*Standing Broad Jump*

This test measured the ability of the athlete to jump forward as far as possible from a standing position. The distance was measured in inches and the average of three jumps was calculated.

*Muscle Strength*

This test measured muscular strength of the athlete. The subject was instructed to hold a ten pound free weight in each hand and performed as many abduction repetitions as physically possible. The exercise involved abduction of the arms, bringing them to meet in the center and back to the sides always staying parallel to the floor.

*Physiological Tests*

*Resting Blood pressure and Resting Pulse Rate*

These measures were taken with an automatic blood pressure and pulse instrument (Marshall 97, Omron Healthcare, Inc, Japan). Measurements were taken with the subject in a sitting position and the cuff around the subjects' right arm. Resting blood pressure (systole and diastole) and pulse rate were then recorded.

*Treadmill/ Stress Test*

This Test was performed on a Vitamaster Pro 1200, Model 8712 SA treadmill, Tyler, Texas 1995. Subjects were first instructed to perform at a warm-up pace of 1.5 miles per hour for two minutes. The velocity was then increased to 5 miles per hour and maintained at that pace for three minutes. The same procedure was followed after a rest period of one hour, but the 5 miles per hour pace was maintained for eight minutes. The pulse rate was monitored by the Vitamaster and recorded at the end of each run.

*Nailfold microcirculation*

This measure was analyzed using a stereo-microscope, (Wolfe, Carolina Biological SupplyCo., Burlington, North Carolina) at 60x magnification. Athletes were first allowed to acclimatize in a constant room temperature (22-23 degrees centigrade) before views were made of the capillaries in the middle finger of both hands maintained at heart level. A thin layer of oil was applied to the nailfold prior to observation. Capillary morphology was assessed, special attention being paid to the presence of dilated capillaries. The number of capillaries in one microscopic view was counted in the left and right middle fingers of each athlete before and after an eight minute treadmill run (considered a cardiovascular stress test). This evaluation was performed at baseline, five weeks and again at fourteen weeks. in each test. The subjects were allowed a cool down period of three minutes after the treadmill run before assessing post cardiovascular stress microcirculation.

*Data Analysis*

In order to evaluate change relative to a common index, each physical and physiological measure over sessions two (five weeks) and three (fourteen weeks) were converted to percentages of baseline values. This conversion was incorporated since the often small magnitude of change in absolute numbers of each parameter, coupled to the small number of subjects, decreased the probability of detecting statistical differences between and within the two groups . Moreover, since positive or negative change could represent improvement (depending on the test, i.e. blood pressure versus muscle strength), a one tailed t-test was used to evaluate data when significant differences ($p < 0.05$) were indicated by analysis of variance.

The rigor of the t-test was increased by using alpha values derived from Dunnett's procedure for comparing multiple t-tests.[20] Moreover, trends were demonstrated graphically by plotting averages of the absolute values to reveal trends within and between the two groups.

In order to further evaluate the magnitude of changes within and between groups, effect sizes were calculated for each measurement. These values were derived by obtaining the difference between absolute value means taken at baseline and five weeks, and baseline and fourteen weeks. The difference was divided by the standard deviation for the baseline mean. This provided an index of the magnitude of change with 0.2 being considered a small effect, 0.5 a moderate effect, and 0.8 a large effect.[21]

All statistical tests were analyzed by the Statmost computer program (Salt Lake City, Datamost Corporation, 1995). All statistical tests were considered significant at the $p < 0.05$ level.

## Results

Data gathered in regard to overall performance and physiological status between and within each group, expressed as a percent of baseline values, are presented in Tables 1 - 3. Distinct improvement was observed within the adjusted group in regard to muscle strength, long jump distance, and vertical jump distance, while a decreased level of performance was observed in the specified broad jump. A similar trend was observed in the control group regarding muscle strength and the vertical jump, with a decrease in performance in the long jump and specified broad jump. Interestingly, while values were not significantly different between the groups, in each instance of improvement the adjusted group demonstrated substantially greater percentage increases relative to baseline than did the control group. Although there were no significant differences within the control group, the group receiving chiropractic care showed significant improvement ($p < 0.05$) in the fourteen week evaluation compared to baseline values in both muscle strength and long jump distance (Table 1, Figures 1, 2). Additionally, while both groups exhibited sufficient improvement in muscle strength to demonstrate a large effect size, the magnitude of the effect size in the adjusted group was more than twice that of the controls (Table 1).

Capillary counts in the left and right fingers of controls and the adjustment group were also substantially different both before and after an eight minute treadmill run (cardiovascular stress). Before the treadmill run, the adjustment group exhibited significantly greater capillary counts in the left finger at both five and

Table 1. Changes in Athletic Ability Associated with Upper Cervical Chiropractic Care

| | Percent Change from Baseline (Mean ± Std. Dev.) | | Effect Size+ | |
|---|---|---|---|---|
| | *Five weeks* | *Fourteen weeks* | *Five Weeks* | *Fourteen Weeks* |
| **Muscle Strength** | | | | |
| Control Group | 4.0 ± 0.42 | 7.7 ± 0.27 | - 0.2 | - 0.8 |
| Adjusted Group | 23.3 ± 0.39 | 35.7 ± 0.34‡ | - 1.2 | - 1.9 |
| **Long Jump** | | | | |
| Control Group | - 7.0 ± 0.26 | - 1.0 ± 0.04 | 1.3 | 0.1 |
| Adjusted Group | 0.32 ± 0.03 | 3.6 ± 0.04‡ | - 0.1 | - 0.3 |
| **Vertical Jump** | | | | |
| Control Group | 0.29 ± 0.02 | 0.90 ± 0.02 | - 0.1 | - 0.2 |
| Adjusted Group | 0.35 ± 0.03 | 0.76 ± 0.02 | - 0.1 | - 0.1 |
| **Specified Broad Jump** | | | | |
| Control Group | - 4.7 ± 0.71 | - 4.0 ± 0.76 | 0.3 | 0.3 |
| Adjusted Group | - 7.0 ± 0.61 | - 2.3 ± 0.85 | 0.4 | 0.4 |

+ Effect size = (baseline mean - test mean / standard deviation of baseline mean). Unlike percent changes from baseline, a negative effect size connotes an increase in magnitude while a positive effect size connotes a decrease in magnitude. Values of 0.2 to 0.4 represent a small effect size, 0.5 to 0.7 a moderated effect, and 0.8 and above, a large effect size.

‡ Represents a significant difference in percent change between the fourteen week value and baseline ($p < 0.05$).

fourteen weeks, compared to baseline counts (Table 2, Figures 4,5). In addition, the magnitude of change was expressed as a large effect size at five weeks ( > 0.8), and a moderate effect (0.5) at fourteen weeks (Table 2). In the adjustment group, right finger capillary counts were significantly greater ($p < 0.05$) than baseline at five weeks, but not at fourteen weeks. This change was also expressed as a large effect (> 0.8).

After the treadmill run, the adjustment group showed a significant increase in capillary count in the left finger at the five week interval, with an accompanying large effect size (> 0.8). Although an increase in capillary count was apparent in the right finger as well, the differences were not statistically significant, but did reveal a moderate effect (> 0.5) at both five and fourteen weeks (Table 2, Figures 6,7). By comparison, there were no significant increases in capillary count in the control group either before or after the treadmill run in regard to the baseline count. However, a substantial increase relative to baseline was observed at fourteen weeks (Table 2, Figure 4) in the right pre-treadmill finger capillary count of controls, with an accompanying moderate effect size (> 0.5).

While no statistically significant differences were recorded in regard to pulse or blood pressure in either the control or adjustment group under any of the conditions of the study, substantial differences were evidenced by the magnitude of effect sizes (Table 3). For example, compared to baseline, controls exhibited moderate (> 0.5) effects at five and fourteen week intervals regarding increases in pulse rate after 3 minute treadmill runs. This same trend was observed within controls at the five week interval following the 8 minute treadmill run. By contrast, the adjustment group showed substantial decreases in pulse rate under the same conditions (Table 3). Resting pulse rate as well as systolic and diastolic blood pressure (without prior treadmill runs) also showed a downward trend in the adjustment group compared to an upward trend in the control group (Table 3, Figure 8). As seen in Table 3, in regard to systolic blood pressure, the magnitude of increased effect was large in the control group (0.8), while the magnitude of decrease in the adjustment group revealed a moderate effect size (0.6).

## Discussion and Conclusions

The present pilot study served to elucidate several important aspects of employing physical and physiological measures to assess the efficacy of chiropractic care in athletes. As anticipated, individuals routinely functioning at a high level of ability and usually in excellent athletic condition, limit the ceiling (or range) of performance levels. Alternatively, certain areas such as muscle strength and ability tests which accommodate a wide range of improvement can serve as useful assessments. This would include repetition movements or coordination events such as the abduction weight movements and the long jump. More subtle events involving kinesthetic perception as well as muscular coordination, such as the specified broad jump and the vertical jump, may require more sensitive measure to assess improvement. This

## Muscle Strength

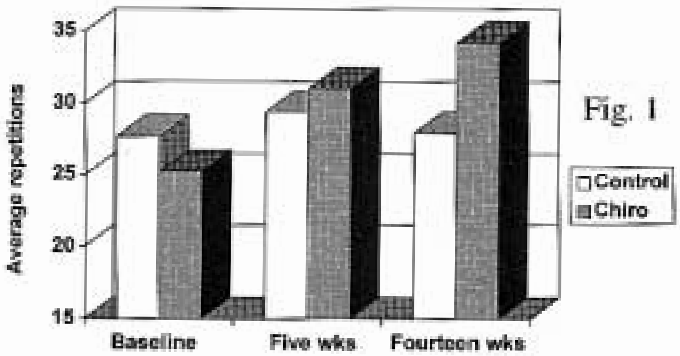


Fig. 1

## Long Jump

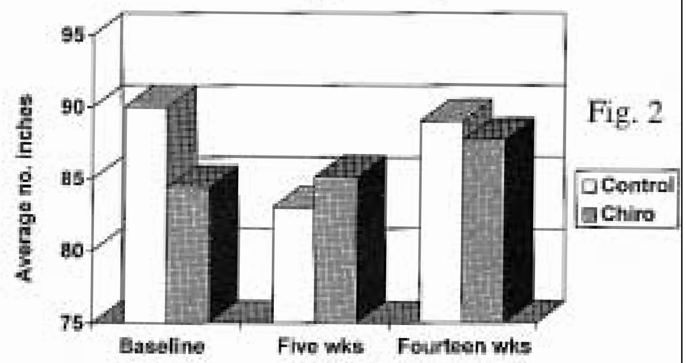


Fig. 2

## Vertical Jump

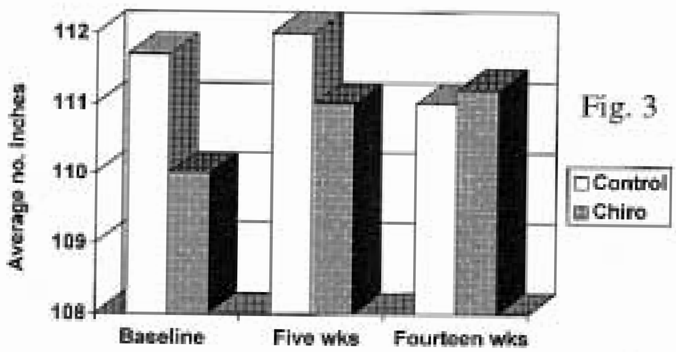


Fig. 3

## Microcirculation of Right Middle Finger

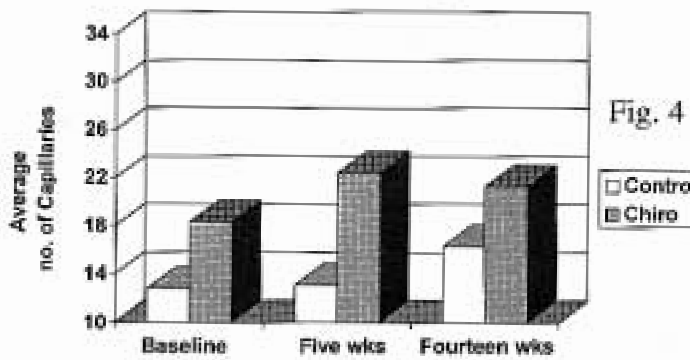


Fig. 4

## Microcirculation of Left Middle Finger

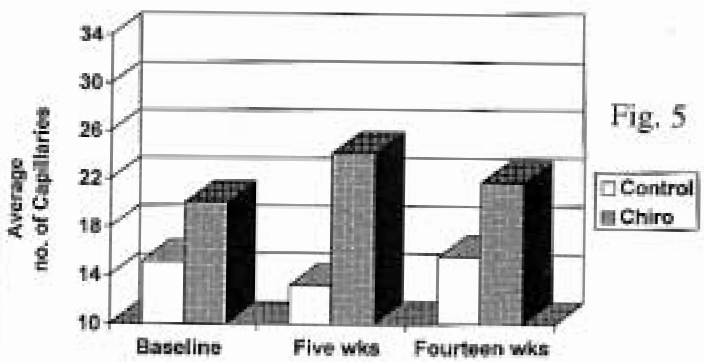


Fig. 5

## Microcirculation of Right Middle Finger (post TM)

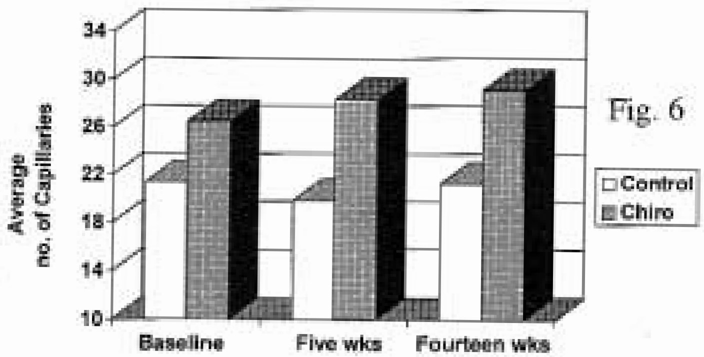


Fig. 6

## Microcirculation of Left Middle Finger (post TM)

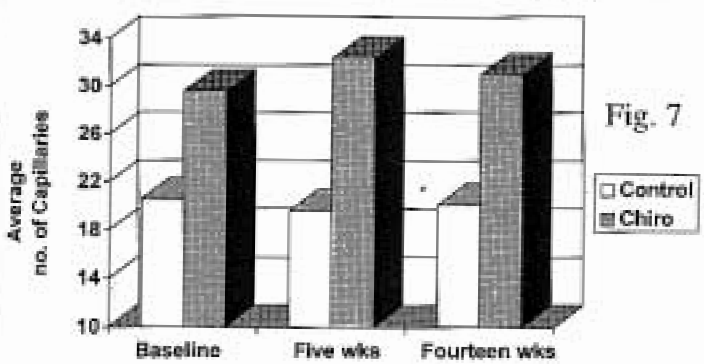


Fig. 7

## Pulse Rate

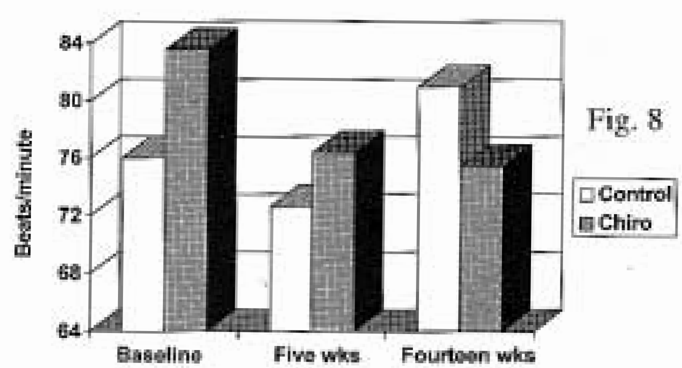


Fig. 8

Table 2. Changes in Microcirculation Associated with Upper Cervical Chiropractic Care

| | Percent Change from Baseline (Mean ± Std. Dev.) | | Effect Size * | |
|---|---|---|---|---|
| | *Five Weeks* | *Fourteen Weeks* | *Five Weeks* | *Fourteen Weeks* |
| **Pre-Stress** | | | | |
| **Left Capillary** | | | | |
| Control Group | – 2.1 ± 0.36 | 19.4 ± 0.77 | 0.4 | – 0.1 |
| Adjustment Group | 21.4 ± 0.19+ | 13.3 ± 0.16‡ | – 1.3 | – 0.5 |
| **Right Capillary** | | | | |
| Control Group | 18.2 ± 0.63 | 45.2 ± 0.72 | – 0.1 | – 0.7 |
| Adjustment Group | 23.8 ± 0.23+ | 18.7 ± 0.30 | – 1.1 | – 0.8 |
| **Post-Stress** | | | | |
| **Left Capillary** | | | | |
| Control Group | – 0.9 ± 0.29 | 4.2 ± 0.38 | 0.2 | – 0.1 |
| Adjustment Group | 9.5 ± 0.09+ | 4.8 ± 0.23 | – 1.0 | – 0.5 |
| **Right Capillary** | | | | |
| Control Group | – 4.7 ± 0.20 | – 0.1 ± 0.38 | 0.3 | 0.1 |
| Adjustment Group | 7.7 ± 0.11 | 12.5 ± 0.16 | – 0.5 | – 0.7 |

* Effect size. See explanation for Table 1.
+ Denotes significant difference ($p < 0.05$) between five week and baseline value.
‡ Denotes significant difference between fourteen weeks and baseline value.

Table 3. Changes in Physiological Measures Associated with Upper Cervical Chiropractic Care.

| | Percent Change from Baseline (Mean ± Std. Dev.) | | Effect Size+ | |
|---|---|---|---|---|
| | *Five Weeks* | *Fourteen Weeks* | *Five Weeks* | *Fourteen Weeks* |
| **Pulse Rates** | | | | |
| **Resting** | | | | |
| Control Group | – 2.2 ± 0.22 | 3.7 ± 0.11 | 0.3 | – 0.4 |
| Adjusted Group | – 6.9 ± 0.18 | -3.9 ± 0.15 | 0.4 | 0.4 |
| **Treadmill 3 min** | | | | |
| Control Group | 12.8 ± 0.24 | 17.4 ± 0.27 | – 0.5 | – 0.7 |
| Adjusted Group | 3.3 ± 0.20 | – 5.0 ± 0.04 | – 0.2 | 0.4 |
| **Treadmill 8 min** | | | | |
| Control Group | 4.9 ± 0.15 | – 1.1 ± 0.10 | – 0.7 | 0.1 |
| Adjusted Group | 12.0 ± 0.23 | – 8.1 ± 0.14 | – 0.4 | 0.1 |
| **Blood Pressure** | | | | |
| **Systole** | | | | |
| Control Group | – 0.2 ± 0.15 | 5.0 ± 0.11 | 0.1 | – 0.8 |
| Adjusted Group | 2.2 ± 0.05 | -2.8 ± 0.05 | – 0.3 | 0.6 |
| **Diastole** | | | | |
| Control Group | 2.0 ± 0.20 | 3.5 ± 0.09 | – 0.1 | – 0.3 |
| Adjusted Group | 3.0 ± 0.08 | 1.7 ± 0.05 | – 0.3 | 0.1 |

+ Effect size. See explanation for Table 1.

theme was also apparent in regard to cardiovascular improvement where relatively well conditioned athletes, while showing improvement or lack thereof, are likely to require more sensitive measures of change before evidencing statistical significance relative to an intervention such as upper cervical chiropractic care. More specific measures such as capillary count appeared to permit detection of differences more readily, perhaps due to the sensitivity of detecting smaller changes occurring at the microscopic level compared to the inability to detect smaller changes occurring at the gross level.

The small sample size of the present study must also be considered when reconciling the lack of statistical significance between or within the groups, even when substantial changes were evident. Although the magnitude of the effect sizes were moderate to large in many instances, the small number of subjects is likely to have increased the probability of failing to detect differences within the spectrum of the statistical analyses employed. Future studies with more statistical power will be required to ascertain if the effect sizes also represent statistical significance.

Nevertheless, within the limits of this pilot study, the consistent trends of improvement in the group receiving adjustments compared to controls strongly suggests an association between the upper cervical chiropractic care administered in the present study and physical and physiological change, and appears to support findings of previous investigations.[3-4] It will be of interest to conduct further studies which also assess athletes regarding self perceptions of performance concomitant with objective measures similar to those studied. This would permit a more thorough evaluation of performance in those areas which elicit changes perhaps too small to detect statistically.

Although the present pilot study was limited in number of subjects, it is evident that changes were measurable in regard to physical strength, tests of athletic ability such as the long jump, and microcirculation. It is also concluded that cardiovascular conditioning tests in already well trained athletes may be more difficult to use as assessments of efficacy of chiropractic methods. Further study appears justified to examine similar outcomes with larger and more varied populations regarding gender and age to investigate the significance of chiropractic care on athletic performance and physiological changes.

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