

REVIEW OF THE LITERATURE

Objective Physiologic Changes and Associated Health Benefits of Chiropractic Adjustments in Asymptomatic Subjects: A Review of the Literature

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ABSTRACT

Objective: To review existing literature documenting objectively measured physiologic changes and their associated health benefits subsequent to chiropractic adjustments, primarily in asymptomatic individuals.

Data Collection: “Asymptomatic” “normal” “pain-free” and “healthy” subjects were keywords used to search for articles pertaining to the objective. Data was collected directly from the bound journals of the Palmer College of Chiropractic library in Davenport, IA, Life University library in Marietta, GA, and the Sherman College of Chiropractic library in Spartanburg, SC. Some articles were downloaded from peer-reviewed journals accessible through campus Internet subscription.

Results: More than twenty studies were found documenting objective health benefits in subjects who were specifically described as “asymptomatic,” “healthy,” “normal,” or “free from physical injury.” Nearly an equal number of studies were found

documenting objectively measured health benefits in subjects to which no symptomatic presentation was described.

Conclusion: The data reviewed lend support to the contention that chiropractic adjustments, often for the purpose of correcting vertebral subluxation, confer measurable health benefits to people regardless of the presence or absence of symptoms. A significant amount of preliminary evidence supports that people without symptoms can benefit from chiropractic care. Improved function can be objectively measured in asymptomatic individuals following chiropractic care in a number of body systems often by relatively non-invasive means. It is plausible that chiropractic care may be of benefit to every function of the body and have the potential for long-term, overall health benefit to those receiving chiropractic care.

Key words: *chiropractic adjustment, subluxation, objective measurement, health benefit*

Introduction

A recent survey of 658 randomly selected US chiropractors revealed some surprising data.¹ Eighty-eight percent (88.3%) of respondents agreed or strongly agreed that the purpose of maintenance care was “to maintain or optimize state of health.” Eighty-percent (80.2%) of respondents agreed or strongly agreed that the purpose of maintenance care was to “determine and treat subluxation.” Furthermore, US chiropractors agreed that “maintenance care was of value to all age groups, with the value increasing slightly with an increase in a patient’s age.” However, only forty-percent (40.2%) agreed that “adequate research existed to support the concept of maintenance care,” and ninety-three percent (93.4%) agreed “there was a need for more research.” It seems that US chiropractors agree and are of the opinion that correcting subluxation is of value to all people, but nearly 60% do not think there is sufficient evidence to verify their opinion. One chiropractor expressed this frustration in a Letter to the Editor in the August 6, 2000 issue of *Dynamic Chiropractic*, a trade journal of the chiropractic profession:

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“I try to encourage my patients who are open to continue maintenance care... However, I have yet to see a single research finding that indicates that those patients who do receive regular chiropractic care, regardless of symptomatology, benefit in any measurable way.”

-Scott Rogers, MA,DC

Others have expressed their opinions on the subject in peer-reviewed literature:

“Many chiropractors will continue to adjust imaginary subluxations in the spines of perfectly healthy patients, perpetuating unsubstantiated claims and discouraging chiropractors who wish to specialize in the treatment of neck and back pain...² Chiropractors who believe that vertebral alignment has something to do with general health often encourage their patients to submit to regular and frequent manipulation, even when these patients are asymptomatic... I cannot personally justify manipulating the spine of a healthy, symptom-free patient... It is unfair to patients to allow them to believe that they must have regular spinal adjustments in order to stay healthy... I cannot see any basis or justification for routinely manipulating the spine of a healthy patient for the purpose of maintaining health or preventing disease.”³

-Samuel Homola, DC

Many in the chiropractic profession, often from seemingly different political camps, contend that chiropractic care is beneficial to people regardless of one's symptomatic presentation.⁴

"Straight chiropractic consists solely of the philosophy, science and art of locating, analyzing and assisting in the correction of vertebral subluxation because they are detrimental to the expression of innate intelligence."

- Definition of Straight Chiropractic according to The Federation of Straight Chiropractors & Organizations

"...pain may not be the symptomatic outcome of nociceptive stimulation of spinal structures. Such a conclusion has profound implications for the chiropractic profession. Clearly, patients do not need to be in pain to be candidates for spinal adjustments."⁵

- David Seaman, DC & James Winterstein, DC (*President of National Health Science University*)

This paper seeks to address this controversial issue and lend scientific validation to such a philosophical perspective by reviewing existing peer-reviewed literature.

Within the last several years there has been a tremendous interest in and focus on *subjective* measurements of chiropractic care as it relates to overall health and wellness. Numerous studies have documented the *subjective*, self-rated assessments of chiropractic care on overall health, quality of life, and wellness.^{6 7 8 9 10 11 50} Many of the studies involve adequate populations and have well-constructed methodologies. However, while self-rated surveys such as the RAND (SF-36) Health Survey, the Global Well-Being Scale (GWBS), and the Self-Rated Health/Wellness Survey (SRHW) are accepted forms of scientific measure, they are still often considered inferior to more *objective* measurements in the hierarchy of scientific methodology. The intent of this paper is to illustrate the objectively measured physiologic changes and their associated health benefit following the administration of chiropractic adjustments.

Particular attention has been given to identifying those studies that were conducted on reportedly "healthy," "normal," or otherwise, "asymptomatic" individuals. This has been done to illustrate that the correction of subluxation can be demonstrated to have both short- and long-term health benefits for individuals beyond that of back and neck pain relief. Furthermore, some studies reviewed here suggest that health benefits accrue regardless of the presence or absence of disease, infirmity, or the presence of symptoms.

Review Design

This paper has three parts. Part I will review literature that documents objective, physiologic changes following chiropractic care in asymptomatic individuals. Part II will review literature that documents objective, physiologic changes following chiropractic care in subjects to which there is *no mention* of symptoms or pathology. This could mean that the individuals involved in these studies may (or may not) have been asymptomatic. The studies in Part II are of particular interest because the lack of a symptomatic description of the subjects involved lends credence to the notion that symptomatic presentation is not necessarily relevant to the administration of chiropractic care. Part III reviews a minority of the literature involving individuals who presented with symptoms or pathology. Part III is of value to this discussion because it further documents stud-

ies to which objective, physiologic changes following chiropractic adjustments were measured.

Much of the data reviewed here have been reviewed before. However, what makes this review unique is that these data are reviewed not so much in terms of *what* factors were measured, but *who* were these factors being measured in. Since this review focuses on objectively measured physiologic changes and their associated health benefits primarily in "asymptomatic" subjects, the phenomenon of pain will not be addressed, despite the numerous studies documenting pain resolution following chiropractic care. Furthermore, for the purpose of consistent terminology and reader simplicity terms such as subluxation, vertebral subluxation complex, segmental dysfunction, joint complex dysfunction, manipulable lesion, or spinal fixation will be collectively referred to as "vertebral subluxation" or "subluxation." Similarly, adjustment, adjustive thrust, spinal manipulative therapy (SMT), HVLA manipulation, etc. will collectively be referred to as "adjustment" or "chiropractic adjustment."

Part I: Objective Physiologic Changes in Asymptomatic Subjects

There is an increasing body of evidence suggesting that the correction of subluxation through chiropractic adjustments improve physical functioning and health regardless of the presence or absence of symptoms or pathology. The studies summarized below document these *objective* physiologic changes and health benefits.

Nansel *et al.*^{12,13,14} conducted several controlled, blinded studies in 1989, 1991, and 1992 to assess the effect of unilateral spinal adjustments on end range asymmetries in "asymptomatic" subjects. Results demonstrated that cervical adjustments ameliorated the lateral flexion asymmetries in the cervical spine. No statistically significant changes were found in control subjects. The vast amount of data regarding the physiologic consequences of a loss of range of motion (ROM) and tissue atrophy associated with immobilization is ample justification to recognize an improvement in ROM as a health benefit or contribution to improved function. The 1991 study also monitored changes in blood pressure, heart rate, and plasma catecholamine levels, but failed to show any statistically significant changes.

In 1993, Nansel *et al.*¹⁵ conducted a randomized, double-blind study again involving sixty-eight "healthy, non-symptomatic" subjects. Results indicated that cervical adjustments have significant effects on the tone of the lumbopelvic musculature by facilitating tonic neck reflexes involving intersegmental pathways. Interestingly, lower cervical adjustments had a more profound effect, a decrease in tone, on lumbopelvic musculature than upper cervical adjustments. In 1998, Pollard & Ward¹⁶ documented a similar link between the cervical spine and range of motion of the hip.

Pollard & Ward¹⁷, in 1996, report a progressive, short-term increase in strength of the quadriceps femoris in 15 subjects following a single chiropractic adjustment to the L₃/L₄ motion segment in the side posture position. Subjects were described as "healthy, asymptomatic students" with "no history of recently diagnosed lumbar disc herniation, sprain, or other lumbar in-

jury.” The control group demonstrated a progressive strength decrease following a sham adjustment. The overall change between the two groups was statistically significant. Bonci & Ratliff,¹⁸ in 1990, failed to demonstrate statistically significant changes in biceps strength following a chiropractic adjustment to the mid-cervical region in “healthy” subjects.

Symons *et al.*¹⁹ were able to detect and measure reflex responses via surface EMG 68% of the time following chiropractic adjustments in nine “healthy, asymptomatic volunteers.” The reflex response originating from the muscle spindles is theorized to be an underlying mechanism explaining the success of chiropractic care for people presenting with numerous symptomatic presentations. The Symons study also demonstrated that reflex responses were least often detected in the cervical spine and were progressively more often detected caudally down the spine.

McGregor *et al.*²⁰ studied immunological responses to twenty “normal” subjects following an adjustment to the lumbar spine or a sham adjustment to the gluteal musculature. Results demonstrate a statistically significant increase in respiratory burst measured by the chemoluminescence response suggesting stimulation of the immune system. The sham adjustment controls did not demonstrate evidence of enhanced respiratory burst activity.

Brennan and Kokjohn *et al.*²¹ studied the effects of chiropractic care on the immune systems of forty-two “healthy adult volunteers” compared to thirty-eight sham adjustment subjects. It was found that the chemoluminescent responses of polymorphonuclear neutrophils (PMNs) and monocytes of those subjects receiving a chiropractic adjustment to the thoracic spine were significantly higher than initial values and significantly higher than the response in the sham adjustment group. This study demonstrated that chiropractic adjustments elicit viscerosomatic responses. Specifically, this study demonstrated that chiropractic adjustments effect cells involved in immune responses.

Brennan and Triano *et al.*²² expanded their previous work. Forty-six “asymptomatic subjects” consisting of “healthy adult volunteers” were used for this study of chiropractic care’s effect on the immune system. This study confirmed their previous report that a chiropractic adjustment to the thoracic spine primes the PMN for an enhanced respiratory burst, and primes mononuclear cells for enhanced endotoxin-stimulated tumor necrosis factor (TNF) production. Significantly elevated levels of the undecapeptide neuroimmunomodulator substance P, accompanied these priming effects, at least for the short-term. Asymptomatic sham adjustment subjects did not show such changes.

Some critics have suggested that the findings of these last 3 studies summarized above merely demonstrate the body’s immune response to trauma and that any form of stimulation applied to the skin might produce an increase in activity of white cells such as “a couple of whacks with a paddle.”²² This suggestion is unfounded, in that both the McGregor study and the Brennan studies *did* have adequate sham-adjustment controls involving significant stimulation of the skin. McGregor stated that immune responses were specific to an application of force directed at the spinal joints and that immune responses similar

to the chiropractic adjustments were *not* observed in those sham-adjustments. More recently, Whelan *et al.*²³ came to a similar conclusion using pre/post salivary cortisol levels as a measure of stress levels associated with chiropractic adjustments.

Vernon *et al.*²⁴ demonstrated a small, but statistically significant increase in serum beta-endorphin levels in a randomly selected group of “normal male subjects” following a single chiropractic adjustment to the cervical spine. Both the sham adjustment and control groups demonstrated a steady decrease in serum beta-endorphin levels. Though these findings are very intriguing, others have failed to produce similar findings of statistical significance.²⁵

Tran & Kirby²⁶ studied the effects of upper cervical chiropractic adjustments upon the physiology of the heart in twenty “normal and healthy” individuals. Seventeen of twenty (85%) subjects presented as “normotensive.” The most significant pre- and post- adjustment changes were a decrease in pulse pressure and an increase in diastolic pressure, which occurred in the majority of subjects tested.

McKnight & DeBoer²⁷ measured the impact of chiropractic adjustment on seventy-five male and female subjects predetermined to have “normotensive” blood pressure. All subjects were “in good physical health with no reported underlying cardiovascular disorders or other relevant pathologies.” Subjects reported not ingesting prescription medication or caffeine prior to blood pressure testing. Those determined to have cervical subluxations were included in the experimental group. Those remaining were controls. Statistically significant changes in blood pressure were observed following chiropractic adjustment though changes were not considered “clinically” significant by the authors.

Gibbons *et al.*²⁸ studied thirteen “healthy male subjects... without a history of eye disease of central or autonomic nervous system pathologic conditions.” They demonstrated that upper cervical adjustment can produce a significant, measurable increase in speed of the autonomically mediated edge light pupillary cycle time (ELPCT), that is, a decrease in the time it takes to complete constriction and redilation of the pupil when exposed to light. These findings suggest an interrelation between somatic and autonomic function and therefore, a more diverse effect on cortical function.

Zhang²⁹ measured the effect of chiropractic care on the autonomic nervous systems of twenty-six “normal” volunteers measured by way of Heart Rate Variability (HRV), subcategorized as Low Frequency (LF), a measure of sympathetic activity, and High Frequency (HF), associated with parasympathetic activity. After one year of chiropractic care the LF/HF ratio changed significantly indicating an increased parasympathetic stimulation, which is associated with a slower heart rate and less anxiety and worry. Zhang notes that this finding is significant because a reduced heart rate can potentially reduce heart attack and other cardiovascular diseases by increasing cardiac reserve and nutrient supply to cardiac muscles.

Miller *et al.*³⁰ studied several variables related to endurance or cardiac and pulmonary physiology in nine “healthy, active” volunteers following chiropractic adjustment to the cervical and thoracic spine. The chiropractic group demonstrated a 6.1% increase in Maximal Aerobic Capacity (VO₂ max), a 3.9% in-

crease in Overall Work (Power Output), a 2.6% increase in Peak Heart Rate and peak systolic blood pressure. Neither control nor secondary intervention (soft tissue massage) subjects demonstrated such changes. However, these findings were not considered statistically significant in terms of endurance.

Menon *et al.*³¹ studied the effect of thoracic spinal adjustment on the peripheral airway function of twenty-two “normal, asymptomatic” subjects. Using dry spirometry, Forced Expiratory Flow Rate (FEF) was measured as an indicator of airway function. Paired t-tests were performed between pre- and post-measurements. FEF values showed a significant post-intervention reduction.

Masarsky & Weber³² report on the lung volumes of 50 patients. Although most subjects presented with musculoskeletal complaints, 43 of 50 (86%) subjects were essentially “lung-normal” in FVC by spirometric criteria and therefore have been included in the asymptomatic section of this paper. Improved FVC values were noted in 35 of these 43 “lung-normal” subjects. Results were significant at the .01 level. Improved FEV-1 values were also observed in 29 subjects and were significant at the .05 level. The authors specifically stated that it was of particular interest to observe the improved lung volumes in a group of essentially “lung-healthy” patients.

Kessinger³³ measured changes in pulmonary function associated with upper cervical chiropractic adjustments on 55 subjects. Twenty-two of 55 (40%) were “typical” subjects, that is, they presented within “normal” range of Forced Vital Capacity (FVC) values. Following two weeks of chiropractic care 73% of these “typical,” normal range subjects further improved FVC values by 6%. Thirty of 55 (55%) were “typical” subjects, that is they demonstrated a normal range of Forced Expiratory Volume per 1 second (FEV-1). Following two weeks of chiropractic care approximately 47% of these “typical,” normal range subjects further improved FEV-1 values by 6%. Overall results of the study indicated that pulmonary function improves significantly in subjects under upper cervical chiropractic care.

Goff, McConnell, & Paone³⁴ explored the relaxation response as it relates to the correction of subluxation via chiropractic adjustment. The relaxation response was measured through EMG potentials, spinal ROMs, and anxiety levels. Twenty-six adults determined to have a subluxation, “but not having a diagnosis of other clinically significant disorders” were used. Results indicated a significant change occurred in the chiropractic group as compared to the 23 controls. Adjustments facilitated a considerable decrease in patient muscle tension.

Lauro & Mouch³⁵ measured changes in agility, balance, kinesthetic perception, power, and speed reaction in twenty-four “asymptomatic” athletes “with no acute or chronic debilitating injuries.” Athletic performance in these five categories was measured at six and twelve weeks of chiropractic care and were compared to twenty-two control athletes. Results of the first six weeks revealed a 10.57% improvement in the chiropractic group and only a 4.5% improvement for controls. The twelve-week evaluation demonstrated further improvement of 16.7%. The authors stated that the data supports that “the correction of the subluxation complex enables the body to function and perform at a higher level.”

Schwartzbauer *et al.*³⁶ demonstrated significant improvement in the performance of twenty-one male college “athletes” who were “free from physical injury.” After fourteen weeks of chiropractic care the athletes showed significant improvement in muscle strength, long jump distance, and capillary counts.

Briggs and Boone³⁷ measured autonomic response monitored as a change in pupillary diameter in eight subluxated subjects. Though not specifically described as “asymptomatic,” all subjects were “screened by a licensed optometrist... (for) visual acuity of 20/20, an accommodative convergence / accommodative ratio of 5 or less, and an accommodative system free of pathology.” This was considered specific-function “normal,” and therefore was included in Part I of this review. Eight out of eight (100%) subluxated subjects demonstrated a 50% or greater change in variables following a single adjustment to the upper cervical spine. Six of seven sham-adjusted subjects acting as controls demonstrated no such change between pre- and post-analysis. The authors conclude that autonomic somato-visceral reflexes of a non-specific nature can be elicited following a chiropractic adjustment. They also stated, “it appears that the efficacy of the chiropractic adjustment rests in the removal of subluxation as opposed to being a treatment entity for specific symptoms associated with visceral organ systems.”

Part II: Objective Physiologic Changes in Subjects without Mention of Symptomatic Presentation

Additional studies measure physiologic improvement following chiropractic care but make *no mention* to symptoms or pathology of subjects involved. The primary focus of these studies was, again, to demonstrate the objective physiologic changes of chiropractic adjustment and any subsequent health benefit.

Kessinger and Boneva³⁸ demonstrated significant improvements in neurocognitive function in 30 subjects receiving 4 weeks of upper cervical care compared to 10 control subjects who did not demonstrate a similar trend. Cognitive function was measured via the computer administered and scored test, Microcog. This program scores attention/mental control, memory, reasoning/calculation, spatial processing, reaction time, information processing speed, information processing accuracy, general cognitive functioning, and general cognitive proficiency.

Kelly, Murphy, and Backhouse³⁹ utilized a mental rotation reaction-time paradigm to assess changes in cortical processing following chiropractic adjustments. Thirty-eight volunteers were tested in this study. The average decrease (improvement) in reaction time for the experimental group was 14.9%. The control group improvement of only 8% was attributed to a learning curve effect. The study demonstrated a small but statistically significant improvement in cognitive function after a single adjustment.

Carrick⁴⁰ conducted a double blind study involving 500 subjects enrolled in a postdoctoral neurology program, which demonstrated, by way of visual field blind spot analysis, that adjustment activates specific neurological pathways associated with cortical hemisphericity. Carrick stated that the clinical results attributed to upper cervical spinal adjustment occur as a consequence of the integration of variables that sum to promote human brain function. He also notes that the benefits of

chiropractic adjustment may not be limited to musculoskeletal or neuromuscular conditions.

Waters & Boone⁴¹ investigated whether or not the presence of subluxation indicators such as leg imbalance, pelvic distortion, and cervical syndrome would have any possible correlation with a poorer performance of fourteen "female dancers." The dancers were first examined for the presence or absence of the subluxation indicators, performed their dance routines, and then were asked to self-rate their own performances. It was found that the presence of indicators associated with subluxation were negatively associated with the overall dance performance relative to muscle balance. Overall dance performance was rated high in individuals exhibiting no spinal misalignment elements and lower in individuals exhibiting spinal misalignment elements. Even though the dancers *subjectively* self-rated their own performances, the dancers were blinded to the presence or absence of subluxation indicators prior to performing the dance routine. Therefore, the results of this study were included in this review.

Kessinger and Boneva⁴² measured visual acuity in 67 subjects (who had not been under previous chiropractic care) following six weeks of upper cervical chiropractic care. Statistically significant improvements for the whole population were demonstrated in the right eye at distances associated with less than "typical" normal vision, and better than "typical" normal vision. Significant improvements were also shown for the left eye at the same distance acuity levels, as well as additional levels. Kessinger concluded that vision changes do occur following upper cervical chiropractic adjustments.

Harris and Wagon⁴³ studied the effects of chiropractic adjustments on distal skin temperatures in 196 subjects. Their work clearly demonstrated that chiropractic adjustments significantly affect temperature in tissues distant from the spine and that these changes will vary depending upon which area of the spine is adjusted. Approximately 84% of adjustments given in the C₁-C₇ area and/or L₄-L₅ area inhibited sympathetic nervous system outflow (a temperature increase), while adjustments in the T₁-L₂ region stimulated the SNS (a temperature decrease) 67% of the time. These findings suggest a regulatory effect of chiropractic adjustments and, therefore, are significant because the purpose of the vast majority of blood flow in this tissue is to regulate temperature, an important aspect of maintaining proper homeostasis.

Tuchin⁴⁴ measured the effects of chiropractic adjustment on salivary cortisol levels in nine subjects. Pre- and post-adjustment data revealed a statistically significant reduction of salivary cortisol over the 5-week study. These findings are significant because salivary cortisol levels closely reflect serum cortisol levels. Elevated serum levels of cortisol have been associated with disturbed concentration, tremors, elevated heart rate and overall stress.

Unger⁴⁵ recognized that muscle strength is a reflection of neurological function. Sixteen patients underwent a course of chiropractic pelvic blocking of the Sacro-occipital Technique (SOT) protocol. Using a dynamometer, measurements of muscle strength were assessed before and immediately after the chiropractic adjustments. There was a significant difference in muscle strength noted in the Left and Right (L&R) pectoralis major

sternal, Left pectoralis major clavicular, L&R anterior deltoid, L&R Latismus dorsi, L&R psoas, L&R tensor fascia lata, L&R adductor muscle, and L&R gluteus medius. The results of this study suggest that the chiropractic SOT pelvic blocking procedure produced a general increase in muscle strength.

Rebechini-Zasadny *et al.*⁴⁶ noted significant increases in the strength of the first dorsal interosseous muscle during isometric contraction following chiropractic adjustments to the cervical spine. The twelve volunteers involved were measured using EMG. Improvement in finger muscle strength following adjustment to the cervical spine demonstrates how chiropractic adjustments can have benefit distal to the locality of adjustment.

Coulter *et al.*⁴⁷ assessed the characteristics of older people who utilize chiropractic care. Of a total sample size of 414 seniors, 23 were called "chiropractic users." Coulter found that senior citizen chiropractic users were more likely to report strenuous levels of exercise, and more likely to report leaving their neighborhood in good weather five or more time per week. Chiropractic users were also less likely to report their health status as "fair" or "poor" and were less likely to report having arthritis than non-chiropractic users. A non-significant trend for chiropractic users to report fewer depressive symptoms was also observed. Furthermore, chiropractic users were less likely to have used a nursing home, and 73.9% of chiropractic users had not been hospitalized in 3 years. Lastly, chiropractic users were associated with a tendency to use less over-the-counter (OTC) and prescription medications than those not using chiropractic care. Coulter was careful to state that these findings were only *associated* with chiropractic use and that it may not constitute a *causal* relationship with chiropractic care. These observations, while neither *objective* nor specifically physiological, do suggest the possible long-term health benefits of chiropractic utilization regardless of the presence or absence of symptoms.

A study by Rupert⁴⁸ involving 311 senior citizens under chiropractic "maintenance care" produced some rather dramatic and significant results. While some chiropractors in this study also provided recommendations pertaining to exercise, nutrition, and relaxation, seventy-three percent (73%) of chiropractors reported that maintenance care was being given to their patients to prevent or control subluxation. Those seniors using maintenance care made approximately half the number of visits to a medical provider compared to the national average. The study also found a significant correlation between the reduced use of non-prescription drugs and the number of years of maintenance care, that is, the longer one was under maintenance care the less likely they are to use non-prescription drugs. Only 36% of patients reported frequent use of non-prescription drugs. Furthermore, the annual health care cost for US senior citizens in 1994 was conservatively estimated at \$10,041.00 per person. The annual health care cost associated with those under chiropractic maintenance care was \$3,106.00 per person. This represents an annual cost less than 2/3 that of the national average among chiropractic recipients. The authors state that those patients receiving maintenance care required far less medical intervention. Like Coulter's study, these data are also strongly suggestive of the possible long-term health benefits associated with chiropractic care.

While some of the data from the Coulter and Rupert studies could be considered *subjective*, (i.e. patient “reports”) it was included because of the relevance to the intent of this review as a whole.

Part III: Objective Physiologic Changes in Subjects Presenting with Symptoms or Pathology

Hundreds of articles document objective physiologic changes in subjects presenting with symptoms or pathology. Here, a handful of studies documenting such changes is discussed.

Allen reviews a study by Alcorn⁴⁹ documenting increases in immunoglobulins IgA, IgG, and IgM in 3 out of 4 subjects (75%) following two-weeks of chiropractic care. Immunoglobulins increased concurrently with the subjective improvement in the subjects’ neuromusculoskeletal conditions. Other studies in humans and animals have correlated immune function with neuromusculoskeletal conditions.^{50,51} Vora and Bates⁵² showed a significant increase in circulating B-lymphocytes in 5 of 8 patients (63%) with radiographically proven neuromusculoskeletal conditions following 4 weeks (eight sessions) of chiropractic adjustments. Although the authors of the study arbitrarily assigned a 50% change in B lymphocyte values to be significant, all 5 patients demonstrated a statistically significant increase well over 100% of their initial value. One of the 5 patients demonstrated over a 200% increase in circulating B-lymphocytes. Two patients showed a decrease that was statistically insignificant, and the remaining patient showed no significant change. Similarly, Selano *et al.*⁵³ measured the CD4 cell counts in five HIV+ subjects receiving six months of upper cervical chiropractic care. These subjects were compared to 5 HIV+ controls that received sham adjustments for six months. All 5 patients’ CD4 cell counts in the adjusted group increased, two of which increased by more than 125% each. This accounted for an overall increase of 48% in the adjusted group over the six-month period. Conversely, 4 of 5 patients in the sham adjustment group’s CD4 values decreased, demonstrating a 7.96% overall decrease in CD4 cell counts. The authors concluded that chiropractic adjustments of the upper cervical spine may increase the CD4 levels in HIV+ individuals. While the findings of the Alcorn, Vora & Bates, and Selano studies are interesting and warrant further investigation, the populations are far too small to draw any general conclusions independently, however when viewed collectively, they appear more significant.

Kokjohn *et al.*⁵⁴ randomly assigned 24 women into an experimental group and 21 women into a control/sham group. All women had a history of primary dysmenorrhea. The experimental group received chiropractic adjustments to all clinically relevant vertebral levels within T10 and L5-S1, and the sacroiliac joints. Plasma levels of KDPGF_{2a} were used as a measurement because plasma concentrations of this metabolite are significantly higher in dysmenorrheic women than eumenorrheic women. Samples were collected pre- and post-adjustment in both the experimental and control/sham group. Results showed a significant reduction in plasma levels of KDPGF_{2a} in the adjusted group. The control/sham group also demonstrated a significant reduction; however, pain and menstrual distress reductions were nearly twice as great in the chiropractic group.

Childs, Freerksen and Plourde⁵⁵ studied the possible effects of regular chiropractic care to changes in lipid metabolism in ten randomly selected subjects exposed to a stressful environment. This retrospective study assessed lab values over a period of one to three years. The same laboratory, personnel, instrumentation, and methods were used for all lipid tests over the three-year period. Results showed the Total Cholesterol (TC) and Low Density Lipid (LDL) levels decrease in 70% of subjects. Sixty-six (66%) percent of subjects classified as “borderline high to high risk” for TC fell to desirable range following regular chiropractic care. Eighty (80%) percent of subjects initially classified as “borderline high to high risk” for LDL fell to desirable levels following regular chiropractic care. Fifty (50%) percent of subjects attained optimal range for Cardiac Risk Factors and in 90% of subjects, Triglyceride levels dropped while under regular chiropractic care. This study demonstrated a tentative correlation between regular chiropractic care and improvement of the blood lipid levels. The correlation established is of significance since it is widely accepted that blood lipid levels are excellent in assessing the risk associated with premature coronary heart disease.

Yates *et al.*⁵⁶ conducted a randomized, controlled trial examining the effects of upper thoracic chiropractic adjustments on blood pressure in twenty-one subjects with elevated blood pressure. Only subjects demonstrated to have thoracic vertebral subluxations were randomly assigned to one of three groups: active, placebo, or control. Subjects in the active group showed statistically significant decreases in both systolic and diastolic blood pressure. Placebo and control groups demonstrated no such changes and did not differ significantly from each other. Results support that adjustment of thoracic subluxation significantly reduces blood pressure of patients with elevated blood pressure.

Jarmel and Zatzkin⁵⁷ demonstrated improvement of cardiac autonomic regulation following chiropractic adjustments in eleven subjects presenting with dysrhythmic abnormalities. Following one month of chiropractic care, a positive trend in the number of ventricular beats, ischemic events, maximum time of ST segment depression, elimination of after-depolarizations, and enhanced heart rate variability was observed. Findings were measured with a 24-hour ECG.

Lott *et al.*⁵⁸ showed that chiropractic adjustments to some extent bring about improved cardiac function. Lott described four case studies of patients presenting with cardiac dysfunction as monitored by ECG. Patients received osseous chiropractic adjustments (and diet/exercise recommendations) over a time period ranging from 5 to 16 months. Improvements in ECG recordings were seen in all four cases. Significant improvements were seen in three of four subjects as indicated on ECG by the CompuMed rating system. Two subjects had significant reductions in blood pressure and pulse rate and one subject showed probable elimination of ischemia in the myocardium.

Dickinson⁵⁹ studied 31 diabetic volunteers receiving chiropractic spinal adjustments and interferential therapy. Volunteers were measured using the Imex 301 Doppler Ultrasound Tracings multiple times over the course of the 5-week study. Twenty-seven of 31 volunteers (87%) demonstrated increased circulation. No measurable changes were observed in 3 volunteers.

Dramatic subjective improvement was also noted in nearly all volunteers. It is difficult to determine if the chiropractic adjustments or the interferential therapy most contributed to the results of this study. However, some literature suggests that interferential therapy is of little or no value.⁶⁰ This may lend more support to the notion that chiropractic adjustments were the critical factor in this study.

Although Kessinger³¹ demonstrated significant improvement in pulmonary function in those subjects with “typical, normal” Forced Vital Capacity (FVC) and Forced Expiratory Volume per 1 second (FEV-1) values, the 33 (60%) subjects presenting “outside the normal range” showed the greatest increases in FVC and FEV-1. Thirty-one of the 33 “atypical” subjects (93%) showed an increase in FVC nearly half of which were now within “normal” FVC range. Of the 25 subjects (45%) presenting outside the “normal” range of ideal FEV-1 values, 21 (84%) showed an increase in FEV-1 after the two week period of chiropractic care. Nearly a third of which were now within “normal” FEV-1 range.

Two medical doctors, Pikalov and Kharin⁶¹ demonstrated that the use of chiropractic adjustments for the treatment of 11 adults with duodenal ulcers experienced clinical remission an average of 10 days earlier than 24 control subjects receiving traditional medical care for the same condition. Remission was confirmed with endoscopy. These medical doctors concluded, “further investigation is necessary to search for optimal conditions and correlation with vertebral correction.”

Jarski *et al.*⁶² conducted a single-blinded, match-controlled outcome study involving 38 post-operative subjects receiving osteopathic manipulation of the lower extremities, (similar to chiropractic adjustments) during a rehabilitation program. A control group of 38 post-operative subjects undergoing the same rehabilitation program was also monitored. The group receiving osteopathic manipulation negotiated stairs 20% earlier and ambulated further on post-operative days 1-4 than did the control group. Additionally, the experimental group also required less pain medication and shorter hospital stays.

Sixteen female distance runners presenting with sacroiliac subluxation were assessed by Grimston *et al.*⁶³ Subjects underwent 12 sessions of chiropractic adjustment (in conjunction with muscular rehabilitation) over a 4-week period. Compared to four control subjects, a statistically significant decrease in lumbo-pelvic asymmetry was observed. Following care, all 12 subjects with sacroiliac subluxation had reinstated their preinjury training mileage. Five of twelve subjects (> 40%) reported their personal best performance over the 10-kilometer distance run. Two subjects achieved personal best times over the marathon distance (42-kilometer). All (100%) subjects reported enhanced awareness of posture and flexibility in addition to reduced symptoms.

Suter *et al.*⁶⁴ studied the effects of sacroiliac spinal adjustments on 18 patients presenting with anterior knee pain. Torque, muscle inhibition and muscle activation for the knee extensor muscles were measured using a Cybex dynamometer before and after chiropractic adjustments. Increases in knee extensor torque and muscle activation were observed following adjustments. A decrease in muscle inhibition was also observed. Fur-

thermore, muscle inhibition was decreased in both legs following adjustments for patients with bilateral anterior knee pain.

Fallon⁶⁵ investigated the relationship of labor time as a function of chiropractic care versus non-chiropractic care. The labor times of sixty-five women who had received chiropractic care from at least the 10th week of pregnancy through labor and delivery were compared to statistically averaged mean labor times. Chiropractic users were found to have significantly reduced labor times of 24% and 39% for primigravidae and multiparous pregnancies, respectively. Fallon concluded that chiropractic can significantly reduce mean labor time.

Conclusion

Data reviewed in this article lend strong support to the popular contention that chiropractic adjustments, for the purpose of correcting subluxations, confer health benefits to people regardless of the presence or absence of symptoms. While each and every one of the studies reviewed here may have inherent weaknesses and limitations in its design and/or conclusions, the data still can be viewed and interpreted collectively. The notion that there is no evidence of chiropractic care being of benefit to individuals without musculoskeletal complaints appears erroneous. Improved function can be measured in “normal” presenting individuals following chiropractic care. Objective physiologic changes and their associated health benefits can be easily measured in a number of body systems, often by relatively non-invasive means. The data presented here are of varying methodologies; several studies are controlled trials, some with randomization (RCTs) and some with single and double blinding. Others are retrospective studies, pilot studies, and still some are case series.

This review collectively documents statistically significant improvements in respiration, range of motion, heart rate variability and autonomic function, endocrine function, cardiovascular function, immune function, muscle strength and overall athletic ability of “healthy” or specific-function “normal” individuals. Other studies have documented statistically significant increases or improvements in neurocognitive functions such as reaction-time and information processing, visual acuity, stress and reproductive hormones, healing / recovery time, general health of senior citizens, and reduced labor times of pregnant women following or during chiropractic care.

Considering that these initial findings document objectively measured physiologic changes and their associated health benefits in nearly every major system of the human body, it is plausible that chiropractic care may benefit every function of the body. Furthermore, these data are congruent with numerous *subjective* studies that suggest chiropractic care is associated with accruing, long-term, overall health benefits. The author of this review agrees that while it is the opinion of an overwhelming majority of practicing doctors of chiropractic that regular chiropractic care is of benefit to all people of all ages, more research is necessary to further document the efficacy of subluxation correction.

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