

THE CHIROPRACTIC CARE OF CHILDREN WITH ATTENTION-DEFICIT/HYPERACTIVITY DISORDER: A RETROSPECTIVE CASE SERIES

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Background: Characterized with hyperactivity, inattention and impulsivity, attention-deficit/hyperactivity disorder (ADHD) has a prevalence in children, ranging from 2.6% to 11.4%. The medical approach is multimodal, with combination therapies of behavioral modification and pharmacotherapy. With growing concerns regarding the safety of both short-term and long-term use of psychotropic medications, the need for investigating alternative approaches to the care of children is warranted.

Objective: The aim of this review was to describe the chiropractic care of children with medically diagnosed ADHD.

Design: Retrospective case series were reviewed.

Setting: The review was conducted in a private practice of chiropractic with a solo practitioner.

Patients/Participants: Pediatric patients (aged ≤ 18 years) attending chiropractic care for a minimum period of five months following a medical diagnosis of ADHD were included in this review.

Intervention: The intervention was chiropractic spinal manipulative therapy augmented by nutritional supplements.

Results: Our review found four patient files satisfying the inclusion criteria. All patients were males, ranging in age from nine to 13 years (mean age, 10 years), with three patients having a history of medication use and two patients having prescribed medication at the start of chiropractic care. Using a 15-item parent/teacher ADHD questionnaire, the patients' responses to chiropractic care were monitored. Using the Friedman test to compare observations repeated on the same subjects, our findings found improvement in ADHD symptoms (ie, hyperactivity, impulsivity, and inattentiveness, as well as behavioral, social, or emotional difficulties) and provide supporting evidence on the effectiveness of chiropractic in the treatment of children with ADHD.

Conclusion: A retrospective case series of ADHD patients under chiropractic care is described. This provides supporting evidence on the benefits of chiropractic spinal manipulative therapy. We encourage further research in this area.

Key words: Chiropractic, ADHD, Pediatrics

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INTRODUCTION

According to Rohde and Halpern,¹ the first reference to hyperactivity and attention-deficit disorders in the nonmedical literature dates as far back as the 19th century.² In 1902, Still³ described 43 children with characteristics of aggression, defiance, emotionality, disinhibition, inattention, and deficient rule governing behavior. Still has been credited as the first to describe what is now known as attention-deficit/hyperactivity disorder (ADHD).¹ Reflective of his time, Still hypothesized that the central feature of this disorder was "a defect in moral control" and could affect individuals with or without cognitive deficiency and with or without a known neurological disorder.¹

Today, the hallmarks of ADHD are hyperactivity, inattention, and impulsivity. In a cross-sectional survey of a nationally representative US population (ie, The National Health and Nutrition Examination Survey, from 2001-2004⁴), Froehlich and colleagues⁵ ascertained (using the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*⁶) the prevalence of ADHD in eight- to

15-year-olds at 8.7%. This was a value within the range of 2.6% to 11.4% prevalence based on measurements in US regional studies.⁷⁻¹¹ The medical management of patients with ADHD involves a multimodal approach with combination therapies of behavioral modification and pharmacotherapy. In a study measuring ADHD treatment prevalence and drug use from 2000 to 2005, based on pharmacy claims from a large population of commercially insured Americans, Castle and colleagues¹² found treatment prevalence increased at 11.8% per year during the period of study. A study by Winterstein and colleagues¹³ to describe the longitudinal trends in ADHD drug utilization and explore demographic differences among youths eligible for a large southern-state Medicaid program found ADHD prevalence increased 1.70-fold—from 3.10% in the fiscal year 1995-1996 to 5.27% in 2003-2004. This was paralleled by a 1.84-fold increase in drug use to 4.63%. In 2003-2004, 0.89% of youths were diagnosed and newly started on drugs, reflecting a 1.38-fold increase over 1995-1996. One in five white males between the ages of 10 and 14 years received ADHD medication in 2003-2004. The most common starting age throughout the study period was five to nine years, but the largest increases in prevalence were observed in adolescents 15-19 years of age. With growing concerns regarding the safety and the prospect of long-term use of psychotropic medications for ADHD and other psychiatric conditions in children,¹⁴ the need for investigating more "alternative and conservative approaches" to the care of children seems warranted. Indeed, the use of complementary and alternative medicine (CAM) for the

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Table 1. Profile of Children Medically Diagnosed With ADHD Under Chiropractic Care

Characteristic	Patient A	Patient B	Patient C	Patient D
Age, y	10	11	7	8
Gender	Male	Male	Male	Male
Prior medication use	Ritalin, Prozac, sleeping pills	Ritalin, Concerta	Ritalin, Concerta, Dexedrine, Strattera	None
Medication at start of DC care	Ritalin, Prozac, sleeping pills	None	Adderall, Zoloft	None
Medication at review	Lowest dose of Strattera	None	None	None
Common sites of spinal segmental dysfunction	C ₁ , C ₆ , and T ₇ VBs and sacrum	C ₁ , C ₄ , T ₆ , L ₄ VBs and sacrum	C ₁ and T ₄ VBs and sacrum	C ₀ , C ₃ , and L ₂ VBs
proEFA supplementation ^a	Yes	Yes	Yes	No
Total number of visits	38	29	20	49
Duration, wk	24	24	32	24
Average visits/week	1.6	1.2	0.6	2.0
Adverse events	None documented	None documented	None documented	None documented

DC, doctor of chiropractic; VB, vertebral body.

^aNordic Naturals, Inc, Watsonville, Calif.

treatment of children diagnosed with ADHD has increased.¹⁵ Of the practitioner-based CAM therapies for children,¹⁶ chiropractic is the most popular and highly utilized. In the interest of evidence-based practice, we describe the findings of our retrospective review of children with medically diagnosed ADHD under chiropractic care.

METHOD

A retrospective analysis of patient files of children presenting with complaints associated with ADHD at a solo-practitioner chiropractic clinic in a period of one year was performed. The following inclusion criteria for file review were used: (1) the patient was provided a medical diagnosis of ADHD, (2) the patient underwent a diagnostic workup, including a history and physical examination to screen for comorbidities and signs and symptoms indicative of a contraindication to chiropractic spinal manipulative therapy (SMT), and (3) the patient received consistent chiropractic care for a period of at least five months. The file review was performed by the attending clinician, with data compiled into an Excel spreadsheet (Microsoft Corporation, Redmond, Wash). In addition to patient demographics (ie, age, gender), information regarding treatment frequency and duration, medication use, spinal segmental dysfunctions addressed, and response to chiropractic care (including adverse events) were examined and described. Categorical data were analyzed using descriptive statistics (ie, frequency distributions and percentages). Repeated measures on the same subject were analyzed using the Friedman test.

RESULTS

Our review found four patient files satisfying the inclusion criteria. All patients were males, ranging in age from seven to 11 years (mean, nine years; median, nine years, mode, none), with three patients having a history of medication use and two patients having prescribed medication at the start of chiropractic care (Table 1). Chiropractic care addressed sites of spinal seg-

mental dysfunctions at all spinal levels (ie, cervical, thoracic, and lumbosacral spine). The clinical trial of care (ie, frequency and durations) was established by the attending clinician at three times per week for eight weeks, followed by twice a week for eight weeks and eventually once per week for eight weeks, but tempered by each patient's response to care and reexamination findings. During the course of care, a continuous process of reevaluation with respect to the patient's response was made. In this regard, the parents were asked to provide feedback in the form of a questionnaire. None of the patients or the parents reported any adverse events with the chiropractic care rendered.

The chiropractic SMT rendered may be characterized as high-velocity, low-amplitude-type thrusts to sites of spinal segmental

Table 2. ADHD Monitoring System Questionnaire

Characteristic	Scale			
1. Fidgets with hands or feet or squirms in seat	0	1	2	3
2. Difficulty remaining seated	0	1	2	3
3. Difficulty waiting turn	0	1	2	3
4. Talks excessively	0	1	2	3
5. Interrupts others	0	1	2	3
6. Always "on the go"	0	1	2	3
7. Easily distracted	0	1	2	3
8. Fails to complete assigned tasks	0	1	2	3
9. Trouble paying attention	0	1	2	3
10. Careless/messy work	0	1	2	3
11. Does not seem to listen when spoken to	0	1	2	3
12. Difficulty following directions	0	1	2	3
13. Follows class rules ^a	0	1	2	3
14. Gets along with peers ^a	0	1	2	3
15. Seems happy and in a good mood ^a	0	1	2	3

ADHD, attention-deficit/hyperactivity disorder.

^aHigher scores for these items indicate better functioning by the child.

Table 3. Parent and Teacher Scoring

Month	Patient A					Patient B ^a					Patient C					Patient D ^a								
	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Parent scoring																								
Questions 1-12	30	30	27	20	16	12	36	35	20	17	19	16	32	29	20	15	12	9	32	30	25	17	17	11
Questions 13-15	1	1	1	4	4	6	2	2	3	6	6	6	2	3	3	4	4	4	1	1	2	4	5	5
Teacher scoring																								
Questions 1-12	35	32	30	22	17	14	...	...	...	...	...	...	36	35	30	22	19	12	...	...	...	...	...	...
Questions 13-15	0	1	2	2	2	3	...	...	...	...	...	...	1	1	1	3	3	3	...	...	...	...	...	...

^aEllipses indicate teacher data was not available.

dysfunctions,¹⁷ utilizing diversified technique¹⁸ and the Gonstead technique.¹⁹ Chiropractic SMT was augmented with nutritional supplementation by using proEFA with borage oil (Nordic Naturals, Inc, Watsonville, Calif). The supplement in tablet form was taken daily and contained a total of 283 mg of omega-3 fatty acids, with 135 mg of eicosapentaenoic acid and 90 mg of docosahexaenoic acid.

To monitor the patient's response to care, the attending chiropractor instituted within his practice a 15-item parent/teacher ADHD questionnaire developed by D. Rabiner (unpublished data; Table 2). Permission was provided by D Rabiner (December, 2004; personal communication) for the use of the questionnaire. The ADHD monitoring system was originally developed to monitor the ongoing effectiveness of medication treatment. According to Rabiner (unpublished data), however, it can be used to monitor other treatments a child is receiving. The responder (parent or teacher) was asked to rate the child's ADHD-related symptoms on a Likert scale of 0 (not at all), 1 (a little), two

(pretty much), and three (very much). The ADHD monitoring system consists of two parts. Part A of the questionnaire (questions 1-12) specifically address the symptoms of ADHD. Questions 1 to 6 refer to the child's hyperactive/impulsive symptoms and questions 7 to 12 provide information on inattentive symptoms. A decrease in scoring was interpreted as an improvement in ADHD symptoms. Part B (questions 13-15) provides a basic screening for behavioral, social, or emotional difficulties. An increase in scoring was interpreted as an improvement in behavior. The results of scoring are provided in Table 3 and graphically represented in Figures 1 to 4. As demonstrated in Table 3, the parent and teacher scoring of the patients' ADHD symptoms decreased on a monthly basis, reflecting an improvement in hyperactivity, impulsivity, and inattentiveness. The parental (Figure 2) and teacher scoring (Figure 4) of the patients' behavioral, social, or emotional difficulties also demonstrated an increasing trend reflective of an improvement in behavior.

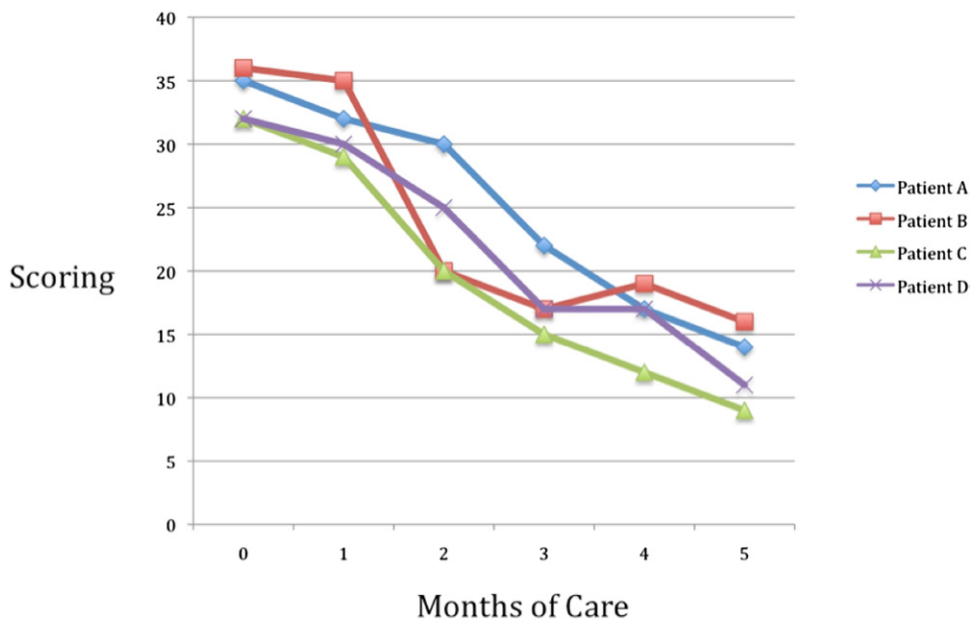


Figure 1. Parental scoring (ie, for hyperactive/impulsive and inattentive symptoms, questions 1-12) with the attention deficit/hyperactivity disorder (ADHD) monitoring system at 4 weeks interval of care.

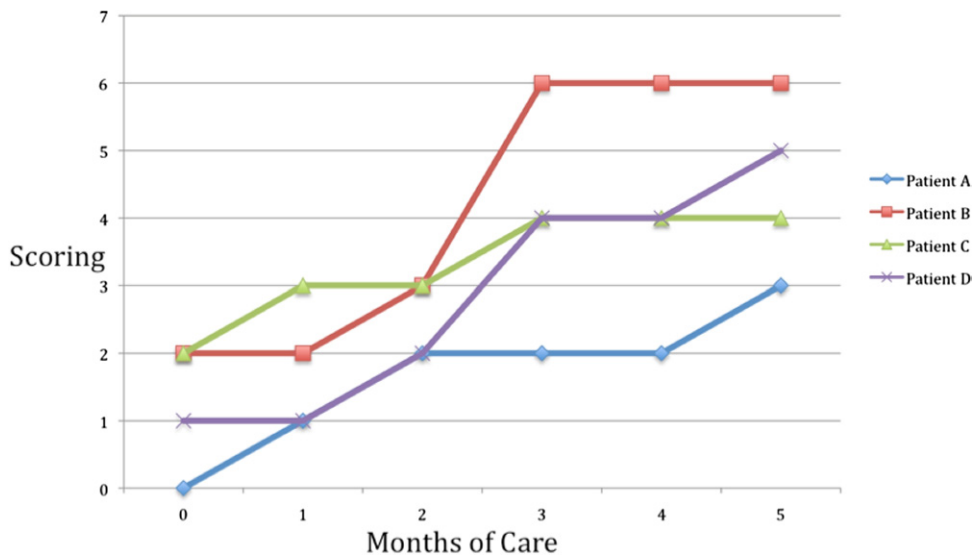


Figure 2. Parental scoring (ie, for behavioral, social, or emotional difficulties, questions 13-15) with the ADHD monitoring system at 4 weeks interval of care.

Data Analysis

From the graphical representation of the results obtained from the ADHD monitoring system, intuitively one observes an improvement in ADHD symptoms as well as in behavioral, social, or emotional difficulties in the individual patient and for the group as a whole. Given the repeated measures obtained, we subjected our data to statistical analysis (ie, pencil and paper calculation) using the Friedman test (Table 4), a nonparametric test used to compare observations repeated on the same subjects. The results of our calculations are shown in Table 4 and support the rejection of the null hypothesis—the hypothesis of no effect.

DISCUSSION

Diagnosis

The classic triad of symptoms that characterize patients with ADHD are inattention, hyperactivity, and impulsivity. Patient diagnosis is based on clinical observations involving an operational clinical criteria as established by the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*.⁶ In addition to clinical observations of the patient's behavior, the diagnosis also takes into account other aspects of the patient's history and input of parents and teachers about the child's functioning. Therefore, as advocated by Rohde and Alpern,¹ the diagnosis of the patient with ADHD should be placed in the context that

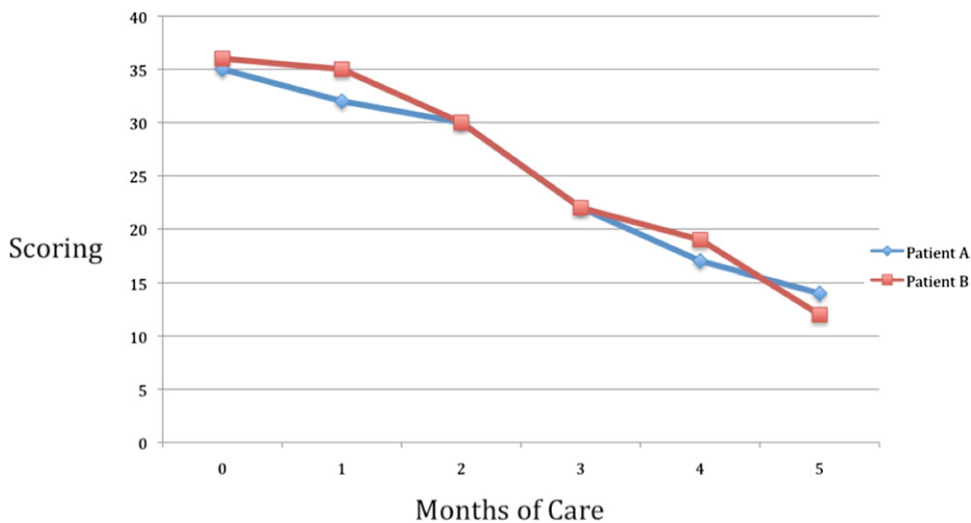


Figure 3. Teacher scoring (ie, for hyperactive/impulsive and inattentive symptoms, questions 1-12) with the ADHD monitoring system at 4 weeks interval of care.

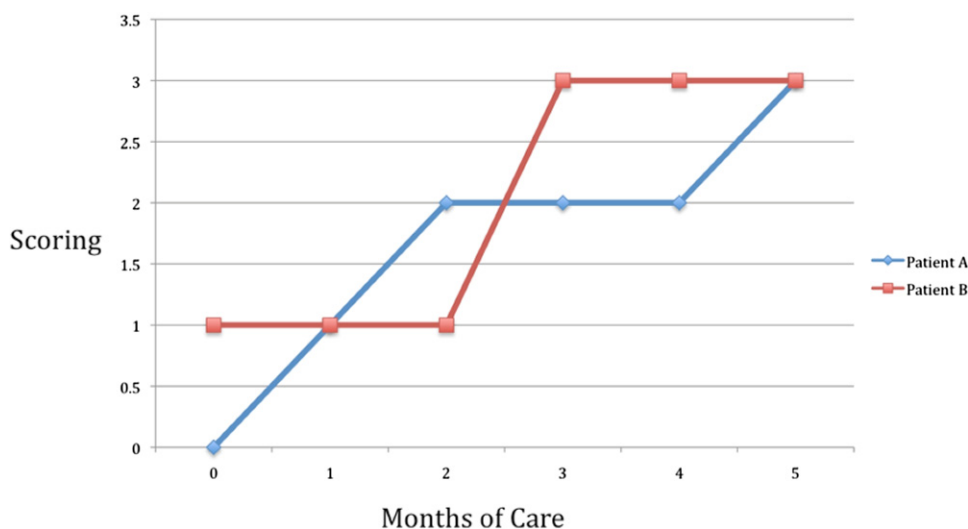


Figure 4. Teacher scoring (ie, for behavioral, social, or emotional difficulties, Questions 13-15) with the ADHD monitoring system at 4 weeks interval of care.

inattention, hyperactivity, and impulsivity may result from other problems of childhood such as the child's interpersonal relationships with parents and peers, an inappropriate educational system, or the presence of comorbidities that are commonly observed in childhood and adolescence.

Etiology

The exact and precise causes of ADHD are unknown. Suffice it to say, both genetic and environmental factors are influential in causing the disease. Genetics predisposes toward susceptibility or vulnerability, whereas environmental factors seem to trigger this vulnerability. Familial studies have demonstrated common recurrence of the disorder. Concordance between monozygotic twins have been demonstrated to be much significantly higher than between dizygotic twins. Several studies have estimated the inheritability of the disorder to be as high as 0.70, suggesting a high genetic component.²⁰ Adoption studies found a higher frequency of ADHD in children with biological parents when compared with adopted parents. The frequency of ADHD is three times more among biological parents when compared with adopted parents.²¹ Genetic studies have also focused on the genes that encode for components of the dopaminergic, noradrenergic, and serotonergic systems.

With respect to environmental factors, in the interest of a holistic and vitalistic approach to patient care, there are indications that complications of pregnancy or childbirth may play a role. Toxemia, eclampsia, fetal postmaturity, length of delivery, fetal stress, low birthweight, antepartum hemorrhage, or poor maternal health may predispose to ADHD disorder.^{22,23} Exposure to tobacco and alcohol during pregnancy have also been implicated,²⁴ as well as injury to the frontal lobes.²⁵ Additionally, food additives/diet, lead contamination, maternal smoking during pregnancy, and low birth weight have also been studied.²⁶ Psychosocial adversities such as severe marital conflict, low socioeconomic level, big family, parental crime, maternal psychopathology, and placement in a foster family have also been associated with ADHD. Therefore it would seem that any psychological agent that affects the child's emotional health seems to play a role in the development and persistence of ADHD.²⁷

Medical Management

The medical treatment of patients diagnosed with ADHD involve a number of approaches encompassing both psychosocial and psychopharmacological interventions. Recently, the Subcommittee on Attention Deficit/Hyperactivity Disorder of the American Academy of Pediatrics²⁸ published guidelines for clin-

Table 4. Results From Friedman Test

	Parent Data		Teacher Data	
	Questions 1-12	Questions 13-15	Questions 1-12	Questions 13-15
χ^2_r calculated	15.09	15.09	11.0	7.74
	$\gamma = k - 1 = 5$	$\gamma = k - 1 = 5$	$\gamma = k - 1 = 5$	$\gamma = k - 1 = 5$
	$P < .01$	$P < .01$	$P < .10$	$P < .10$
χ^2_r critical	16.14	16.38	9.24	9.24
Decision	Reject H_0	Reject H_0	Reject H_0	Fail to reject H_0

ical pediatricians on the treatment of ADHD. These guidelines consist of five basic principles: acknowledge that ADHD is a chronic disease; the aims of treatment outcomes should be specified; failure to meet these goals should lead to further reassessment for possible comorbidities; prescribe stimulants and/or behavioral therapy when appropriate; and establish a feedback mechanism from the child with ADHD, their family, and school.

Adverse reactions to the currently available short-acting stimulant medication are a major concern to parents and have been documented in the scientific literature.²⁹ These include appetite suppression, potential long-term growth concerns, insomnia, headache, dizziness, and abdominal pain. Less frequent side effects include anxiety, irritability, proneness to crying, and emergence of, or increase in, motor tics. It's been estimated that in approximately 30% of children, the medications are ineffective.²⁹ In addition to misuse and diversion by high school and college students, epidemiological studies now suggest that stimulant medication prescriptions are for children who do not meet the criteria for ADHD but may suffer from other behavioral or learning disturbances.³⁰ Of greater concern are the effects of stimulant medication in increasing the risk for sudden unexplained death in childhood, which have been documented repeatedly in case reports and case series since the early 1990s.³¹ Gould and colleagues³² demonstrated an association between the use of stimulants and sudden unexplained death in children and adolescents. In a retrospective, case-control study, the investigators matched children who had died of sudden unexplained death to children who had died as passengers in motor vehicle accidents. Information was collected from autopsy reports and toxicology results, and direct parental interviews were obtained. Cases with identified heart abnormalities or family history of sudden unexplained death were excluded. Of the final sample of 564, 10 cases (1.8%) of the sudden unexplained death cases were treated with stimulant medication at the time of their death, compared with only two cases (0.4%) of mortality from the motor vehicle accident victims.

Implications for Chiropractic Care

To provide a context and direction for further discussion, we performed a selective review of the literature by using CINAHL (1965-2009), Index to Chiropractic Literature (1984-2009), and PubMed (1966-2009). With PubMed, we used the search terms "ADHD OR attention deficit hyperactivity disorder AND chiropractic." With the Index to Chiropractic Literature, the search terms "ADHD" and "chiropractic" were used in ALL, specified to the chiropractic discipline and the English language. Our literature review revealed the description of methods of a randomized controlled clinical trial,³³ two case reports,^{34,35} one case series,³⁶ one survey study,³⁷ and two commentaries on the chiropractic care of children with ADHD.^{38,39} Of interest were four studies related to the topic of ADHD. The first described the care of a patient with attention and hyperactivity problems without the diagnosis of ADHD.⁴⁰ The second was a pilot study examining the effect of chiropractic intervention on attention span.⁴¹ The third was a pilot study examining the effects of chiropractic on hyperactivity,⁴² and the fourth was a commen-

tary on addressing hyperactivity and learning disabilities in children.⁴³

Karpouzis and colleagues³³ recently described their design and protocol for the first placebo-controlled, double-blind randomized clinical trial examining the effectiveness of neuro emotional technique (NET) on a cohort of children with medically diagnosed ADHD. The patients were randomized into three groups: one group receiving NET care, another group under "usual" medical care, and the third group receiving sham NET. The patients under the active and sham NET were treated at twice a week for the first month and once per week for the following six months. Established outcome measures (ie, Connor's questionnaire) for ADHD were used in addition to subjective measures. Unfortunately, the publication is preliminary and the results regarding outcomes of care were not reported.

Bastecki and colleagues³⁴ described the care of a five-year-old patient diagnosed with ADHD and treated by a pediatrician, unsuccessfully, with methylphenidate (Ritalin), Adderall, and Haldol for three years. The patient received 35 chiropractic treatments during the course of eight weeks. A change from a 12° C₂₋₇ kyphosis to a 32° C₂₋₇ lordosis was observed after treatment. During chiropractic care, the child's facial tics resolved and his behavior vastly improved. After 27 chiropractic visits, the child's pediatrician stated that the child no longer exhibited symptoms of ADHD. The authors posit the possibility that changes in structure (ie, correction of cervical kyphosis) may be related to function (ie, improvement in ADHD symptoms).

Elster³⁵ described the care of a patient that may be appropriately described as having a multiple symptom complex. This nine-year-old patient suffered from asthma and upper respiratory infections since infancy; headaches since age six; Tourette's syndrome, ADHD, depression, and insomnia since age seven; and neck pain since age eight. Medication use included Albuterol, Depakote, Wellbutrin, and Adderall. During the patient's initial examination, evidence of spinal segmental dysfunction was notable at the upper cervical spine through the use of thermographic and radiographic diagnostics. Chiropractic care using an upper cervical technique was administered to correct and stabilize the patient's upper cervical spine dysfunction. After six weeks of care, the patient's conditions were no longer present and all medications were discontinued with the exception of a half dose of Wellbutrin. At the conclusion of his case at five months, all symptoms remained absent.

Pauli³⁶ described the care of nine adults (four males, five females; age range, 22-58 years) undergoing chiropractic care using Network Spinal Analysis. The patients were evaluated with the Test of Variable of Attention⁴⁴ prior to and at two months of care. Pretreatment and comparative testing demonstrated significant changes in ADHD scoring.

In a semistructured interview of mothers of ADHD sufferers, Hermansen and Miller³⁷ sought to determine if chiropractic and the use of the interactive metronome (a tool developed to enhance motor coordination, and in ADHD patients, motor and cognitive skills) were helpful for their children. Five main themes emerged from their interviews: (1) medication use was an issue with mothers resistant to its use despite feelings of pressure from healthcare providers and the educational system, (2) there are challenges with living with a child with ADHD, (3) family life

and relationships among family members were strained, (4) there was a lack of support overall from their healthcare provider and the educational system, and (5) high satisfaction with their child's chiropractic care. Schetchikova³⁸ discussed the role of chiropractic in the care of children with ADHD and stressed the importance of assessing all aspects of a child's problem and working to restore balance to the physical, chemical, and mental aspects of the child's life. Barnes³⁹ performed a literature review of the multiple etiologies of ADHD and discussed alternative nonpharmacological treatment options. Since ADHD was strongly associated with learning disabilities, Barnes advocated that treatment should be based on educational interventions rather than drug therapy. Furthermore, Barnes saw the role of the chiropractor as significant in the care of children with ADHD, since chiropractors assess all aspects of a child's problem and work to restore balance to several aspects of the child's life.

Our literature review found studies related to the symptoms of ADHD. Bedell⁴⁰ described the care of a seven-year-old girl with problems associated with attention and focusing at school, hyperactive behavior, sleep disturbances, and aggressive, negative behavior toward her sister. The patient was not diagnosed with ADHD. Using the Torque Release Technique augmented with dietary changes (ie, avoidance of sugars, sodas, etc) and nutritional supplements over a 90-day treatment schedule, improvements in the patient's behavior were noted during her weekly assessment as well as an overall change in her attitude and improved performance with specific tasks.

Goff and colleagues⁴¹ assessed the effects of chiropractic SMT on attention span as measured by a computerized continuous performance test. Forty-one patients at a chiropractic teaching clinic aged 22-47 (mean age, 32 years) were tested with the Conners' Continuous Performance Test computer program, version 3.0 before and after chiropractic SMT. Individuals showed improved attention span at clinically significant levels following the chiropractic intervention.

Giesen and colleagues⁴² examined the effectiveness of chiropractic SMT in children with hyperactivity. Using blinding between investigators and a single subject research design, the investigators evaluated the effectiveness of treatment for reducing activity levels in seven hyperactive children. Data collection included independent evaluations of behavior by using a unique wristwatch-type device (ie, measured activity while the children completed tasks simulating school work), electrodermal testing to measure autonomic nervous system activity, chiropractic clinical evaluations to measure improvement in spinal biomechanics, and parent rating for activity. Data were analyzed visually and using nonparametric statistical methods. Five of the seven children showed improvement in mean behavioral scores. Four of the seven children showed improvement in arousal levels, and the improvement in the group as a whole was highly significant. For all seven children, three of the four principal tests used to detect improvement were in agreement either positively or negatively (ie, parent ratings of activity, motion recorder scores, electrodermal measures, and biomechanical distortions). Null⁴³ provides a commentary on the care of the child with hyperactivity and learning disabilities by advocating for a conservative treatment approach—particularly nutritional interventions.

Based on our selective review of the literature and to the best of our knowledge, this is the first reporting in the scientific literature on the chiropractic care of children with medically diagnosed ADHD by using the diversified technique and the Gonstead technique augmented with nutritional supplements. Similar to previous reports, we observed changes in medication use (ie, decreased dose and withdrawal of medication) concomitant with improvement in ADHD symptoms while under chiropractic care. More importantly, our retrospective review revealed the use of an outcome measure specifically designed for the purpose of monitoring response to treatment in addition to subjective outcome measures. Our findings demonstrated a treatment effect with improvements in ADHD symptoms along with improved overall behavior.

Our systematic review of the literature revealed the lack of documentation in the scientific literature on the chiropractic care of children with ADHD. A valid comparison of our findings with those of previous studies is challenging given the clinical heterogeneity of the case reports/case series reported. Beyond differences in patient gender and age, etc, the clinical trial described by Karpouzis and colleagues³³ utilized NET,⁴⁵ whereas previous case reports and case series described chiropractic SMT as Chiropractic Biophysics,⁴⁶ upper cervical technique,⁴⁷ Network Spinal Analysis,⁴⁸ and Torque Release Technique.⁴⁹ Despite the clinical heterogeneity, an examination of the cases described finds claims of resolution of ADHD in the two case reports^{34,35} and in eight of nine patients in the case series by Pauli,³⁶ with duration of care ranging from six weeks to two months.

Our retrospective review demonstrated that with continued chiropractic care, the symptoms of ADHD (ie, hyperactivity, impulsivity, and inattention as well as behavioral, social, or emotional difficulties) improve as measured by the Rabiner questionnaire (unpublished data). Given that ADHD is a chronic condition, it remains to be determined if continued chiropractic care will result in continued improvement (perhaps even to the point where ADHD symptoms are no longer problematic for patients) or a "saturation effect" occurs (ie, ADHD symptom improvements have reached a plateau regardless continued care), or if withdrawal of chiropractic care maintains the improvements observed. Our retrospective case series observed continued improvement in only five months of care. Regardless, this study provides supporting evidence that chiropractic may abate the symptoms of ADHD and may provide a complementary or alternative care approach to allopathic care approaches (ie, stimulant medication). The chiropractic perspective in the care of patients with ADHD is not one of "all or none" (ie, care results in no effect or complete remission of ADHD), but rather the symptoms of ADHD are abated (ie, "like a dimmer for the lights") concomitant with improvement in spinal function.

Further research using validated outcome measures (ie, Conner's Continuous Performance Test⁵⁰) in higher-level design studies (ie, randomized controlled clinical trials) or within a chiropractic practice-based research setting will further contribute to our understanding of the effects of chiropractic care in ADHD sufferers. With respect to the specificity of the treatment employed in our retrospective review, (ie, chiropractic SMT and ProEFA [Nordic Naturals, Inc]), the contributing salutary effect of SMT versus

ProEFA remains to be determined. The theoretical mechanisms upon which the primary approach to patient care (ie, chiropractic SMT) may abate the symptoms of ADHD are predicated upon the framework that elimination of craniospinal biomechanical dysfunctions leads to proper central nervous system functioning. In the reviewed literature on chiropractic SMT (regardless of technique) and ADHD, the primary approach to patient care was SMT with the intent and purpose of eliminating spinal segmental dysfunctions.

No more is this true than in the case report by Bastecki and colleagues,³⁴ where they demonstrated an improvement in nervous system functioning (ie, abatement of ADHD symptoms) concomitant with restoration of cervical spine lordosis. The authors cite the work of Breig⁵¹ and Grostic⁵¹ for an explanatory mechanism. Breig⁵¹ observed and was able to demonstrate measurable spinal canal and spinal cord deformation in various configurations (ie, spinal flexion, extension, etc.) and related these to various nervous system dysfunctions. Grostic's dentate ligament-cord distortion hypothesis⁵² provides a model to explain how misalignment of the C₁ and C₂ vertebral bodies can produce neurological insult by mechanical irritation, via the dentate ligaments, of the spinal cord and, indirectly, through vascular compromise. Grostic proposed that the dentate ligaments may adversely affect nerve conduction within the spinal cord. Given the presence of the dentate ligament throughout the spine, it stands to reason for the possibility that Grostic's dentate ligament-cord distortion hypothesis may also occur throughout the spine.

Another point of view of the consequence of spinal cord distortion, vis a vis spinal segmental dysfunctions, may be compromised circulation to the brain. In such a situation, circulation (and functionality) to the brain (or parts of the brain) is compromised but remains alive with the potential to be fully functional. Terrett⁵³ referred to this as ischemic penumbra,⁵⁴ which results in brain hibernation. In support of this chiropractic theory, consider the findings by Valera and colleagues⁵⁵ in statistically analyzing structural imaging data via a meta-analysis of children with ADHD. The authors found all regions across all neuroimaging studies indicated global reductions for ADHD subjects compared with control subjects. The regions most frequently assessed and showing the largest differences were the cerebellar regions, the splenium of the corpus callosum, total and right cerebral volume, and the right caudate.

In terms of the effects of SMT on brain function, consider the work of Kelly and colleagues⁵⁶ in demonstrating a significant improvement in complex reaction-time task (ie, improved functionality) following SMT to the upper cervical spine. According to the authors, chiropractic SMT may be affecting cortical processing. We theorize that this may also be occurring in patients with ADHD as a result of reanimating previously "hibernating" portions of the brain. A study by Haavik-Taylor and Murphy⁵⁷ demonstrated among 12 subjects and similarly numbered control subjects that SMT to the cervical spine may alter cortical somatosensory processing and sensorimotor integration. According to the authors, these findings may help elucidate the mechanisms responsible for the effective relief of pain and restoration of functional ability such as those in patients with ADHD. In addition, chiropractic's scope of practice allows for

the use of nutritional intervention as possible roles in prevention. These are discussed below.

A number of publications exist advocating for the use of nutritional therapies for mental disorders and for ADHD specifically.^{58,59} Nutritional intervention is an attractive alternative to prescribed medication. However, its safety and effectiveness also remain to be documented. With respect to the safety of chiropractic, Vohra and colleagues⁶⁰ systematically reviewed the literature on adverse events associated with pediatric SMT and found only 14 cases of documented adverse events. Ten of these were associated with chiropractic.

In a practice-based research network, Alcantara and colleagues⁶¹ addressed the safety and effectiveness of pediatric chiropractic and found three adverse events per 5,438 chiropractic visits from the treatment of 577 children, based on chiropractor responders, and two adverse events from 1,735 office visits involving the care of 239 children, based on parent responders. The adverse events were minor (ie, did not require medical attention) and were addressed successfully by the attending clinicians.

With respect to pharmacological interventions, physicians perceive stimulant medications as effective for treating children or adolescents with ADHD. However, physicians prefer non-stimulant medication due to the side effects, risk of diversion, and administrative burden of stimulant medications.⁶²

Within the framework of chronic epidemiology, it is well established that prevention and health promotion strategies are the best means of intervention.⁶³⁻⁶⁵ Chiropractic care was founded on a vitalistic and holistic approach to health and incorporates a number of prevention and health promotion strategies. We advocate for chiropractic care in children with ADHD but also add that, given the environmental factors such as toxemia, eclampsia, fetal postmaturity, length of delivery, fetal stress, low birthweight, antepartum hemorrhage, and poor maternal health may predispose for the development of ADHD, chiropractors may also play a role in providing prenatal care (within the context of integrative care) for the pregnant patient and prevent environmental stressors through counseling for proper nutrition, exercise, etc. The use of the Webster technique⁶⁶ in correcting for lumbopelvic dysfunction in pregnant women and concomitant relief of in-utero constraint may have an effect on the development of these predisposers, such as fetal stress, length of delivery, prevention of birth trauma, etc. We encourage further exploration on these covariates of care.

There are inherent limitations in making cause and effect inferences as a result of the findings of this study. By virtue of research design, this retrospective file review with perceived salutary effects on the part of chiropractic may be due to the following competing explanations: (1) the natural history, (2) regression to the mean, and (3) the result of placebo. Furthermore, as a result of a "self-fulfilling prophecy," both the clinician and the patient/parent may make incorrect inferences from treatment due to (4) the demand characteristics of the therapeutic encounter and (5) subjective validation. On the issue of natural history, Mannuzza and Klein⁶⁷ traced the developmental course of ADHD from childhood to adulthood, showing that it is a "bumpy road" for many. In early and middle adolescence, relative deficits are seen in academic and social functioning, ADHD

symptoms remain problematic in two thirds to three quarters of these children, and antisocial behaviors, in some cases amounting to conversion disorder, are common. Many of these same difficulties persist into the late teenage years, with continued deficits in academic and social domains (compared with controls, probands exhibit lower grades, more courses failed, worse performance on standardized tests, have fewer friends, and are rated less adequate in psychosocial adjustment). When evaluated in their midtwenties, ADHD individuals complete less schooling, hold lower-ranking occupations, and continue to suffer from poor self-esteem and social skills deficits. On a brighter note, Mannuzza and Klein⁶⁷ found that nearly all probands were gainfully employed. Furthermore, some had achieved a higher-level education (eg, completed master's degree, enrolled in medical school) and occupation (eg, accountant, stock broker). In addition, a full two thirds of their subjects showed no evidence of any mental disorder in adulthood. On the issue of placebo, as with most CAM therapies, chiropractic embraces the nonspecific effects of treatment (ie, placebo) and considers it a crucial part of the clinical encounter. Randomized clinical trials attempt to minimize these effects to demonstrate treatment effectiveness. Studies remain to address the placebo effect of the chiropractic intervention in patients with ADHD. In reviewing existing studies that evaluated whether placebos produce significant changes in children with ADHD, Waschbusch and colleagues⁶⁸ found little evidence that placebos produce significant changes in the behavior or cognition of elementary school-age children with ADHD. However, there may be significant placebo effects in adults who evaluate children with ADHD. According to the authors, the evidence suggests that parents and teachers tend to evaluate children with ADHD more positively when they believe the child has been administered stimulant medication, and they tend to attribute positive changes to medication even when medication has not actually been administered. Similar effects on outcome may be occurring with the administration of CAM therapy. However, to what extent parents and teachers attribute positive changes to alternative treatments remains to be addressed.

CONCLUSION

This study suggests that patients with ADHD may benefit from chiropractic care characterized as high-velocity, low-amplitude thrusts to sites of spinal segmental dysfunction, and nutritional supplementation with ProEFA. We advocate further research in this field.

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REFERENCES

- Rohde LA, Halpern R. Recent advances on attention deficit/hyperactivity disorder [in Portuguese]. *J Pediatr (Rio J)*. 2004;80(2 suppl):S61-S70.
- Hoffmann H. *Der Struwwelpeter*. Berlin, Germany: Deutsche Bund Gebrauch Muster; 1854.
- Still GF. Some abnormal psychical conditions in childhood. *Lancet*. 1902;1:1008.
- Centers for Disease Control and Prevention. National health and nutrition examination survey. Available at: http://www.cdc.gov/nchs/nhanes/nhanes_questionnaires.htm. Accessed June 6, 2007.
- Froehlich TE, Lanphear BP, Epstein JN, Barbaresi WJ, Katusic SK, Kahn RS. Prevalence, recognition, and treatment of attention-deficit/hyperactivity disorder in a national sample of US children. *Arch Pediatr Adolesc Med*. 2007;161:857-864.
- American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*. Washington, DC: American Psychiatric Association; 2000.
- Wolraich ML, Hannah JN, Baumgaertel A, Feurer ID. Examination of DSM-IV criteria for attention deficit/hyperactivity disorder in a county-wide sample. *J Dev Behav Pediatr*. 1998;19:162-168.
- Wolraich ML, Hannah JN, Pinnock TY, Baumgaertel A, Brown J. Comparison of diagnostic criteria for attention-deficit hyperactivity disorder in a county-wide sample. *J Am Acad Child Adolesc Psychiatry*. 1996;35:319-324.
- Costello EJ, Mustillo S, Erkanli A, Keeler G, Angold A. Prevalence and development of psychiatric disorders in childhood and adolescence. *Arch Gen Psychiatry*. 2003;60:837-844.
- Gaub M, Carlson CL. Behavioral characteristics of DSM-IV ADHD subtypes in a school-based population. *J Abnorm Child Psychol*. 1997;25:103-111.
- Angold A, Erkanli A, Farmer EM, et al. Psychiatric disorder, impairment, and service use in rural African American and white youth. *Arch Gen Psychiatry*. 2002;59:893-901.
- Castle L, Aubert RE, Verbrugge RR, Khalid M, Epstein RS. Trends in medication treatment for ADHD. *J Atten Disord*. 2007;10:335-342.
- Winterstein AG, Gerhard T, Shuster J, et al. Utilization of pharmacologic treatment in youths with attention deficit/hyperactivity disorder in Medicaid database. *Ann Pharmacother*. 2008;42:24-31.
- Kruger J, Park A, Klarreich K, Whitaker L. Medicating young minds. *Time Magazine*. November 3, 2003. Available at: <http://www.time.com/time/magazine/article/0,9171,1006034,00.html>. Accessed December 25, 2009.
- Sawni A. Attention-deficit/hyperactivity disorder and complementary/alternative medicine. *Adolesc Med State Art Rev*. 2008;19:313-326.
- Barnes PM, Bloom B, Nahin RL. Complementary and alternative medicine use among adults and children: United States, 2007. *Natl Health Stat Report*. 2008;12:1-23.
- Alcantara J, Plaughner G, Lopes MA, Cichy DL. Spinal subluxation. In: Anrig C, Plaughner G, eds. *Pediatric Chiropractic*. Baltimore, Md: Williams & Wilkins; 1997.
- Bergmann TF, Peterson DH, Lawrence DJ. *Chiropractic Technique: Principles and Procedures*. New York, NY: Churchill Livingstone; 1993.
- Plaughner G. *Textbook of Clinical Chiropractic: A Specific Biomechanical Approach*. Baltimore, Md: Williams & Wilkins; 1992.
- Thapar A, Holmes J, Poulton K, Harrington R. Genetic basis of attention-deficit and hyperactivity. *Br J Psychiatry*. 1999;174:105-111.
- Sprich S, Biederman J, Crawford MH, Muncy E, Faraone SV. Adoptive and biological families of children and adolescents with ADHD. *J Am Acad Child Adolesc Psychiatry*. 2000;39:1432-1437.
- Faraone SV, Biederman J. Neurobiology of attention-deficit/hyperactivity disorder. *Biol Psychiatry*. 1998;44:951-958.
- Langley K, Holmans PA, van den Bree MB, Thapar A. Effects of low birth weight, maternal smoking in pregnancy and social class on the phenotypic manifestation of attention deficit hyperactivity disorder

- and associated antisocial behaviour: investigation in a clinical sample. *BMC Psychiatry*. 2007;7:26.
24. Mick E, Biederman J, Faraone S, Sayer J, Kleiman S. Case control study of ADHD and maternal smoking, alcohol use, and drug use during pregnancy. *J Am Acad Child Adolesc Psychiatry*. 2002;41:378-385.
 25. Levy F, Barr C, Sunohara G. Directions of aetiological research on attention deficit/hyperactivity disorder. *Aust N Z J Psychiatry*. 1998;32:97-103.
 26. Banerjee TD, Middleton F, Faraone SV. Environmental risk factors for attention-deficit hyperactivity disorder. *Acta Paediatr*. 2007;96:1269-1274.
 27. Biederman J, Milberger S, Faraone SV, et al. Family-environment risk factors for ADHD: a test of Rutter's indicators of adversity. *Arch Gen Psychiatry*. 1995;52:464-470.
 28. Campbell Daley K. Update on attention deficit hyperactivity disorder. *Curr Opin Pediatrics*. 2004;16:217-226.
 29. Steer CR. Managing attention deficit/hyperactivity disorder: unmet needs and future directions. *Arch Dis Child*. 2005;90:19-25.
 30. Wilens TE, Adler LA, Adams J, et al. Misuse and diversion of stimulants prescribed for ADHD: a systematic review of the literature. *J Am Acad Child Adolesc Psychiatry*. 2008;47:21-31.
 31. Nissen SE. ADHD drugs and cardiovascular risk. *N Engl J Med*. 2006;354:1445-1448.
 32. Gould MS, Walsh BT, Munfakh JL, et al. Sudden death and use of stimulant medications in youths. *Am J Psychiatry*. 2009;166:992-1001.
 33. Karpouzis F, Pollard H, Bonello R. A randomised controlled trial of the Neuro Emotional Technique (NET) for childhood attention deficit hyperactivity disorder (ADHD): a protocol. *Trials*. 2009;10:6.
 34. Bastecki AV, Harrison DE, Haas JW. Cervical kyphosis is a possible link to attention-deficit/hyperactivity disorder. *J Manipulative Physiol Ther*. 2004;27:e14.
 35. Elster E. Upper cervical chiropractic care for a nine-year-old male with Tourette syndrome, attention deficit hyperactivity disorder, depression, asthma, insomnia, and headaches: a case report. *J Vert Sublux Res*. 2003;1:11.
 36. Pauli Y. Improvement in attention in patients undergoing network spinal analysis: a case series using objective measures of attention. *J Vert Sublux Res*. 2007:1-9.
 37. Hermansen MS, Miller PJ. The lived experience of mothers of ADHD children undergoing chiropractic care: a qualitative study. *Clin Chiropr*. 2008;11:175-181.
 38. Schetchikova NV. Children with ADHD: medical vs. chiropractic perspective and theory. *J Am Chiropr Assoc*. 2002;39(7):28-38.
 39. Barnes T. Attention deficit hyperactivity disorder and the triad of health. *J Clin Chiropr Ped*. 1996;1:59-65.
 40. Bedell L. Successful care of a young female with ADD/ADHD & vertebral subluxation: a case study. *J Vert Sublux Res*. 2008:1-7.
 41. Goff P, Sheader W, Sheader DF, Thornton M. Using a computerized continuous performance test to assess the effects of chiropractic adjustment on attention span: a pilot study. *Chiropr J Aust*. 2000;30:48-54.
 42. Giesen JM, Center DB, Leach RA. An evaluation of chiropractic manipulation as a treatment of hyperactivity in children. *J Manipulative Physiol Ther*. 1989;12:353-363.
 43. Null G. Hyperactivity and learning disabilities. *J Chiropr*. 1988;25(12):34-38.
 44. Introducing the test of variables of attention (T.O.V.A.). The TOVA Company Web site. Available at: <http://www.tovatest.com/>. Accessed October 2, 2009.
 45. What is NET? N.E.T. Inc Web site. Available at: http://www.netmindbody.com/what_is_net.html. Accessed October 2, 2009.
 46. Chiropractic Biophysics. CBP Seminars, Inc. Spring Creek, NV, USA. Available at: <http://www.idealspine.com/>. Accessed October 2, 2009.
 47. Knutson GA. An examination of the premises for chiropractic specific upper cervical technique. *J Vert Sublux Res*. 2005:1-7.
 48. What is Network Spinal Analysis? The official website of Dr Donald Epstein. Available at: <http://www.donaldepstein.com/nsa/network.shtml>. Accessed October 2, 2009.
 49. Torque Release Technique. Available at: <http://www.torquerelease.com/overview.htm>. Accessed October 2, 2009.
 50. Homack S, Riccio CA. Conners' Continuous Performance Test (2nd ed.; CCPT II). *J Atten Disord*. 2006;9:556-558.
 51. Breig A. *Adverse Mechanical Tension in the Central Nervous System. An Analysis of Cause and Effect*. New York, NY: John Wiley & Sons; 1977:1-57.
 52. Grostic JD. Dentate ligament-cord distortion hypothesis. *Chiropr Res J*. 1988;1:47-55.
 53. Terrett AGJ. The cerebral dysfunction theory. In: Gatterman MI, ed. *Foundations of Chiropractic: Subluxations*. St. Louis, Mo: Mosby; 2005:340-352.
 54. Astrup J, Siesjo BK, Symon L. Thresholds in cerebral ischemia-ischemic penumbra. *Stroke*. 1981;12:723-735.
 55. Valera EM, Faraone SV, Murray KE, Seidman LJ. Meta-analysis of structural imaging findings in attention-deficit/hyperactivity disorder. *Biol Psychiatry*. 2007;61:1361-1369.
 56. Kelly DD, Murphy BA, Backhouse DP. Use of a mental rotation reaction-time paradigm measure the effects of upper cervical adjustments on cortical processing: a pilot study. *J Manipulative Physiol Ther*. 2000;23:246-251.
 57. Haavik-Taylor H, Murphy B. Cervical spine manipulation alters sensorimotor integration: a somatosensory evoked potential study. *Clin Neurophysiol*. 2007;118:391-402.
 58. Lakhan SE, Viera KF. Nutritional therapies for mental disorders. *Nutr J*. 2008;7:1-8.
 59. Rucklidge JJ, Johnstone J, Kaplan BJ. Nutrient supplementation approaches in the treatment of ADHD. *Expert Rev Neurother*. 2009;9:461-476.
 60. Vohra S, Johnston BC, Cramer K, Humphreys K. Adverse events associated with pediatric spinal manipulation: a systematic review. *Pediatrics*. 2007;119:e275-e283.
 61. Alcantara J, Ohm J, Kunz D. The safety and effectiveness of pediatric chiropractic: a survey of chiropractors and parents in a practice-based research network. *Explore (NY)*. 2009;5:290-295.
 62. Stockl KM, Hughes TE, Jarrar MA, Secnik K, Perwien AR. Physician perceptions of the use of medications for attention deficit hyperactivity disorder. *J Manag Care Pharm*. 2003;9:416-423.
 63. National Academy of Science, Institute of Medicine. *The Future of the Public's Health in the 21st Century*. Washington, DC: National Academies Press; 2003.
 64. *2004 National Assessment of Epidemiologic Capacity: Findings and Recommendations*. Atlanta, GA: Council of State and Territorial Epidemiologists; 2004. Available at: <http://www.cste.org/Assessment/ECA/pdffiles/ECAfina105.pdf>. Accessed December 19, 2009.
 65. Marks JS. Epidemiology, public health, and public policy. *Prev Chronic Dis*. 2009;6:A134.
 66. The Webster technique. International Chiropractic Pediatric Association. Available at: http://icpa4kids.com/about/webster_technique.htm. Accessed October 2, 2009.
 67. Mannuzza S, Klein RG. Long-term prognosis in attention-deficit/hyperactivity disorder. *Child Adolesc Psychiatr Clin N Am*. 2000;9:711-726.
 68. Waschbusch DA, Pelham WE Jr, Waxmonsky J, Johnston C. Are there placebo effects in the medication treatment of children with attention-deficit hyperactivity disorder? *J Dev Behav Pediatr*. 2009;30:158-168.