

# CASE STUDY

## Improvement in Behavior, Anxiety & Pain Following Chiropractic Care in a 9-Year-Old Boy with Asperger's Syndrome and Anxiety Disorder: Case Report & Review of the Literature

Laura Stone, DC, MS<sup>1</sup> & Joel Alcantara, DC<sup>2</sup>

### Abstract

**Objective:** To report on the positive health outcomes following chiropractic care experienced by a child with Asperger's Syndrome.

**Clinical Features:** A 9-year-old male with Asperger's Syndrome presented for care with complaints of neck pain, midback and low back pain, stomach aches and anxiety.

**Intervention and Outcome:** The patient was cared for with combinations of Gonstead and Thompson Technique at a frequency of care at 1 x/week for two months. Re-integration/brushing exercises of his hands and feet were also provided. The patient's musculoskeletal symptoms improved as did his behavioral challenges as measured by the Autism Treatment Evaluation Checklist for parents and quality of life as measured by the PROMIS-25 parent proxy measure.

**Conclusion:** This study provides supporting evidence on the benefits of chiropractic care in patients with ASD. Additional research on this is recommended.

**Keywords:** *Asperger's Syndrome, musculoskeletal complaints, pediatrics, subluxation, adjustment, spinal manipulation, autism*

### Introduction

Defined as lifelong deficits in social communication and interaction, restricted and repetitive behaviors, interests, and activities<sup>1</sup>, the prevalence of autism spectrum disorder (ASD) has increased dramatically in recent times to as high as 1-2% of children. In 2012, the combined estimated prevalence of ASD among the 11 ADDM Network sites in the United States was 14.6 per 1,000 or 1 in 68 children aged 8 years. This is a stark contrast to data indicating 1 in 110 children aged 8 years from previous years.

Estimated prevalence was significantly higher among boys aged 8 years (23.6 per 1,000) than among girls aged 8 years (5.3 per 1,000).<sup>2</sup> Loomes et al.<sup>3</sup> examined 54 studies involving 13,784,284 participants with whom 53,712 had ASD (i.e., 43,972 boys and 9,740 girls). According to the authors, the true male-to-female ratio is not 4:1 for ASD but rather more likely to be 3:1. In addition, they raised the issue that a diagnostic gender bias may exist such that girls who meet the diagnostic criteria for ASD are at disproportionate risk of not

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1. Private Practice of Chiropractic, Hampton, IL  
2. Research Director, International Chiropractic Pediatric Association, Media, PA

receiving a clinical diagnosis and ultimately care.

With genetic, environmental, cognitive, and social heterogeneity in the ASD phenotype, the identification of an effective intervention provides numerous challenges. There is minimal evidence to support the benefit of most medical interventions and concerns of harm exists<sup>4</sup>, particularly for children and young adults.<sup>5</sup> Given the limitations and concerns of harm of medical treatments, many parents are turning to alternative therapies for their child diagnosed with ASD.<sup>6</sup> Chiropractic is a popular and commonly utilized care approach for children<sup>7,8</sup> and specifically for children with ASD.<sup>9</sup> In the interest of evidence-informed practice (i.e., the integration of research evidence, clinical expertise and needs and wants of parents for their child), we describe the care of a child with ASD and Anxiety Disorder.

## Case Report

### *History*

A 9-year-old male presented with his mother for chiropractic consultation and possible care with presenting complaints of neck on the right side, midback and low back pain, stomach aches and anxiety. According to the patient's mother, her son was "born with torticollis" and continues to have slight head tilt. The patient's neck pain was characterized as constant, aching and throbbing that worsened with increased movement and prolonged sitting (i.e., as the day goes on) and rated on the visual analog scale (VAS) at 4/10 (0=no pain; 10=worst pain experienced). His midback pain was described as a constant ache that worsened with increasing movement and prolonged sitting (i.e., as the day goes on) with a VAS rating of 5/10. His low back pain was characterized as frequent tightness and worsened with prolonged sitting (i.e., as the day goes on) with sharp referral pain to his buttocks and a VAS score of 6/10.

According to the patient's mother, the patient's presenting complaints have affected the quality of life of the patient by difficulty concentrating at school, irritability and often increased his temper. This also affected the quality of life of the patient's brother and mother. Additional notable history findings include previous medical treatment for the above complaints. The patient also attended care with another chiropractor during his colic episodes. The patient and his mother denied the use of self-care approaches.

According to the patient's mother, she was on birth control for the first six weeks when she was pregnant with the patient. Then, at approximately 12 weeks of gestation, she contracted an illness and diagnosed with tonsillitis. She ran a fever of 103<sup>0</sup>F and was prescribed antibiotics. The patient was born at 40 weeks gestation after 24+ hours of active labor and 2 hours of pushing. The patient's mother also recalled she received an epidural. Following his birth, the patient remained in the hospital an extra day due to his bilirubin count.

A few days after coming home from the hospital, the patient's mother was advised to formula feed her son for 3 days to "help flush" his system. According to the patient's mother, the patient's jaundice was rather extreme. After 3 days of being formula fed, the patient's bilirubin count was back to "normal" range and breastfeeding was resumed.

Based on the patient's mother's assessment, the patient's first six weeks of life seemed to be rather normal except his mother noticed that the patient would not turn his head to the right. His head was in fact, cocked upward and to the left. At six weeks old, the patient started crying more than what seemed to be normal, particularly when they were not at home. Only 3 people were able to hold the patient without the infant being easily agitated throughout the day. At 5 p.m. daily, the patient would start screaming until 11 pm, the patient would then take a nap and be awake at 2 am screaming. The patient's mother and grandmother would take turns holding the patient. Alteration of the patient's mother's diet had no effect on improving the patient's condition at the time.

Eventually the patient's mother sought medical care with the child resulting in the infant being diagnosed and treated for torticollis and plagiocephaly. At-home physical therapy was performed 6 times daily as the mother was instructed. A neurological consult occurred, and the patient was fitted for a cranial band which he wore until he was 11 months old. During one of his physical therapy sessions, the physical therapist noticed that the patient kept his left hand fistled and his thumb tucked. The patient was attended to by an occupational therapist and he wore a glove to extend his thumb until he was 11 months. He started walking around the age of 15 months. Other notable history findings include the patient was born with a pilonidal sinus cavity which was closed at age 4 years. Over time, the patient's mother became suspicious that he was "wired" differently. The patient was tested and demonstrated traits of Asperger's Syndrome and determined to have anxiety disorder. The patient has been receiving counseling therapy on and off since the 1st grade for these problems.

### *Examination*

Visual inspection confirmed the patient's torticollis posture to the left along with an elevated left ilium and left shoulder relative to the contralateral side. In addition, the patient demonstrated a left short leg. Digital palpation revealed tenderness on the right side of the upper cervical vertebra (i.e., C<sub>0</sub>-C<sub>2</sub> vertebral levels) and hypertonicity of the right cervical spine at C<sub>1</sub>-C<sub>5</sub> vertebral levels. Additionally, hypertonicity was noticeable on the left side paraspinal muscles at L<sub>1</sub>-L<sub>5</sub>.

Motion palpation revealed restricted motion of the right side at the C<sub>0</sub>-C<sub>1</sub> and C<sub>1</sub>-C<sub>2</sub> functional spinal units (FSUs), at the right at the T<sub>4</sub>-T<sub>5</sub> FSU, on the left sacroiliac (SI) joint and left Sacrum. Passive range of motion (ROM) restriction was notable on right cervical rotation to approximately 60 degrees (i.e., based on visual observation). Other directions of ROM were unremarkable.

Maximum Foraminal Compression testing of the cervical spine was positive, bilaterally. Erichsen's test was positive on the left sacrum. Kemp's Test was positive on the right while Patrick Fabre was positive on the left SI joint. Neurological testing was not performed.

In addition to rule out fractures, dislocations and other pathologies (i.e., neoplasms), radiological examination was performed based on the history and physical examination findings and for the purpose of spinography. Utilizing the

Gonstead spinographic measurements concomitant with the physical examination, the patient was determined to have a Left SI PI<sub>2</sub>IN<sub>5</sub>, at the Sacrum (left 52 mm and right 41mm). L<sub>4</sub> PR-m, T<sub>11</sub> PRI-t, T<sub>4</sub> PL-t, C<sub>2</sub> PRS, ASLP, AS-RS-RP. Right towering of cervical and thoracic spine, left towering of lumbar spine. Reflex testing was positive for the palmar and plantar reflexes and negative on rooting and spinal Galant testing.

Chiropractic evaluation was performed from occiput to the S<sub>4</sub> level of the sacrum. Instrumentation readings were present with a dual probe instrument on three consecutive glides indicative of subluxation at various levels. The patient was determined to have subluxation findings at: S<sub>2</sub> P-L Sacrum, Left SI PIIN, L<sub>4</sub> PR-m (not spinally adjusted), T<sub>4</sub> PL-t, C<sub>2</sub> PRS, ASLP (not spinally adjusted), AS-RS-RP (not spinally adjusted).

### *Intervention & Outcomes*

The patient was cared for with the Gonstead Technique and Thompson Technique at a frequency of care set at 1 x/week for two months. The following spinal adjustments were performed in the following manner. The Left SI IN and S<sub>2</sub> P-L sacrum was addressed using the Thompson drop. The subluxation findings of PL-t utilized the Gonstead Technique. The patient's C<sub>2</sub> PRS was addressed with Gonstead and Thompson Technique. The patient was adjusted 10 times during the treatment period along with re-integration/brushing exercises of his hands and feet. These were performed according to schedule and patient tolerance. The patient was able to initiate hand brushing and was able to complete the hand brushing stroke 3 weeks later.

In the second phase of this case approach (i.e., moving from 5 to 10 brushstrokes), the patient did not tolerate much of an increase, thus slower integration was necessary during this specific phase. The patient's mother reported as the brushing went on for a longer duration and increased brushstrokes, the patient had many less tantrums and meltdowns and had better days at school. The patient was described as, "able to settle himself down more without redirection from his mom."

A month after initiating chiropractic care, the patient reported, "I had a GREAT day at school." The patient's mother noted, "this never happens." At the end of his treatment phase of care, the patient's mother mentioned that the dentist was recommending a palate spreader for the patient's narrowed palate. This could be leading to the tension in the upper cervical region and not allowing the attached muscle groups to relax, thus maintaining head tilt and continual upper cervical subluxation (and perhaps throughout the spine).

The patient's mother indicated they were moving forward with the dentist's recommendation despite the chiropractic suggestion of performing an intraoral and cranial release technique to see if that would help narrow the patient's palate. Towards the end of the patient's care, his parents were having severe marital problems and had a temporary separation. This may have negatively affected the post-assessment responses. Due to the stress with her marriage and raising three boys, the patient's mother decided to suspend her child's chiropractic care.

Of interest in this case report beyond the clinical encounter as described was the utilization of the attending chiropractor to measure the patient's mother's quality of life using the Patient Reported Outcomes Measurement Information System (i.e., PROMIS29)<sup>10</sup>, the use of the PROMIS-25 parent-proxy to measure the child's quality of life<sup>11</sup> and the use of the Autism Treatment Evaluation Checklist.<sup>12</sup>

The PROMIS-29 is a 29-item profile instrument consisting of a fixed collection of short forms to measure emotional distress (anxiety and depression), fatigue, pain interference and intensity (i.e., 0=no pain; 10=worst imaginable pain), physical functioning, sleep disturbance, and satisfaction with participation in social roles.<sup>10</sup> The PROMIS-25 parent-proxy instrument is a 25-item survey consisting of a fixed collection of short forms for physical functioning mobility, anxiety, depressive symptoms, fatigue, peer relationships, pain interference and pain based on a numeric rating scale (NRS) (0=no pain; 10=worst pain you can think of).<sup>11</sup> The ATEC consists of four subtests: I. Speech/Language Communication (14 items); II. Sociability (20 items); III. Sensory/ Cognitive Awareness (18 items); and IV. Health/Physical/Behavior (25 items).<sup>12</sup> In addition, the parent at a follow-up visit completed the Interpersonal Process of Care questionnaire (i.e., IPC-18)<sup>13</sup> to measure their satisfaction and experience at their child's chiropractic clinic.

The IPC-18 domains were communication (i.e., lack of clarity, elicitation and concern of patient problems and explanation of clinical findings, decision making (i.e., decided together and interpersonal style (i.e., compassionate and respectful caregiver, discriminated against and disrespectful staff).

Assessment of the PROMIS short forms (i.e., anxiety, physical functioning, pain interference) utilized a scoring table developed to associate the raw scores to a T score metric, with a mean of 50 and standard deviation of 10 as provided by Health Measures.<sup>14</sup> The greater the T score, the greater the measured quality of life domain. The ATEC was scored by using the Autism Research Institute online scoring system for ATEC.<sup>15</sup> A lower ATEC score indicates improvements in the subject's behavior. The IPC-18 responses utilized a Likert scale that were linearly transformed from 1(i.e., low score)-5 (i.e., high score) to obtain a mean scoring for the various domains described.

The baseline and comparative measures for the ATEC, PROMIS-29 and PROMIS-25 and IPC-18 are provided in Tables 1, 2 and 3, respectively. The mother's IPC-18 scoring were: The mean scoring to the IPC-18 survey are the following: communication (i.e., lack of clarity (score=1.5), elicitation and concern of patient problems (score=5) and explanation of clinical findings (score=5)), decision making (i.e., decided together (score=5) and interpersonal style (i.e., compassionate and respectful caregiver (score=5), discriminated against (score=5) and disrespectful staff (score=1)).

### **Discussion**

The subject of ASD is complex to say the least. In the interest of brevity, we address aspects of ASD which in our humble opinion are salient for the Doctor of Chiropractor in the care

of patients diagnosed with ASD.

In 1944, Hans Asperger described children with difficulties in non-verbal communication and related social skills which he termed “autistic psychopathy”. Since the core symptoms of these children were like those described for autistic children, albeit in higher-functioning individuals.<sup>16</sup> In 1981, Wing coined the term “Asperger syndrome” to describe children with symptoms as described by Asperger as well as to remove the connotations of “psychopathy”.<sup>17-18</sup>

The DSM-5 has been refined from DSM-4 such that Autistic Disorder, Asperger’s Syndrome and Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS) were removed as diagnostic classifications and collapsed into two diagnoses: Autism Spectrum Disorder and Social Communication Disorder.<sup>1</sup> According to Volkmar et al.<sup>19</sup>, this change reflected a growing concern about the validity of the Asperger’s diagnosis, given evidence that it was frequently interchanged across time with Autistic Disorder. Individuals who would have previously received a diagnosis of Asperger’s Syndrome were generally thought to receive a diagnosis of “Autism Spectrum Disorder without language or cognitive impairment.”<sup>18-19</sup>

Of interest to chiropractors and point of contention within and outside the profession. The body of published literature now provides evidence supporting the etiological link between exposure to environmental toxicants and the development of ASD.<sup>20</sup> In children exposed to heavy metals (Hg and Pb), persistent organic pollutants (DDT, PBDEs and PCBs) and emerging chemicals of concern (phthalates and BPA) exhibit signature traits of ASD and other adverse events to their bodies. Wang et al.<sup>21</sup> examined data from 37,634 autistic children and 12,081,416 non-autistic children enrolled in 17 studies were collated. During the prenatal period, the factors associated with autism risk were maternal and paternal age $\geq$ 35 years, mother’s and father’s race: White and Asian, gestational hypertension, gestational diabetes, maternal and paternal education college graduate+, threatened abortion, and antepartum hemorrhage. During perinatal period, the factors associated with autism risk were caesarian delivery, gestational age $\leq$ 36 weeks, parity $\geq$ 4, spontaneous labor, induced labor, no labor, breech presentation, preeclampsia, and fetal distress. During the postnatal period, the factors associated with autism risk were low birth weight, postpartum hemorrhage, male gender, and brain anomaly. Parity $\geq$ 4 and female were associated with a decreased risk of autism. In addition, exposure to cigarette smoking, urinary infection, mother’s and father’s race: Black and Hispanic, mother’s country of birth outside Europe and North America, umbilical cord around neck, premature membrane rupture, 5-minutes Apgar score $<$ 7, and respiratory infection were not associated with increased risk of autism. The authors caution that it remains unclear whether these factors are causal or play a secondary role in the development of autism.

### *Implications of Chiropractic Care*

The economic and societal cost of ASD has been significant. A study conducted by the Harvard School of Public Health estimated that the lifetime cost to care for an individual with an ASD is \$3.2 million.<sup>22</sup> Despite this great burden, palliative

treatment options to address symptoms associated with ASDs (i.e., symptoms related to diagnostic criteria, comorbidities and other medical conditions known to provoke the severity of presentations) remains poorly documented.<sup>23</sup> For example, the use of antipsychotic medications, serotonin reuptake inhibitor (SRI) medications opioid receptor antagonist naltrexone have questionable effectiveness with documented adverse events. Examples of CAM therapies for individuals with autism include multivitamins, the gluten-free casein-free diet and methyl B-12 injections along with sensory integration therapy, melatonin, off-label use of prescription antifungal medications.<sup>24</sup> Chiropractors commonly utilized these adjunctive care approaches for children with ASD to complement their primary approach to care, the detection and removal of spinal subluxation.<sup>25</sup>

To begin to address the implications of chiropractic care in patients with ASD, we begin with a systematic review of the literature on the chiropractic care of patients with ASD. We build upon the work of the brothers Alcantara with their systematic review of the literature on this subject was published in 2011.<sup>26</sup> We utilized PubMed (2010-2017), Index to Chiropractic Literature (2010-2017) and MANTIS (2010-2017). In Boolean combination with chiropractic, we used the terms ASD, autism, Asperger’s Syndrome. Our findings are provided in Table 4. We found 6 case reports and 4 case series.<sup>27-36</sup>

To the best of our knowledge, this is the first publication in a case report on the use of multiple validated instruments, namely: the PROMIS-29 and PROMIS-25 parent proxy and the IPC-18 as well as the ATEC questionnaire for a child with ASD.

The parental QoL measure documents a compromised QoL when compared to a representative sample of the US population.<sup>37</sup> In terms of the parent-proxy evaluation for QoL, we find over the course of 4 visits, the patient’s mobility remained the same, pain interference worsened with anxiety, depression and fatigue scores improving.

Overall, the patient’s QoL as measured improved over a course of chiropractic care. At the 4<sup>th</sup> visit, the patient’s mother completed the IPC18 survey. The scoring for the following subscales indicated she experienced good communication, the attending chiropractor elicited and demonstrated concern for her patient problems and explained to the patient’s mother her clinical findings. Furthermore, the parent felt that she was part of the decision making for her child’s care and she experienced a compassionate and respectful caregiver. The patient’s mother was not discriminated against nor was the chiropractic staff disrespectful. Future research should utilize these outcome measures during the care of children with ASD to inform research and clinical practice.

In this case report, the clinical utility of the PROMIS instruments and the IPC-18 have been demonstrated. The ATEC questionnaire was successfully utilized to demonstrate effectiveness of chiropractic care. The patient’s ATEC subscale scores improved from 52 to 42 reflecting an improvement in the patient’s overall behavior. Pellegrino,<sup>29</sup> Marini & Marini<sup>36</sup> and Khorsid et al.<sup>38</sup> similarly utilized the

ATEC questionnaire to measure the effectiveness of the chiropractic care protocol.

### Limitations

The post-positivist paradigm of research cautions about making cause and effect inferences from case reports due to a lack of a control group to account for natural history or effects of placebo as well as the demand characteristics of the therapeutic encounter challenge. the epistemological need of objectivity, However, based on the paradigm of constructivism where experience creates reality, this case report is epistemologically consistent with evidence-informed practice that supports our need to learn from our clinical experience in informing patients with similar clinical presentations that we can help them.

### Conclusion

This study provided supporting evidence on the benefits of chiropractic care in patients with ASD, document the burden of raising a child with ASD and parental satisfaction with their child's chiropractic care.

### References

1. APA. Diagnostic and Statistical Manual of Mental Disorders. Fifth Edition. Washington, DC: American Psychiatric Association, 2013.
2. Christensen DL, Baio J, Van Naarden Braun K, Bilder D, Charles J, Constantino JN, et al. Prevalence and characteristics of autism spectrum disorder among children aged 8 years - Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2012. *MMWR Surveill Summ.* 2016;65:1-23.
3. Loomes R, Hull L, Mandy WPL. What is the male-to-female ratio in autism spectrum disorder? a systematic review and meta-analysis. *J Am Acad Child Adolesc Psychiatry.* 2017;56(6):466-474.
4. McPheeters ML, Warren Z, Sathe N, Bruzek JL, Krishnaswami S, Jerome RN, et al. A systematic review of medical treatments for children with autism spectrum disorders. *Pediatrics.* 2011;127:e1312-e1321.
5. Dove D, Warren Z, McPheeters ML, Taylor JL, Sathe NA, Veenstra-VanderWeele J. Medications for adolescents and young adults with autism spectrum disorders: a systematic review. *Pediatrics.* 2012;130(4):717-726.
6. Levy SE, Hyman SL. Complementary and alternative medicine treatments for children with autism spectrum disorders. *Child Adolesc Psychiatr Clin N Am.* 2015;24(1):117-143.
7. Black LI, Clarke TC, Barnes PM, Stussman BJ, Nahin RL. Use of complementary health approaches among children aged 4-17 years in the United States: National Health Interview Survey, 2007-2012. *Natl Health Stat Report.* 2015;(78):1-19.
8. 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.

9. Alcantara J, Alcantara JD, Alcantara J. A systematic review of the literature on the chiropractic care of patients with autism spectrum disorder. *Explore (NY).* 2011;7(6):384-90.
10. Patient Reported Outcomes Measurement Information System (PROMIS29). Accessed November 29, 2017 at: [http://www.healthmeasures.net/index.php?option=com\\_content&view=category&layout=blog&id=147&Itemid=806](http://www.healthmeasures.net/index.php?option=com_content&view=category&layout=blog&id=147&Itemid=806).
11. Irwin DE, Gross HE, Stucky BD, Thissen D, DeWitt EM, Lai JS, Amtmann D, Khastou L, Varni JW, DeWalt DA. Development of six PROMIS pediatrics proxy-report item banks. *Health Qual Life Outcomes.* 2012 Feb 22; 10:22.
12. Rimland B, Edelson M. Autism Treatment Evaluation Checklist. Autism Research Institute, 4812 Adams Avenue, San Diego, CA 92116, 1999.
13. Stewart AL, Nápoles-Springer AM, Gregorich SE, Santoyo-Olsson J. Interpersonal processes of care survey: patient-reported measures for diverse groups. *Health Serv Res.* 2007 Jun;42(3 Pt 1):1235-56.
14. HealthMeasures. Accessed November 29, 2017 at: [healthmeasures.net](http://healthmeasures.net).
15. Autism Research Institute. Autism Treatment Evaluation Checklist (ATEC) Accessed November 16 at: <http://www.surveygizmo.com/s3/1329619/Autism-Treatment-Evaluation-Checklist-revised>
16. Asperger H. Die Autistischen Psychopathen im Kindesalter. *Arch Psychiatr Nervenkr* 1944, 117: 76-136. Trans. U. FRITH in U. FRITH (ed.). *Autism and Asperger Syndrome.* Cambridge: Cambridge University Press, 1991: 37-92.
17. Wing L. Asperger's syndrome: a clinical account. *Psychol Med.* 1981;11:115-129.
18. Masi A, DeMayo MM, Glozier N, Guastella AJ. An Overview of Autism Spectrum Disorder, Heterogeneity and Treatment Options. *Neurosci Bull.* 2017;33(2):183-193.
19. Volkmar FR, Reichow B. Autism in DSM-5: progress and challenges. *Mol Autism.* 2013;4:13
20. Ye BS, Leung AOW, Wong MH. The association of environmental toxicants and autism spectrum disorders in children. *Environ Pollut.* 2017;227:234-242.
21. Wang C, Geng H, Liu W, Zhang G. Prenatal, perinatal, and postnatal factors associated with autism: A meta-analysis. *Medicine (Baltimore).* 2017;96(18):e6696.
22. Ganz ML. The lifetime distribution of the incremental societal costs of autism. *Arch Pediatr* 2007;161:343-349.
23. Dove D, Warren Z, McPheeters ML, Taylor JL, Sathe NA, Veenstra-VanderWeele J. Medications for adolescents and young adults with autism spectrum disorders: a systematic review. *Pediatrics.* 2012;130(4):717-726.
24. Brondino N, Fusar-Poli L, Rocchetti M, Provenzani U, Barale F, Politi P. Complementary and Alternative Therapies for Autism Spectrum Disorder. *Evid Based Complement Alternat Med.* 2015;2015:258589.
25. Alcantara J, Ohm J, Kunz D. The chiropractic care of children. *J Altern Complement Med.* 2010;16(6):621-6.
26. Alcantara J, Alcantara JD, Alcantara J. A systematic review of the literature on the chiropractic care of patients with autism spectrum disorder. *Explore (NY).* 2011;7(6):384-390.

27. Rubin D, Wilson H, Harward R. improvement in autistic behaviors following chiropractic care: the application of polyvagal theory and its relationship to pediatric chiropractic. *Journal of Pediatric, Maternal & Family Health - Chiropractic* 2016; 2016(3):80-83.
28. Rubin D, Brown S, Landhi E, Cooper S, Bermudez-Hernandez T. Combining chiropractic care with extinguishing of primitive reflexes: a case series of 8 children. *Journal of Pediatric, Maternal, & Family Health.* 2016;2016(2): 57-60.
29. Pellegrino A. Improvements in a 4-year-old with Autism Spectrum Disorder following chiropractic care to reduce vertebral subluxation. *Journal of Pediatric, Maternal & Family Health - Chiropractic ~ Volume 2016; 2016 (2):* 50-56.
30. Lumb K, Feely K. Improved language development following network spinal analysis in children diagnosed with Autism Spectrum Disorder. *Journal of Pediatric, Maternal & Family Health - Chiropractic* 2014; 2014(4): 70-75.
31. Noriega A, Chung J, Brown J. Improvement in a 6-year-old child with autistic spectrum disorder and nocturnal enuresis under upper cervical chiropractic care. *Journal of Upper Cervical Chiropractic Research* 2012; 2012(1):1-8.
32. Handt M. improvement in a child with pervasive developmental disorder undergoing chiropractic care. *Journal of Pediatric, Maternal & Family Health - Chiropractic* 2011;2011(1):5-8.
33. Cohn A. Improvement in Autism Spectrum Disorder following vertebral subluxation reduction: a case study. *Journal of Pediatric, Maternal & Family Health - Chiropractic* 2011; 2011(3): 87-91.
34. Cleave J, Alcantara J, Holt K. Improvement in autistic behaviors following chiropractic care: a case series. *Journal of Pediatric, Maternal & Family Health – Chiropractic* 2011; 2011(4):125-131.
35. Scelfo TA, Chelenyak PL. Resolution of autistic symptoms in a child undergoing chiropractic care to correct vertebral subluxations: a case study. *Journal of Pediatric, Maternal & Family Health - Chiropractic* 2011;2011(3):106-110.
36. Marini NS, Marini SC. Improvement in autism in a child coupled with reduction in vertebral subluxations: a case study & selective review of the literature. *Journal of Pediatric, Maternal & Family Health - Chiropractic* 2010;2010(3):107-115.
37. Rothrock NE, Hays RD, Spritzer K, Yount SE, Riley W, Cella D. Relative to the general US population, chronic diseases are associated with poorer health-related quality of life as measured by the Patient-Reported Outcomes Measurement Information System (PROMIS). *J Clin Epidemiol* 2010; 63(11): 1195-1204.
38. Khorshid KA, Sweat RW, Zemba DA, Zemba BN. Clinical efficacy of upper cervical versus full spine chiropractic care on children with autism: a randomized clinical trial. *Journal of Vertebral Subluxation Research* 2006;2006:1-7.

## Appendix

	Baseline Scoring	Comparative Scoring
Speech/Language/Communication	2	1
Sociability	11	7
Sensory/Cognitive Awareness	8	8
Health/Physical Behavior	31	24
Subscale Totals	52	40

	Baseline Scoring	Comparative Scoring	US Population <sup>37</sup>
Physical Function	56.9	54	51
Anxiety	63.4	46	48
Depression	51.8	46	48
Fatigue	53.1	44	47
Sleep Disturbance	54.3	-----	-----
Ability to Participate in Social Roles and Activities	38.8	-----	-----
Pain Interference	57.1	47	49
Pain NRS	6	-----	-----

<b>Table 3. Baseline and comparative parental PROMIS-25 parent-proxy scoring</b>			
	Baseline Scoring	Comparative Scoring	Interpretation
Physical Function Mobility	48.9	48.9	No Change
Anxiety	76.3	61.8	↓ 14.5
Depression	62.6	60.7	↓ 1.9
Fatigue	44.1	35.4	↓8.7
Peer Relationships	-----	46.7	-----
Pain Interference	49.3	55	↑5.7
Pain NRS	4	4	No Change