Characteristics and Treatment of Pediatric Patients in an Osteopathic Manipulative Medicine Clinic

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Context: Osteopathic manipulative medicine (OMM) is recognized as an adjunctive medical approach for the treatment of pediatric patients, but few studies have detailed the pediatric conditions that prompt the use of osteopathic manipulative treatment (OMT) or the types and frequency of OMT used.

Objective: To present descriptive data of pediatric patients receiving OMT from a neuromusculoskeletal medicine/OMM outpatient clinic.

Methods: Data were drawn from electronic health records from a single outpatient specialty clinic for pediatric clinical encounters involving OMT that took place between January 1, 2014, and December 31, 2016. Encounter notes and billing records were reviewed for demographic information, presenting complaints, clinical assessments, somatic dysfunction assessments, OMT techniques used, and payment method. Data were categorized by patient age and analyzed.

Results: Five hundred thirty-seven pediatric patients (321 girls, 216 boys) received OMT during the study. These patients accounted for 1688 clinical encounters (1106 for girls, 582 for boys). Mean (SD) number of encounters was 2.7 (1.3) encounters for boys and 3.5 (1.1) encounters for girls. A higher percentage of patients younger than age 2 were boys, while a higher percentage of patients older than age 2 were girls (both P=.005). Musculoskeletal complaints and assessments were the most common for children aged 6 years and older; misshapen head, feeding difficulties, and colic were the most frequently reported for children younger than 6 years. There were 8557 somatic dysfunction assessments documented; thoracic and cervical somatic dysfunction were most commonly assessed. There were 8485 OMT techniques documented, and myofascial release was most frequently used. Encounters with self-pay patients (n=72) involved fewer somatic dysfunction assessments (P<.001) than encounters with patients using private insurance (n=1060) or Medicaid (n=542).

Conclusion: The electronic health records reviewed in the current study revealed descriptive data of pediatric patients presenting to an OMM clinic; these data were rarely documented in previous literature. They may be used by clinicians to better understand the role of OMM as a pediatric adjunctive medical approach and to identify conditions to target for future outcome studies based on common presenting complaints.

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Osteopathic manipulative medicine (OMM) is used to diagnose and treat somatic dysfunction, normalize structure-function relationships, and promote the intrinsic self-healing mechanisms of the body. Along with other types of manual medicine, OMM is a commonly used adjunctive medical approach in the care of patients, including pediatric patients. In 2012, Black et al[1] estimated that approximately 11.6% of pediatric patients aged 4-17 years in the United States received a complementary health approach. Osteopathic manipulative medicine and chiropractic were among the most frequently used complementary health approaches for pediatric patients; neck and back pain were the most frequently treated conditions.[1] Because of growing interest in and use of complementary health approaches, the American Academy of Pediatrics recommended that primary care physicians become familiar with clinical indications that may warrant referral for this health approach,[2] and with scope of practice for the different approaches.

Osteopathic manipulative medicine has been studied in pediatric patients in various age categories, for a variety of conditions. It is considered a safe and effective method for numerous pediatric conditions commonly seen in the outpatient primary care setting.[2-4] The treatment component of OMM, osteopathic manipulative treatment (OMT), has been used to treat a variety of musculoskeletal conditions, such as torticollis, neck pain, and scoliosis,[5-9] and nonmusculoskeletal conditions, such as asthma, constipation, and otitis media.[10-24]

Although OMM is recognized as an adjunctive medical option for the treatment of pediatric patients, few studies have published detailed characteristics of these patients or the conditions for which they are frequently treated. This lack of published data may contribute to inadequate physician knowledge of OMM within the general medical community, the role that it plays in a multimodal treatment strategy, and the indications for referral of pediatric patients to an OMM clinic. A study by Lund and Carreiro[8] reported the most common musculoskeletal and nonmusculoskeletal conditions from an outpatient OMM clinic for a range of pediatric ages. During the 1-year study period, most diagnoses were for musculoskeletal conditions, but 43.5% were for nonmusculoskeletal conditions.[8] However, that study lacked descriptive data for the patients, assessments, and treatment details.

Given the limited studies in this area, the purpose of the current study was to present descriptive data of pediatric patients receiving OMM at a neuromusculoskeletal medicine (NMM)/OMM outpatient clinic. We hypothesized that presenting complaints, clinical assessments, and OMT techniques used would vary based on the age of the patient. Reporting such age-specific data may be beneficial to better describe the appropriate use of OMM as an adjunctive medical approach.

Methods

Medical records from January 1, 2014, through December 31, 2016, were reviewed for outpatient pediatric clinical encounters at a specialty NMM/OMM clinic. Encounters of all pediatric patients aged from birth to 21 years receiving OMT who were seen by an attending physician or resident physician under the supervision of an attending physician were included. Eleven attending physicians participated in the study. Ten attending physicians were board certified or board eligible in NMM/OMM or had a Certification of Special Proficiency in OMM. One attending physician was board certified in family practice/OMT. Twenty-four resident physicians participated: 12 NMM/OMM residents, 5 family practice/OMT residents, 4 family medicine/NMM residents, and 3 internal medicine/NMM residents. We excluded pediatric encounters with patients seen in the other specialty clinics within the clinic group and encounters that did not involve OMM. The study was reviewed by the local institutional review board and was determined to be exempt.

Data were obtained from the OMM clinic's electronic health record (EHR), NextGen Healthcare Ambulatory EHR version 5.8.3 with knowledge-based

model templates version 8.3.8. The EHR was queried to produce data files with demographic, presenting complaint, assessment, and treatment data. The data were entered into a Microsoft Excel 2016 spreadsheet for tabulation and statistical analysis. Data were de-identified before analysis.

Patient data collected included sex, age, number of encounters, presenting complaints, clinical assessments, body regions of somatic dysfunction assessed, OMT techniques used by the physician during the encounter, and payment method. The data were grouped according to pediatric developmental age categories recognized by the National Institute of Child Health and Human Development.[25] Specifically, we used the following age categories: term neonatal (birth to 27 days), infancy (28 days to 12 months), toddler (13-23 months), early childhood (2-5 years), middle childhood (6-11 years), early adolescence (12-18 years), and late adolescence (19-21 years). Presenting complaints were grouped according to the complaint or body region and were categorized using the defined age categories. Clinical assessments were grouped by their *International Classification of Disease, Tenth Revision* (ICD-10)[26] number, body region, and clinical similarity (eg, all causes of headache were grouped together and given the designation "headache" for analysis). Clinical assessments coded under the *International Classification of Disease, Ninth Revision* (ICD-9) system were given an ICD-10 designation by using an online ICD conversion tool (www.icd10data.com/Convert). When there was no appropriate conversion from ICD-9 to ICD-10, the clinical assessment was excluded from analysis. Payment methods were grouped by private insurance, Medicaid, self-pay, or worker's compensation.

Statistical Analysis

Collected patient data were summarized using frequency and percentage or mean (SD). Age categories reflected the number of discrete patients seen in the defined age category. Patients who were seen multiple times during the study were counted once for each age category in which they were seen as a patient. The grouped presenting complaints were analyzed for frequency and stratified to determine the most frequent presenting complaints by the defined age categories. To determine sex differences between the pediatric patients younger than 2 years and those aged 2 years and older, a χ^2 analysis was performed to determine differences for total number of patients, number of encounters, and mean encounters per patient. Primary payment method types were compared with the number of somatic dysfunction assessments per encounter using analysis of variance. Multiple comparisons were conducted using Hochberg's GT2 method when appropriate. A $P<.05$ was considered statistically significant.

Results

The EHR search of the OMM clinic identified in 537 pediatric patients, 216 boys and 321 girls, who received OMM during the study period (**Table 1**). The early adolescence category had the largest age range and accounted for the greatest number of patients (191 [32.9%]). Differences were found between the total number of boys and girls younger than 2 years and those aged 2 years and older; boys accounted for more patients younger than 2 years (n=93; 56.7%) but fewer patients aged 2 years and older (n=142 [34.1%]; $\chi^2=24.9$, $P<.005$).

The 537 patients accounted for 1688 clinical encounters, 582 for boys and 1106 for girls (**Table 1**). Early adolescents accounted for the greatest number of encounters (737 [43.7%]). The mean (SD) number of encounters per patient was 3.1 (1.3): 2.7 (1.3) encounters for boys and 3.5 (1.1) encounters for girls. No differences in the number of encounters per patient were found between boys and girls for those younger than 2 years nor those aged 2 years and older ($\chi^2=0.79$, $P=.37$). Boys younger than 2 years accounted for 203 of 582 total boy encounters (34.9%), while girls younger than 2 years accounted for 140 of 1106 (12.7%) total girl encounters. Differences were found

Table 1.
Frequency of Pediatric Patients Treated With Osteopathic Manipulative Medicine in an Outpatient Clinical Setting by Total Number of Patients, Number of Encounters, and Mean Encounters per Patient for Defined Age Categories

	Age Category[a]						
Outcome	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Patients, No. (%) (N=537)[b]							
Total	42 (7.2)	108 (18.6)	14 (2.4)	22 (3.8)	51 (8.8)	191 (32.9)	152 (26.2)
Boys	25 (4.3)	59 (10.2)	9 (1.6)	11 (1.9)	33 (5.7)	60 (10.3)	38 (6.6)
Girls	17 (2.9)	49 (8.4)	5 (0.9)	11 (1.9)	18 (3.1)	131 (22.6)	114 (19.7)
Encounters, No. (%) (N=1688)[c]							
Total	51 (3.0)	258 (15.3)	34 (2.0)	65 (3.9)	136 (8.1)	737 (43.7)	407 (24.1)
Boys	27 (1.6)	151 (8.9)	25 (1.5)	25 (1.5)	89 (5.3)	181 (10.7)	84 (5.0)
Girls	24 (1.4)	107 (6.3)	9 (0.5)	40 (2.4)	47 (2.8)	556 (32.9)	323 (19.1)
Mean (SD) Encounters per Patient[d]							
Total	1.2 (0.1)	2.4 (0.5)	2.4 (0.1)	3.0 (0.03)	2.7 (0.1)	3.9 (0.3)	2.7 (0.2)
Boys	1.1 (0.1)	2.6 (0.7)	2.8 (0.1)	2.3 (0.02)	2.7 (0.1)	3.0 (0.2)	2.2 (0.1)
Girls	1.4 (0.1)	2.2 (0.3)	1.8 (0.03)	3.6 (0.04)	2.6 (0.1)	4.2 (0.4)	2.8 (0.2)

[a] Age categories: 1, term neonatal (birth-27 days); 2, infancy (28 days-12 months); 3, toddler (13-23 months); 4, early childhood (2-5 years); 5, middle childhood (6-11 years); 6, early adolescence (12-18 years); 7, late adolescence (19-21 years).
[b] 216 boys, 321 girls.
[c] 582 for boys, 1106 for girls.
[d] Overall mean (SD), 3.1 (1.3); boys, 2.7 (1.3); girls, 3.5 (1.1).

between the total number of encounters for boys and girls younger than 2 years and those aged 2 years and older (χ^2=116.3, P<.005).

The top 3 presenting complaints by age category are presented in **Table 2**. The most common presenting complaint was feeding difficulties (27 [50.0%]) in the term neonatal age category. The most common presenting complaint was misshapen head in the infancy (133 [43.3%]) and toddler (14 [41.2%]) age categories. The most common presenting complaint was lower extremity complaints (18 [23.7%]) in the early childhood age category and headache (39 [23.2%]) in the middle childhood age category. The most common presenting complaint was back pain in the early adolescence (475 [45.8%]) and late adolescence (278 [47.8%]) age categories. An extended list of presenting complaints by age category is presented in **eAppendix 1**.

There were 3314 clinical assessments, excluding somatic dysfunction, documented during the study. The top 3 clinical assessments by age category are presented in **Table 3**. The most common clinical assessment was feeding difficulty (26 [38.8%]) in the term neonatal age category. The most common clinical assessment was plagiocephaly in the infancy (100 [28.6%]) and toddler (14 [38.9%]) age categories. The most common clinical assessment was congenital anomaly of the lower extremity (11 [13.6%]) in the early childhood age category and headache (45 [23.4%]) in the middle childhood age category. The most common clinical assessment was low back pain/lumbar sprain/strain in the early adolescence (331 [19.2%]) and late adolescence (186 [21.5%]) age categories. An extended list of clinical assessments by age category is presented in **eAppendix 2**.

Table 2.
The Most Common Presenting Complaints Treated With Osteopathic Manipulative Medicine in an Outpatient Clinical Setting by Patient Encounter for Pediatric Patients by Defined Age Categories

Age Category[a]	No. (%)
Category 1 (n=54)	
Feeding difficulties	27 (50.0)
Misshapen head	18 (33.3)
Nonspecific head complaints[b]	3 (5.6)
Category 2 (n=307)	
Misshapen head	133 (43.3)
Feeding difficulties	27 (8.8)
Colic	26 (8.5)
Category 3 (n=34)	
Misshapen head	14 (41.2)
Ear complaints	10 (29.4)
Other musculoskeletal complaints[c]	4 (11.8)
Category 4 (n=76)	
Lower extremity complaints	18 (23.7)
Neurological/psychological complaints	14 (18.4)
Back pain	6 (7.9)
Respiratory complaints	6 (7.9)
Category 5 (n=168)	
Headache	39 (23.2)
Back pain	28 (16.7)
Cervical complaints	27 (16.1)
Category 6 (n=1037)	
Back pain	475 (45.8)
Headache	155 (14.9)
Cervical complaints	82 (7.9)
Category 7 (n=582)	
Back pain	278 (47.8)
Neck pain	65 (11.2)
Headache	54 (9.3)

[a] Age categories: 1, term neonatal (birth-27 days); 2, infancy (28 days-12 months); 3, toddler (13-23 months); 4, early childhood (2-5 years); 5, middle childhood (6-11 years); 6, early adolescence (12-18 years); 7, late adolescence (19-21 years).
[b] Nonspecific head complaints included cranial manipulation, head check, and scalp injury.
[c] Other musculoskeletal complaints included hip pain, musculoskeletal pain, posture and balance problems, and gait abnormality.

The assessment frequency of the 10 body regions of somatic dysfunction is presented in Table 4. There were 8557 documented somatic dysfunction assessments during the study. The thoracic region was most frequently assessed overall (1236/8557 [14.4%]) and in the early adolescence (608/4050 [15.0%]) and late adolescence (340/2189 [15.5%]) age categories. For all other age categories, the head was most frequently assessed. Across all age categories, the cervical region was the third most frequently assessed.

The types of OMT techniques used are presented in Table 5. There were 8485 OMT techniques documented during the study. Myofascial release was the most frequently used technique overall (1300/8485 [15.3%]) and in early childhood (54/282 [19.1%]), middle childhood (108/673 [16.0%]), and early adolescence (592/4073 [14.5%]) age categories. Osteopathic cranial manipulative medicine was the most frequently used technique in term neonatal (48/146 [32.9%]), infancy (230/872 [26.4%]), and toddler (28/128 [21.9%]) age categories. Muscle energy was the most frequently used technique used in the late adolescence (316/2311 [13.7%]) age category.

There were 1675 encounters that documented a primary payment method during the study. Of these, 1060 (63.2%) were private insurance, 542 (32.3%) were Medicaid, 72 (4.2%) were self-pay, and 1 (0.1%) was worker's compensation. The mean (SD) number of somatic dysfunction assessments per encounter was 4.9 (1.8), and the range was 1 to 10. The mean (SD) number of somatic dysfunction assessments per encounter by payer method was 5.0 (1.8) for private insurance, 5.0 (1.8) for Medicaid, 3.3 (1.5) for self-pay, and 5.0 (NA) for worker's compensation. Excluding the single encounter involving worker's compensation, there was a difference between payment method and the number of somatic dysfunction assessments ($P<.001$); self-pay had a lower number of somatic dysfunction assessments than the other 2 payment methods.

Discussion

The current study analyzed the characteristics of pediatric patients for whom OMM was used as an adjunctive

Table 3.
The Most Common Clinical Assessments Treated With Osteopathic Manipulative Medicine in an Outpatient Clinical Setting and Defined by the International Classification of Disease, Tenth Revision by Patient Encounter for Pediatric Patients by Defined Age Categories

Age Category[a]	No. (%)
Category 1 (n=67)	
Feeding difficulty (R63.3, P92.8, P92.9, F98.29)	26 (38.8)
Plagiocephaly/cranial molding (Q67.3, M95.2)	13 (19.4)
Abnormalities of skull and/or face bones (Q75.9)	7 (10.4)
Category 2 (n=350)	
Plagiocephaly (Q67.3)	100 (28.6)
Abnormalities of skull and/or face bones (Q75.9)	47 (13.4)
Torticollis (M43.6, Q68.0)	42 (12.0)
Category 3 (n=36)	
Plagiocephaly (Q67.3)	14 (38.9)
Otitis media (H65.91, H66.90, H66.91)	9 (25.0)
Colic/fussy infant (R10.83, R68.12)	4 (11.1)
Category 4 (n=81)	
Congenital anomaly of lower extremity (Q74.9, Q66.22, Q66.4)	11 (13.6)
Lower extremity pain/sprain or strain (M25.579, M79.609, S86.919A)	8 (9.9)
Abnormal involuntary movements (R25.9)	7 (8.6)
Category 5 (n=192)	
Headache (R51, G43.0, G43.009, G43.909, G44.1, G44.209, G44.219, G44.329, G44.89)	45 (23.4)
Neck pain/strain/sprain (M54.2, S13.4XXA)	27 (14.1)
Back pain/dorsalgia/thoracic pain (M54.9, M54.6)	18 (9.4)
Category 6 (n=1724)	
Low back pain/lumbar sprain/strain (M54.5, S33.5XXA, S33.5XXD, S33.8XXA, S33.9XXA, S39.012A)	331 (19.2)
Back pain/dorsalgia/thoracic pain/sprain/strain (M54.6, M54.89, M54.9, S23.3XXA)	274 (15.9)
Neck pain/strain/sprain (M53.82, M54.2, S13.4XXA, S19.9XXA)	258 (15.0)
Category 7 (n=864)	
Low back pain/lumbar sprain/strain (M53.87, M54.16, M54.30, M54.5, S33.9XXA)	186 (21.5)
Neck pain/strain/sprain (M54.12, M54.2, S13.4XXA)	120 (13.9)
Back pain/dorsalgia/thoracic pain/sprain/strain (M54.6, M54.89, M54.9, S23.3XXA)	113 (13.1)

[a] Age categories: 1, term neonatal (birth-27 days); 2, infancy (28 days-12 months); 3, toddler (13-23 months); 4, early childhood (2-5 years); 5, middle childhood (6-11 years); 6, early adolescence (12-18 years); 7, late adolescence (19-21 years).

medical approach. We found sex variations in the use of OMM in a pediatric population and age-related variations in presenting complaints, clinical assessments, and type of OMT technique used. Boys accounted for the majority of encounters for patients younger than 2 years. Furthermore, feeding difficulties and

Table 4.
Documented Somatic Dysfunction Assessments (N=8557) by Body Region for Pediatric Patients Treated With Osteopathic Manipulative Medicine in an Outpatient Clinical Setting as Defined by the International Classification of Disease, Tenth Revision and Defined Age Categories

	Age Categories,[a] No. (%)						
Body Region	1 (n=205)	2 (n=1065)	3 (n=117)	4 (n=285)	5 (n=646)	6 (n=4050)	7 (n=2189)
Head (M99.00) (n=1196)	59 (28.8)	261 (24.5)	29 (24.8)	45 (15.8)	105 (16.3)	480 (11.9)	217 (9.9)
Cervical (M99.01) (n=1195)	29 (14.1)	134 (12.6)	15 (12.8)	29 (10.2)	99 (15.3)	579 (14.3)	310 (14.2)
Thoracic (M99.02) (n=1236)	24 (11.7)	113 (10.6)	16 (13.7)	33 (11.6)	102 (15.8)	608 (15.0)	340 (15.5)
Lumbar (M99.03) (n=1017)	10 (4.9)	70 (6.6)	9 (7.7)	27 (9.5)	62 (9.6)	558 (13.8)	281 (12.8)
Sacral (M99.04) (n=1017)	36 (17.6)	177 (16.6)	13 (11.1)	37 (13.0)	65 (10.1)	463 (11.4)	226 (10.3)
Hip/pelvis (M99.05) (n=876)	10 (4.9)	70 (6.6)	9 (7.7)	33 (11.6)	59 (9.1)	443 (10.9)	252 (11.5)
Lower extremities (M99.06) (n=430)	2 (1.0)	7 (0.7)	5 (4.3)	30 (10.5)	32 (5.0)	223 (5.5)	131 (6.0)
Upper extremities (M99.07) (n=293)	3 (1.5)	11 (1.0)	0 (0.0)	7 (2.5)	13 (2.0)	138 (3.4)	121 (5.5)
Rib (M99.08) (n=1079)	21 (10.2)	137 (12.9)	17 (14.5)	36 (12.6)	88 (13.6)	511 (12.6)	269 (12.3)
Abdomen (M99.09) (n=218)	11 (5.4)	85 (8.0)	4 (3.4)	8 (2.8)	21 (3.3)	47 (1.2)	42 (1.9)

[a] Age categories: 1, term neonatal (birth-27 days); 2, infancy (28 days-12 months); 3, toddler (13-23 months); 4, early childhood (2-5 years); 5, middle childhood (6-11 years); 6, early adolescence (12-18 years); 7, late adolescence (19-21 years).

plagiocephaly were the most frequently documented presenting complaints and clinical assessments for patients younger than 2 years. This finding was consistent with a study by Lund and Carreiro,[8] which reported torticollis and skull or face deformity as the leading assessments for OMM in pediatric patients aged from birth to 11 months. Our finding also correlated with the documented prevalence of plagiocephaly in an infant population.[27] Although the current study did not assess sex-related differences in the types of presenting complaints or clinical assessments, the larger number of clinical encounters for boys younger than 2 years is consistent with plagiocephaly being more common in that group.[28-30]

The current study found that girls accounted for the majority of encounters for patients aged 2 years and older and for more patients and encounters overall. The early adolescence age category had the largest number of patients, encounters, and mean number of encounters per patient. This age category also had the largest number of female patients, encounters for girls, and mean number of encounters for girls. The current study did not differentiate clinical assessments based on sex, but the female predominance in the older age categories may be related to the increased frequency of specific musculoskeletal complaints. For example, we identified headache as the most common assessment (23.4%) in the middle childhood age category (6-11 years). Similarly, a study by Lund and Carreiro[8] reported a headache prevalence of 13.6% in children aged 5 to 12 years. The predominance of girls within this age category may be related to findings of other studies, which reported that headaches are more common in female pediatric patients.[31,32]

The frequency of musculoskeletal presenting complaints and clinical assessments increased with patient age in the current study. Black et al[1] suggested that musculoskeletal conditions are common reasons for children seeking out adjunctive medical approaches.

Table 5.
Documented Osteopathic Manipulative Treatment Techniques Used (N=8485) for Pediatric Patients Treated With Osteopathic Manipulative Medicine in an Outpatient Clinical Setting by Defined Age Categories

	Age Categories,[a] No. (%)						
Technique	1 (n=146)	2 (n=872)	3 (n=128)	4 (n=282)	5 (n=673)	6 (n=4073)	7 (n=2311)
Articular (n=672)	8 (5.5)	70 (8.0)	8 (6.3)	27 (9.6)	62 (9.2)	311 (7.6)	186 (8.0)
Counterstrain (n=488)	3 (2.1)	11 (1.3)	4 (3.1)	7 (2.5)	26 (3.9)	266 (6.5)	171 (7.4)
Facilitated positional release (n=175)	0 (0.0)	15 (1.7)	7 (5.5)	7 (2.5)	20 (3.0)	71 (1.7)	55 (2.4)
Functional technique (n=96)	0 (0.0)	11 (1.3)	6 (4.7)	5 (1.8)	8 (1.2)	33 (0.8)	33 (1.4)
High-velocity, low-amplitude (n=772)	0 (0.0)	5 (0.6)	1 (0.8)	9 (3.2)	52 (7.7)	475 (11.7)	230 (10.0)
Indirect balanced ligamentous tension (n=691)	25 (17.1)	107 (12.3)	12 (9.4)	34 (12.1)	64 (9.5)	257 (6.3)	192 (8.3)
Ligamentous articular strain (n=209)	1 (0.7)	14 (1.6)	2 (1.6)	18 (6.4)	33 (11.7)	87 (2.1)	54 (2.3)
Lymphatic (n=24)	0 (0.0)	2 (0.2)	2 (1.6)	1 (0.4)	1 (0.1)	11 (0.3)	7 (0.3)
Muscle energy (n=977)	3 (2.1)	23 (2.6)	3 (2.3)	18 (6.4)	69 (10.3)	545 (13.4)	316 (13.7)
Myofascial release (n=1300)	36 (24.7)	181 (20.8)	24 (18.8)	54 (19.1)	108 (16.0)	592 (14.5)	305 (13.2)
Neurofascial release (n=77)	0 (0.0)	9 (1.0)	4 (3.1)	16 (5.7)	10 (1.5)	20 (0.5)	18 (0.8)
Neuromuscular release (n=52)	0 (0.0)	2 (0.2)	0 (0.0)	3 (1.1)	6 (0.9)	25 (0.6)	16 (0.7)
Osteopathic cranial manipulative medicine (n=930)	48 (32.9)	230 (26.4)	28 (21.9)	35 (12.4)	78 (11.6)	357 (8.8)	154 (6.7)
Other (n=151)	5 (3.4)	40 (4.6)	5 (3.9)	5 (1.8)	11 (1.6)	56 (1.4)	29 (1.3)
Percussion hammer (n=379)	2 (1.4)	13 (1.5)	3 (2.3)	4 (1.4)	14 (2.1)	247 (6.1)	96 (4.2)
Progressive inhibition of neuromuscular structures (n=53)	2 (1.4)	2 (0.2)	0 (0.0)	2 (0.7)	2 (0.3)	17 (0.4)	28 (1.2)
Soft tissue (n=535)	8 (5.5)	49 (5.6)	15 (11.7)	8 (2.8)	34 (5.1)	242 (5.9)	179 (7.7)
Still technique (n=759)	2 (1.4)	42 (4.8)	3 (2.3)	24 (8.5)	65 (9.7)	419 (10.3)	204 (8.8)
Visceral manipulation (n=145)	3 (2.1)	46 (5.3)	1 (0.7)	5 (1.8)	10 (1.5)	42 (1.0)	38 (1.6)

[a] Age categories: 1, term neonatal (birth-27 days); 2, infancy (28 days-12 months); 3, toddler (13-23 months); 4, early childhood (2-5 years); 5, middle childhood (6-11 years); 6, early adolescence (12-18 years); 7, late adolescence (19-21 years).

Low back pain/lumbar sprain/strain was the most frequently documented clinical assessment for the early and late adolescence age categories (12-21 years) in the current study. MacDonald et al[33] reported a growing incidence of low back pain in school-aged children beginning around 10 years that steadily increased throughout adolescence; by 18 years, the prevalence approached that documented in adults. Being female has been reported as a risk factor for back pain in school-aged children.[9] A study by Ramirez et al[34] found the average age for pediatric patients to present with back pain was 14.8 years, and

girls accounted for 68% of their pediatric back pain population. The increased frequency of back pain observed during adolescence in conjunction with the greater number of female patient encounters may represent a future area of study for adjunctive medical approaches in the pediatric population.

The thoracic, head, and cervical body regions were the most common body regions of somatic dysfunction assessed in the current study. Myofascial release, muscle energy, and osteopathic cranial manipulative medicine were the most commonly used OMT techniques. In a study by Snider et al,[35] myofascial release, balanced ligamentous tension, and muscle energy were the most commonly used OMT techniques in the inpatient setting across all age ranges. In the current study, we found differences in OMT techniques based on age category. Term neonatal, infancy, and toddler age categories (birth to 23 months) most commonly received osteopathic cranial manipulative medicine, myofascial release, balanced ligamentous tension, and soft tissue. Middle childhood and early and late adolescence age categories (6-21 years) most commonly received myofascial release, muscle energy, and high-velocity, low-amplitude. We observed that from birth to 18 years, osteopathic cranial manipulative medicine was among the 5 most commonly used techniques. This finding may reflect a 2003 study by Johnson and Kurtz,[36] which reported osteopathic cranial manipulative medicine was ranked last in a list of 11 OMT techniques used by 955 contemporary osteopathic physicians in a clinical setting. However, OMT specialists were significantly more likely to use osteopathic cranial manipulative medicine than were family practitioners.[36] The current study occurred within an NMM/OMM specialty clinic where medical students and residents are trained in osteopathic cranial manipulative medicine as part of a wide variety of OMT techniques. The data presented in the current study may also reflect variations between physicians. Specifically, the current study pooled treatment data from 11 attending physicians and 24 resident physicians, but physicians within an individual group practice may have similar practice patterns that differ from physicians outside of that group practice.

The current study had several limitations. We had a low number of patients and encounters for the term neonatal, toddler, early childhood, and middle childhood age categories. These low numbers limit the conclusions that can be made for those age categories. Race was not studied as a demographic variable because a large number of patients did not have race indicated in the EHR. Another limitation was that our data were obtained from a single OMM outpatient clinic. This clinic may not be representative of OMM clinics in other geographic regions or of how pediatric patients present to other OMM clinics. Furthermore, because our patients were treated in an NMM/OMM specialty clinic, our results may not reflect the presentation of patients or the approach taken by osteopathic pediatricians or other osteopathic primary care physicians in a non-NMM/OMM specialty setting. One notable difference in the current study was the inclusion of data from patients seen by NMM/OMM residents. In a previous pediatric study,[8] only data from attending physicians were used. Last, encounters involving self-pay patients had significantly less somatic dysfunction assessments than encounters with patients using private insurance or Medicaid payment methods. This difference is challenging to interpret given that self-pay accounted for only 4.2% of encounters. As such, the difference may be due to the sampling bias of a small sample size or due to the insurance-based fee structure of the studied clinic. Therefore, this finding may not reflect OMM clinics with a cash-based fee structure.

Conclusion

Our review of pediatric patients presenting to an outpatient OMM clinic identified common presenting complaints, clinical assessments, body regions of somatic dysfunction assessed, and OMT techniques used for defined age categories. We also identified differences between boys and girls for total number of

patients, number of encounters, and mean encounters per patient for each age category. The small number of encounters with patients who were self-pay had significantly less somatic dysfunction assessments than encounters with patients using other payment methods. Future studies comparing insurance-based clinics with cash-based clinics would be helpful for investigating this difference. The current study may be useful for performing similar descriptive studies of pediatric patients being treated by osteopathic physicians. Further, our findings may help elucidate the role of OMM as an adjunctive medical approach in the treatment of pediatric patients and guide areas for future outcome studies by identifying common presenting complaints of patients receiving OMM.

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Author Contributions

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References

1. 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.
2. Kemper KJ, Vohra S, Walls R, Task Force on Complementary and Alternative Medicine, Provisional Section on Complementary, Holistic, and Integrative Medicine. American Academy of Pediatrics: the use of complementary and alternative medicine in pediatrics. *Pediatrics*. 2008;122(6):1374-1386. doi:10.1542/peds.2008-2173
3. Hayes NM, Bezilla TA. Incidence of iatrogenesis associated with osteopathic manipulative treatment of pediatric patients. *J Am Osteopath Assoc*. 2006;106(10):605-608.
4. Todd AJ, Carroll MT, Robinson A, Mitchell EKL. Adverse events due to chiropractic and other manual therapies for infants and children: a review of the literature. *J Manipulative Physiol Ther*. 2015;38 (9):699-712. doi:10.1016/j.jmpt.2014.09.008
5. Andreoli E, Troiani A, Tucci V, et al. Osteopathic manipulative treatment of congenital talipes equinovarus: a case report. *J Bodyw Mov Ther*. 2014;18(1):4-10. doi:10.1016/j.jbmt.2013.03.011
6. Bolin DJ. The application of osteopathic treatments to pediatric sports injuries. *Pediatr Clin North Am*. 2010;57(3):775-794. doi:10.1016/j.pcl.2010.02.002
7. Lessard S, Gagnon I, Trottier N. Exploring the impact of osteopathic treatment on cranial asymmetries associated with nonsynostotic plagiocephaly in infants. *Complement Ther Clin Pract*. 2011;17 (4):193-198. doi:10.1016/j.ctcp.2011.02.001
8. Lund G, Carreiro JE. Characteristics of pediatric patients seen in medical school-based osteopathic manipulative medicine clinics. *J Am Osteopath Assoc*. 2010;110(7):376-380.
9. Noll M, Candotti CT, Rosa BN, Loss JF. Back pain prevalence and associated factors in children and adolescents: an epidemiological population study. *Rev Saúde Pública*. 2016;50:31.
10. Accorsi A, Lucci C, Di Mattia L, et al. Effect of osteopathic manipulative therapy in the attentive performance of children with attention-deficit/hyperactivity disorder. *J Am Osteopath Assoc*. 2014;114(5):374-381. doi:10.7556/jaoa.2014.074
11. Aquino A, Perini M, Cosmai S, et al. Osteopathic manipulative treatment limits chronic constipation in a child with Pitt-Hopkins syndrome. *Case Rep Pediatr*. 2017;2017:5437830. doi:10.1155/2017/5437830
12. Carr RR, Nahata MC. Complementary and alternative medicine for upper-respiratory-tract infection in children. *Am J Health Syst Pharm*. 2006;63(1):33-39. doi:10.2146/ajhp040613
13. Castellarin IB, Drysdale I, Patel V. Evaluation of behavioural and gastrointestinal symptoms in autistic children after visceral osteopathic treatment. *Int J Osteopath Med*. 2013;16(1):e13-e14. doi:10.1016/j.ijosm.2013.01.008
14. Castillo I, Wolf K, Rakowsky A. Concussions and osteopathic manipulative treatment: an adolescent case presentation. *J Am Osteopath Assoc*. 2016;116(3):178-181. doi:10.7556/jaoa.2016.034
15. Degenhardt BF, Kuchera ML. Osteopathic evaluation and manipulative treatment in reducing the morbidity of otitis media: a pilot study. *J Am Osteopath Assoc*. 2006;106(6):327-334.
16. Guiney PA, Chou R, Vianna A, Lovenheim J. Effects of osteopathic manipulative treatment on pediatric patients with asthma: a randomized controlled trial. *J Am Osteopath Assoc*. 2005;105(1):7-12.
17. Hayden C, Mullinger B. A preliminary assessment of the impact of cranial osteopathy for the relief of infantile colic. *Complement Ther Clin Pract*. 2006;12(2):83-90. doi:10.1016/j.ctcp.2005.12.005
18. Mills MV, Henley CE, Barnes LL, Carreiro JE, Degenhardt BF. The use of osteopathic manipulative treatment as adjuvant therapy in children with recurrent acute otitis media. *Arch Pediatr Adolesc Med*. 2003;157 (9):861-866. doi:10.1001/archpedi.157.9.861
19. Pratt-Harrington D. Galbreath technique: a manipulative treatment for otitis media revisited. *J Am Osteopath Assoc*. 2000;100(10):635-639.
20. Steele KM, Carreiro JE, Viola JH, Conte JA, Ridpath LC. Effect of osteopathic manipulative treatment on middle ear effusion following acute otitis media in young children: a pilot study. *J Am Osteopath Assoc*. 2014;114(6):436-447. doi:10.7556/jaoa.2014.094

21. Steele KM, Viola J, Burns E, Carreiro JE. Brief report of a clinical trial on the duration of middle ear effusion in young children using a standardized osteopathic manipulative medicine protocol. *J Am Osteopath Assoc*. 2010;110(5):278-284.

22. Tarsuslu T, Bol H, Simsek IE, Toylan IE, Cam S. The effects of osteopathic treatment on constipation in children with cerebral palsy: a pilot study. *J Manipulative Physiol Ther*. 2009;32(8):648-653.

23. Van Dyck C, Dekeyser A, Vantricht E, et al. The effect of orofacial myofunctional treatment in children with anterior open bite and tongue dysfunction: a pilot study. *Eur J Orthod*. 2016;38(3):227-234. doi:10.1093/ejo/cjv044

24. Vandenplas Y, Denayer E, Vandenbossche T, et al. Osteopathy may decrease obstructive apnea in infants: a pilot study. *Osteopath Med Prim Care*. 2008;2:8. doi:10.1186/1750-4732-2-8

25. Williams K, Thomson D, Seto I, et al. Standard 6: age groups for pediatric trials. *Pediatrics*. 2012;129(suppl 3):S153-S160. doi:10.1542/peds.2012-0055I

26. World Health Organization. *The ICD-10 Classification of Mental and Behavioural Disorders: Clinical Descriptions and Diagnostic Guidelines*. Geneva, Switzerland: World Health Organization; 2016. http://www.who.int/substance_abuse/terminology/ICD10ClinicalDiagnosis.pdf. Accessed November 16, 2018.

27. Mawji A, Vollman AR, Hatfield J, McNeil DA, Sauve R. The incidence of positional plagiocephaly: a cohort study. *Pediatrics*. 2013;132(2):298-304. doi:10.1542/peds.2012-3438

28. Ballardini E, Sisti M, Basaglia N, et al. Prevalence and characteristics of positional plagiocephaly in healthy full-term infants at 8-12 weeks of life. *Eur J Pediatr*. 2018;177(10):1547-1554. doi:10.1007/s00431-018-3212-0

29. Pogliani L, Mameli C, Fabiano V, Zuccotti GV. Positional plagiocephaly: what the pediatrician needs to know: a review. *Childs Nerv Syst*. 2011;27(11):1867-1876. doi:10.1007/s00381-011-1493-y

30. van Vlimmeren LA, van der Graaf Y, Boere-Boonekamp MM, L'Hoir MP, Helders PJ, Engelbert RH. Risk factors for deformational plagiocephaly at birth and at 7 weeks of age: a prospective cohort study. *Pediatrics*. 2007;119(2):e408-e418. doi:10.1542/peds.2006-2012

31. Casucci G, Terlizzi R, Cevoli S. Headache in school age. *Neurol Sci*. 2014;35(suppl 1):31-35.

32. Kroner-Herwig B. Pediatric headache: associated psychosocial factors and psychological treatment. *Curr Pain Headache Rep*. 2013;17(6):338. doi:10.1007/s11916-013-0338-7

33. MacDonald J, Stuart E, Rodenberg R. Musculoskeletal low back pain in school-aged children: a review. *JAMA Pediatr*. 2017;171(3):280-287. doi:10.1001/jamapediatrics.2016.3334

34. Ramirez N, Flynn JM, Hill BW, et al. Evaluation of a systematic approach to pediatric back pain: the utility of magnetic resonance imaging. *J Pediatr Orthop*. 2015;35(1):28-32. doi:10.1097/BPO.0000000000000190

35. Snider KT, Snider EJ, DeGooyer BR, Bukowski AM, Fleming RK, Johnson JC. Retrospective medical record review of an osteopathic manipulative medicine hospital consultation service. *J Am Osteopath Assoc*. 2013;113(10):754-767. doi:10.7556/jaoa.2013.045

36. Johnson SM, Kurtz ME. Osteopathic manipulative treatment techniques preferred by contemporary osteopathic physicians. *J Am Osteopath Assoc*. 2003;103(5):219-224.