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A Retrospective Review of Oromyofunctional Therapy in the Treatment of Pediatric Sleep-Disordered Breathing: A Local Single-Center Study

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Abstract

Background and objectives

Pediatric sleep-disordered breathing (SDB) ranges from primary snoring to obstructive sleep apnea (OSA). Oromyofunctional therapy (OMT) aims to improve upper airway function through targeted muscle training. This study reviewed the observed clinical and polysomnography (PSG) outcomes in children with SDB receiving OMT and explored associations between treatment compliance and observed outcomes.

Methods

This single-center retrospective observational study reviewed medical records of children aged three to 18 years who received OMT for SDB between January 2018 and December 2024. Outcomes included caregiver-reported changes in snoring and daytime sleepiness, modified Epworth Sleepiness Scale (mESS) scores, and pre- and post-intervention PSG parameters as follows: obstructive apnea-hypopnea index (OAHI), nadir oxygen saturation (SpO_2), and arousal index. A sensitivity analysis was performed in an isolated OMT subgroup, excluding patients with concurrent weight reduction, improvement in allergic rhinitis, adenotonsillectomy, or nocturnal non-invasive ventilation. Acceptable compliance was defined as completion of at least 50% of the prescribed treatment components.

Results

Among 48 patients (median age nine years {IQR: 7-12}; 70.8% male), snoring improved in 46/48 (95.8%) and daytime sleepiness in 26/27 (96.2%). Median mESS scores decreased from 4 (IQR: 2-7) to 1 (IQR: 0-3; $p<0.001$). In the isolated OMT subgroup (n=32), snoring improved in 30/32 (93.8%) and daytime sleepiness in 12/13 (92.3%); median mESS scores decreased from 4.5 (IQR: 2-7) to 1 (IQR: 0-3; $p<0.001$). Among the 17 patients with paired PSG data in the overall study group, median time between baseline and post-OMT PSG was 20 months (IQR: 17-27.5). COVID pandemic-induced healthcare disruptions and patient-led deferrals contributed to the extended timeline between the paired PSG evaluations. In the whole study group, median OAHI decreased from 8.7 to 2.8 events/h ($p=0.015$), SpO_2 nadir increased from 89% to 91% ($p=0.003$), and median arousal index decreased from 9.6 to 6.4 events/h ($p=0.006$). In the isolated OMT subgroup (n=11), changes in median OAHI (8.7 to 4.9 events/h; $p=0.213$), SpO_2 nadir (89% to 91%; $p=0.050$), and median arousal index (7.3 to 6.4 events/h; $p=0.075$) were not statistically significant. Acceptable compliance was achieved by 35/48 patients (72.9%). No significant associations were found between compliance and age, sex, or comorbidities. Significant improvement in clinical symptoms and mESS scores was observed in both compliance groups. No significant changes in PSG parameters were observed in either compliance group.

Conclusion

Improvement in symptoms of snoring and daytime sleepiness and reduced mESS scores were observed following OMT intervention in both the whole study group and the isolated OMT subgroup. Although PSG parameters improved significantly in the overall study group, these findings were not consistently demonstrated in the isolated OMT subgroup. Given the retrospective design, small sample size, relatively long interval between pre- and post-intervention PSGs, and potential confounding from concurrent interventions, the independent efficacy of OMT could not be established from this study. Larger prospective controlled studies are needed to evaluate the efficacy of OMT in pediatric SDB.

Categories: Pediatrics
Keywords: obstructive sleep apnea, oromyofunctional therapy, pediatrics, sleep-disordered breathing, sleep medicine

Introduction

Pediatric sleep-disordered breathing (SDB) encompasses a spectrum of upper airway dysfunction during

sleep, ranging from primary snoring to obstructive sleep apnea (OSA). SDB is a common clinical condition, affecting approximately 4-11% of children globally, with OSA occurring in 1-5% of the general pediatric population [1,2]. In the pediatric population, while adenotonsillar hypertrophy remains the primary etiology, growing evidence highlights the significant pathophysiological contributions of rising childhood obesity, craniofacial anomalies, upper airway neuromuscular tone, and dysfunctional orofacial habits [3]. Pediatric patients with SDB typically present with nocturnal disruptions, such as snoring and sleep fragmentation, alongside daytime manifestations including excessive somnolence, hyperactivity, and cognitive impairment [1].

Management of pediatric SDB requires an individualized approach based on its underlying cause. For children with adenotonsillar hypertrophy, adenotonsillectomy served as the standard first-line surgical option [4]. However, residual disease may persist post-operatively, particularly in patients with neuromuscular disorders, craniofacial variations, obesity, or syndromic conditions [3]. Non-surgical options include positive airway pressure (PAP) therapy, orthodontic interventions, and medical management for allergic rhinitis. Although PAP therapy is an effective treatment modality, its clinical application can be limited by poor tolerance and adherence in pediatric populations [5]. These clinical challenges highlight the need for alternative strategies that address the functional components of SDB.

Oromyofunctional therapy (OMT) has emerged as a non-invasive, targeted intervention designed to retrain the oropharyngeal musculature and restore upper airway stability. Through a structured regimen of exercises, OMT aims to enhance tone, coordination, and endurance across the muscles of the tongue, soft palate, lips, and face, thereby optimizing neuromuscular control and resting tongue posture [6]. In adults, OMT has demonstrated efficacy in reducing OSA severity [7,8]. A recent systematic review showed OMT may provide a reasonable alternative for OSA patients who cannot tolerate PAP or other more established treatment options, and OMT benefits appear limited in children due to poor compliance [9].

To explore these aspects, this retrospective study aimed to review the observed clinical and polysomnographic (PSG) changes in pediatric patients with SDB who received OMT at a single tertiary center. Additionally, we sought to evaluate the association between baseline demographic factors and compliance, as well as the relationship between treatment compliance and observed changes in clinical symptoms and PSG parameters.

Materials And Methods

Study design and setting

This study was a retrospective observational study at Pamela Youde Nethersole Eastern Hospital, a local tertiary pediatric center in Hong Kong. Medical records of children clinically diagnosed with SDB who underwent OMT in the department of occupational therapy between January 1, 2018, and December 31, 2024, were reviewed. This study was approved by the Hospital Authority Central Institutional Review Board (#PAED-2026-064). The requirement for informed consent was waived due to the retrospective nature of the study.

Study population

Inclusion criteria comprised pediatric patients aged three to 18 years with a clinical diagnosis of SDB who were recruited for OMT in the department of occupational therapy in the study institution. Patients were excluded if they enrolled in the OMT program for indications other than SDB.

Data collection

The baseline demographics of the patients were retrieved from a computerized electronic medical record system, which included age, sex, presence of obesity defined as body mass index (BMI) equal to or greater than the 95th centile for age and sex, presence of allergic rhinitis (AR), attention-deficit/hyperactivity disorder (ADHD), developmental delay, and any syndromic diagnoses, baseline symptoms of sleep-disordered breathing including snoring and daytime sleepiness, and modified Epworth Sleepiness Scale (mESS) score at baseline. Clinical diagnosis of SDB was made when there was presence of habitual, loud snoring occurring more than three nights per week, as reported by the caregivers. Improvement in snoring was defined as a documented reduction in both the intensity and frequency of snoring symptoms based on caregiver reporting at the earliest clinic visit upon completing OMT intervention. Improvement in daytime sleepiness was defined as a reduction in daytime somnolence and a concurrent improvement of daytime functioning, as reported by the caregivers at the earliest clinic visit upon completing OMT intervention. Clinical data on weight reduction, AR treatment and improvement, adenotonsillectomy during the OMT intervention period, and use of nocturnal non-invasive ventilation during the OMT intervention were also collected. Significant weight reduction was defined as a BMI z-score reduction >0.5, following the recommendation by the European Respiratory Society (ERS), which demonstrated that this benchmark effectively reduces OSA severity in obese adolescents [3]. Improvement of AR symptoms was defined at the post-OMT clinical follow-up by the presence of at least one of the following criteria: (1) documented clinical symptom resolution or a significant reduction in daytime or nighttime nasal obstruction; (2) resolution of inferior turbinate hypertrophy on physical examination; or (3) a successful step-down of maintenance AR

medications due to achieved symptom control. Information about tonsillar size, adenoid size, and history of tonsillectomy before the OMT intervention was also collected. Finally, information about upper airway anatomy was collected, including Mallampati score and presence of craniofacial abnormalities such as retrognathia, narrow maxilla, high arched palate, and dental malocclusion.

Given the inherent heterogeneity of retrospective data, an isolated OMT subgroup was formed to help control for potential confounding variables. By excluding patients with concurrent changes in clinical conditions or adjunctive treatments that could influence SDB, this subgroup permitted OMT to be examined more closely as a monotherapy, thereby reducing co-intervention bias and allowing for a more conservative observation of associated clinical changes. Outcomes for the overall study group and the isolated OMT subgroup were compared for a sensitivity analysis. Patients were excluded from this subgroup if they met the aforementioned criteria for significant weight reduction or AR symptom improvement, underwent adenotonsillectomy during the OMT intervention period, or utilized nocturnal non-invasive ventilation during the OMT intervention period.

At the study center, full polysomnography (PSG) was performed using the Philips Respironics Alice 6 system (Murrysville, PA: Respironics, Inc.), and all component setups followed the recommendations in the American Academy of Sleep Medicine (AASM) Manual for the Scoring of Sleep and Associated Events. The PSG records in the study were scored by highly experienced registered polysomnographic technologists (RPSGT) according to the AASM manual. To maintain quality control, a specialist in pediatric respiratory medicine audited all the studies to ensure scoring consistency. Polysomnographic parameters of patients were retrieved from the computer system, including obstructive apnea-hypopnea index (OAHI) per hour of total sleep time (OAHI, /h total sleep time {TST}), nadir of oxygen saturation by pulse oximetry (SpO_2), and arousal index. Grading of OSA severity was primarily based on the values of OAHI. For patients aged below 13 years, OSA severity grading was defined as the following: mild (OAHI: 1-5/h TST), moderate (OAHI: >5-10/h TST), severe (OAHI: >10/h TST) [10]. For patients aged 13 years or above with an adult body habitus, the adult criteria for grading of OSA severity were adopted instead as follows: mild (OAHI: 5-15/h TST), moderate (OAHI: >15-30/h TST), and severe (OAHI: >30/h TST) [11].

Intervention: oromyofunctional therapy

The OMT intervention in the study institution was administered by dedicated occupational therapists who had completed formal training in oromyofunctional therapy. The OMT program consisted primarily of 10 weekly face-to-face sessions. Supplementary online sessions via Zoom (San Jose, CA: Zoom Communications, Inc.) were provided on an as-needed basis for selected patients. Participants were also instructed to perform prescribed exercises at home three times daily, with each practice session lasting approximately 10-15 min. There was a single review session by occupational therapists three months after the completion of the intervention.

The primary clinical aim of the program was to reduce strain on the jaw and airway by eliminating tongue thrust, mouth breathing, and improper swallowing. Exercises were designed to strengthen, coordinate, and retrain the muscles of the tongue, lips, and face. Specific techniques included as follows: tongue retraining and strengthening - exercises such as identifying the correct rest position (the "spot"), tongue lifts/push-ups against the hard palate, and suction clicking; lip and coordination - the "marshmallow twist" (using lips and tongue to pull a weighted string), "monkey face" pouting, and lip seal exercises using buttons or sticks; pharyngeal and nasal focus - swallowing exercises, yawning, uvula raises, and specialized nasal breathing techniques.

To support home compliance and learning, participants received exercise handouts and access to pre-recorded instructional videos. Myofunctional tools, such as tongue trainers, resistance devices, and jaw exercisers, were utilized during the sessions. Educational content focused on orofacial anatomy, habit elimination (e.g., leaning), and the education of correct rest posture for the tongue, lips, and jaw.

Participant compliance was monitored throughout the duration of the program. Compliance with face-to-face and online sessions was evaluated based on documentation by occupational therapists. Compliance with home exercises was evaluated through patient or caregiver reporting. Satisfactory compliance was defined as meeting at least 50% adherence for each of the following, including face-to-face sessions, supplementary online sessions when required, and home exercises. Patients who did not satisfy all three requirements were classified as having suboptimal compliance. This 50% benchmark was supported by a recent systematic review, which highlighted that pediatric patients with poor compliance below 50% did not show any improvements in PSG parameters or snoring frequency [9]. This suggested that achieving at least 50% adherence may be necessary for observing a significant therapeutic response.

Outcome measures

The primary outcome was observed improvement in snoring, daytime sleepiness, and mESS score as documented at the first post-OMT intervention clinical assessment. For secondary outcomes, pre- and post-intervention OAHI, SpO_2 nadir, and arousal index were compared in patients with available paired PSG data.

Additionally, compliance with the OMT intervention was assessed, and the following demographic factors were evaluated for association with OMT compliance: demographic characteristics (age and sex), comorbidities (obesity, ADHD, developmental delay, and syndromic diagnoses). To explore potential effects of OMT adherence within the isolated OMT group, we compared changes in clinical symptoms and PSG parameters between the satisfactory and suboptimal compliance groups within the OMT subgroup as well.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 29 (Armonk, NY: IBM Corp.). Continuous variables were summarized as medians and interquartile ranges (IQR), while categorical variables were presented as frequencies and percentages. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. Comparisons of paired continuous variables before and after OMT were performed using the Wilcoxon signed-rank test. Individual paired changes were calculated as the post-intervention value minus the pre-intervention value (Δ = post - pre). Results were summarized as median baseline and post-intervention values with IQR, together with the median paired change and its corresponding 95% confidence interval (CI). The 95% CIs for median paired changes were estimated using bootstrap resampling in SPSS. The bootstrap CIs were calculated independently of the Wilcoxon signed-rank tests. Comparisons of continuous variables between two independent groups were performed using the Mann-Whitney U test. A $p<0.05$ was considered statistically significant.

Results

A total of 53 patients were identified as having participated in the OMT program within the study period from January 1, 2018, to December 31, 2024. Five of those patients were excluded from the study because they participated in the program for daytime habitual mouth breathing but not SDB. A total of 48 pediatric patients were included in the study, with a median age of nine years (IQR: 7-12) and a male predominance (70.8%) (Table *1*). The majority of referrals originated from pediatric services (93.8%). Comorbid conditions were common, particularly allergic rhinitis (81.3%), while obesity was present in 43.8% of the cohort. Craniofacial abnormalities, including retrognathia, narrow maxilla, high-arched palate, and dental malocclusion, were present in 45.8% of the patients. Attention-deficit/hyperactivity disorder (ADHD) was present in 18.8% of patients. Developmental delay and syndromic conditions were relatively uncommon, and no patients had underlying neuromuscular disorders. All patients reported snoring at baseline, and over half (56.3%) reported daytime sleepiness. The median baseline mESS score was 4 (IQR: 2-7). Complete paired PSG data before and after OMT intervention were available for 17 patients (35.4%). Review of clinical records showed all PSG before and after OMT were performed without use of non-invasive ventilation. The median time between baseline and post-OMT PSGs was 20 months (IQR: 17-27.5). Baseline PSGs were available for 32 patients (66.7%). Among these 32 patients, the distribution of OSA severity was as follows: no OSA in one (3.1%), mild OSA in 11 (34.4%), moderate OSA in 10 (31.3%), and severe OSA in 10 (31.3%) individuals.

Variables	n (%)
Age at baseline, median	9 (IQR: 7-12)
Sex	
Male	34 (70.8)
Female	14 (29.2)
Source of referral	
Pediatrics	45 (93.8)
ENT	3 (6.3)
Obesity	21 (43.8)
Allergic rhinitis	39 (81.3)
Craniofacial abnormalities	22 (45.8)
Asthma	4 (8.3)
ADHD	9 (18.8)
Developmental delay	2 (4.2)
Syndromic condition	3 (6.3)
Neuromuscular disorder	0 (0)
Snoring at baseline	48 (100)
Excessive daytime sleepiness	27 (56.3)
Baseline modified Epworth Sleepiness Scale Score, median	4 (IQR: 2-7)
Nocturnal non-invasive ventilation use during OMT intervention period	6 (12.5)
Adenotonsillectomy during OMT intervention period	4 (8.3)
Surgical treatment for correction of craniofacial abnormalities during OMT intervention period	0 (0)
Baseline and post-OMT PSG available	17 (35.4)
Time between baseline and post-OMT PSG in months, median	20 (IQR: 17-27.5)
Baseline PSG available	32 (66.7)
OSA severity based on baseline PSG OAHI (n=32)	
No OSA	1 (3.1)
Mild	11 (34.4)
Moderate	10 (31.3)
Severe	10 (31.3)

TABLE 1: Baseline demographic and clinical characteristics.

ADHD: attention-deficit/hyperactivity disorder; OMT: oromyofunctional therapy; PSG: polysomnography; OAHI: obstructive apnea-hypopnea index; OSA: obstructive sleep apnea

Of the overall study group (n=48), 16 patients met one or more exclusion criteria, leaving an isolated OMT subgroup of 32 patients for subgroup sensitivity analysis. The concurrent clinical modifications and adjunctive interventions during the study period consisted of weight reduction defined as a BMI z-score reduction >0.5 (n=1), meeting pre-defined criteria for improvement in allergic rhinitis symptoms (n=14), concurrent adenotonsillectomy during the OMT intervention period (n=4), and nocturnal non-invasive ventilation (NIV) use during the OMT intervention period (n=6). Patients meeting more than one exclusion criterion for the isolated OMT subgroup were counted only once within the overall 16 exclusions. The flowchart of patient selection for isolated OMT subgroup analysis in the study is shown in Figure *1*.

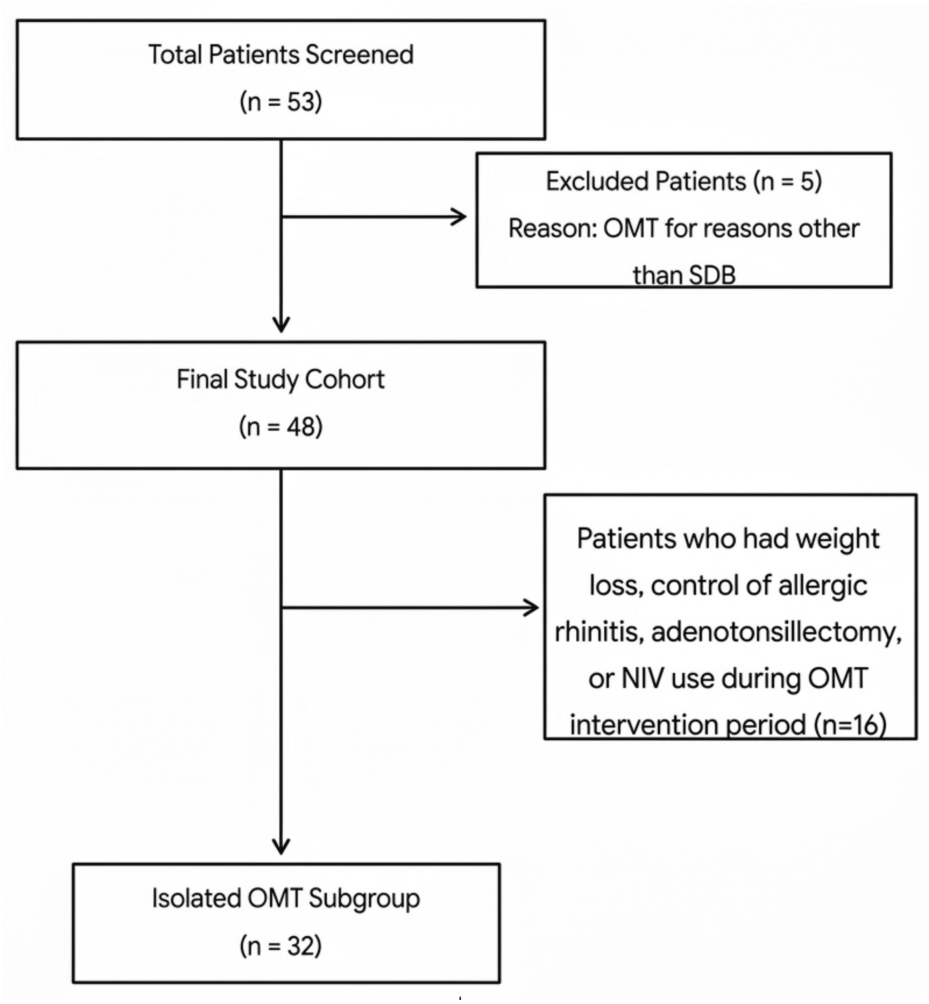


FIGURE 1: Patient selection and formation of isolated OMT subgroup.

OMT: oromyofunctional therapy; SDB: sleep-disordered breathing; NIV: non-invasive ventilation

Information on upper airway and craniofacial assessment results is shown in Table 2. Most patients had relatively favorable Mallampati anatomy, with Class I observed in 38 patients (79.2%) and Class II in nine (18.8%), while only one patient (2.1%) had Class III anatomy. Tongue tie was not identified in the study population. Retrognathia and high-arched palate were each present in 14 patients (29.2%), suggesting a notable prevalence of craniofacial features associated with upper airway narrowing. Narrow maxilla was identified in three patients (6.3%), while dental malocclusion was present in four patients (8.3%). None of the patients in the study had undergone surgery for correction of craniofacial abnormalities during the OMT intervention period.

Variables	n (%)
Mallampati class	
Class I	38 (79.2)
Class II	9 (18.8)
Class III	1 (2.1)
Tongue tie	0 (0)
Retrognathia	14 (29.2)
Narrow maxilla	3 (6.3)
High-arched palate	14 (29.2)
Dental malocclusion	4 (8.3)
Surgical treatment for correction of craniofacial abnormalities during OMT intervention period	0 (0)

TABLE 2: Craniofacial examination findings and related surgical intervention.

OMT: oromyofunctional therapy

The findings of baseline adenotonsillar assessment and related surgical history are shown in Table *3*. Tonsillar size was clinically evaluated using the standardized Brodsky grading scale (grade 0 to 4), defined by the proportion of the transverse oropharyngeal airway occupied by the palatine tonsils as follows: grade 0 (within the fossa or absent), grade 1 (<25%), grade 2 (25-50%), grade 3 (51-75%), and grade 4 (>75%). Tonsil size was most commonly grade 2 (16 patients; 33.3%), followed by grade 0 (12 patients; 25%) and grade 1 (11 patients; 22.9%). More significant tonsillar hypertrophy (grades 3-4) was present in nine patients (18.8%). Adenoid size was evaluated endoscopically and graded from grade 1 to 4 based on the proportion of posterior choanal obstruction as follows: grade 1 (<25%), grade 2 (25-50%), grade 3 (51-75%), and grade 4 (>75%). Over half of the cohort had grade 0 adenoids (56.3%), while grades 1, 2, and 3 were observed in 16.7%, 16.7%, and 10.4% of patients, respectively. Prior adenotonsillectomy had been performed in 11 patients (22.9%), and four patients (8.3%) underwent adenotonsillectomy during the OMT intervention period.

Tonsil size	n (%)
Grade 0	12 (25.0)
Grade 1	11 (22.9)
Grade 2	16 (33.3)
Grade 3	7 (14.6)
Grade 4	2 (4.2)
Adenoid grade	
Grade 0	27 (56.3)
Grade 1	8 (16.7)
Grade 2	8 (16.7)
Grade 3	5 (10.4)
History of T&A before OMT intervention	11 (22.9)
T&A during intervention period	4 (8.3)

TABLE 3: Adenotonsillar findings and related surgical intervention.

OMT: oromyofunctional therapy; T&A: tonsillectomy and adenoidectomy

Results for the primary outcome of improvement in snoring and daytime sleepiness are shown in Table *4*. In the overall study group, 95.8% (46/48) of patients reported improvement in snoring symptoms, compared to 93.8% (30/32) in the isolated OMT subgroup. Among patients who reported daytime sleepiness at baseline in the overall study group, 96.2% (26/27) experienced symptom improvement after OMT. In the isolated OMT subgroup, 92.3% (12/13) of patients with baseline daytime sleepiness reported improvement following OMT intervention.

Variables	Overall study group, n/N (%)	Isolated OMT subgroup, n/N (%)
Snoring improvement	46/48 (95.8%)	30/32 (93.8%)
Daytime sleepiness improvement	26/27 (96.2%)	12/13 (92.3%)

TABLE 4: Symptom improvement of snoring and daytime sleepiness in overall study group and isolated OMT subgroup.

OMT: oromyofunctional therapy

Pre- and post-intervention modified Epworth Sleepiness Scale (mESS) scores were compared using the Wilcoxon signed-rank test in both the overall study group and the isolated OMT subgroup (Table *5*). In the overall study group, the median mESS score decreased from 4 (IQR: 2-7) at baseline to 1 (IQR: 0-3) post-intervention (median paired difference: -3, 95% CI: -3 to -2; $Z = -4.13$, $p<0.001$, $r=0.59$). Similarly, in the isolated OMT subgroup, the median mESS score decreased from 4.5 (IQR: 2-7) at baseline to 1 (IQR: 0-3) post-intervention (median paired difference: -3, 95% CI: -4.5 to -2; $Z = -3.32$, $p<0.001$, $r=0.58$).

Variables	Overall study group (n=48)	Isolated OMT subgroup (n=32)
Pre-OMT mESS score, median (IQR)	4 (2-7)	4.5 (2-7)
Post-OMT mESS score, median (IQR)	1 (0-3)	1 (0-3)
Median difference (95% CI)	-3 (-3,-2)	-3 (-4.5,-2)
Z-statistic	-4.13	-3.32
P-value	<0.001	<0.001
Effect size (r)	0.59	0.58

TABLE 5: Pre- and post-OMT modified Epworth Sleepiness Scale (mESS) score.

OMT: oromyofunctional therapy

Complete paired pre- and post-OMT PSG data were available for 17 patients in the overall study group and 11 patients in the isolated OMT subgroup. Comparisons of pre- and post-intervention PSG parameters using the Wilcoxon signed-rank test are presented in Table *6*.

PSG parameters	Overall study group (n=17)	Isolated OMT subgroup (n=11)
OAHI (events/h)		
Pre-OMT, median (IQR)	8.7 (4.6-14.1)	8.7 (4.9-12.8)
Post-OMT, median (IQR)	2.8 (1.2-6.5)	4.9 (1.6-9.1)
Median difference (95% CI)	-1.6 (-9.7, -0.3)	-1.4 (-9.2, 0.4)
Z-statistic	-2.44	-1.25
P-value	0.015	0.213
Effect size (r)	0.59	0.38
SpO_2 nadir (%)		
Pre-OMT, median (IQR)	89 (85-91)	89 (85-92)
Post-OMT, median (IQR)	91 (89.5-94.5)	91 (89-95)
Median difference (95% CI)	3 (2, 6)	2 (1, 6)
Z-statistic	-2.99	-1.96
P-value	0.003	0.05
Effect size (r)	0.72	0.59
Arousal index (events/h)		
Pre-OMT, median (IQR)	9.6 (7.3-13)	7.3 (6.2-10.2)
Post-OMT, median (IQR)	6.4 (4.9-9.1)	6.4 (4.4-9)
Median difference (95% CI)	-3.3 (-5.8, -0.5)	-0.8 (-4.9, -0.3)
Z-statistic	-2.77	-1.78
P-value	0.006	0.075
Effect size (r)	0.67	0.54

TABLE 6: Pre- and post-OMT PSG parameters in overall study group and isolated OMT subgroup.

OMT: oromyofunctional therapy; PSG: polysomnography; OAHI: obstructive apnea-hypopnea index

In the overall study group (n=17), the OAHI decreased from 8.7 (IQR: 4.6-14.1) to 2.8 (IQR: 1.2-6.5) events/h (median difference: -1.6, 95% CI: -9.7 to -0.3; Z = -2.44, p=0.015, r=0.59). The median SpO_2 nadir increased from 89% (IQR: 85-91) to 91% (IQR: 89.5-94.5) (median difference: 3, 95% CI: 2-6; Z = -2.99, p=0.003, r=0.72). The median arousal index decreased from 9.6 (IQR: 7.3-13.0) to 6.4 (IQR: 4.9-9.1) events/h (median difference: -3.3, 95% CI: -5.8 to -0.5; Z = -2.77, p=0.006, r=0.67).

In the isolated OMT subgroup (n=11), the median OAHI decreased from 8.7 (IQR: 4.9-12.8) to 4.9 (IQR: 1.6-9.1) events/h (median difference: -1.4, 95% CI: -9.2 to 0.4; Z = -1.25, p=0.213, r=0.38). The median SpO_2 nadir increased from 89% (IQR: 85-92) to 91% (IQR: 89-95) (median difference: 2, 95% CI: 1-6; Z = -1.96, p=0.050, r=0.59). The median arousal index decreased from 7.3 (IQR: 6.2-10.2) to 6.4 (IQR: 4.4-9.0) events/h (median difference: -0.8, 95% CI: -4.9 to -0.3; Z = -1.78, p=0.075, r=0.54). Using a prespecified significance threshold of $p<0.05$, none of the changes in PSG parameters in the isolated OMT subgroup reached statistical significance.

Compliance with OMT intervention

Regarding intervention compliance, 38 patients (79.1%) attended ≥50% of the 10 scheduled face-to-face sessions. Among the 23 patients who required supplemental online Zoom sessions, all 23 (100%) achieved ≥50% attendance. In addition, 35 patients (72.9%) or their caregivers reported completing ≥50% of assigned home exercises. Overall, based on the predefined criteria, 35 patients (72.9%) achieved satisfactory compliance, whereas 13 patients (27.1%) had suboptimal compliance. Age did not differ significantly between the satisfactory and suboptimal compliance groups. Both groups had a median age of nine years,

with IQRs of 7-12 and 6.5-12.5 years, respectively (Mann-Whitney U=242.00, z=0.34, p=0.735). Associations between baseline clinical characteristics and treatment compliance were examined using Fisher's exact test, with odds ratios (OR) and 95% confidence intervals (CI) reported as effect estimates (Table 7). No significant associations were identified.

Variables		Satisfactory compliance, n (%)	Suboptimal compliance, n (%)	Total number of patients, N	p-Value*	Odds ratio (95% CI)
Sex	Male	25 (73.5)	9 (26.5)	48	1.0	1.11 (0.28, 4.45)
	Female	10 (71.4)	4 (28.6)			
Obesity	Yes	17 (81.0)	4 (19.0)	48	0.338	2.13 (0.55, 8.21)
	No	18 (66.7)	9 (33.3)			
Allergic rhinitis	Yes	27 (69.2)	12 (30.8)	48	0.410	0.28 (0.03, 2.51)
	No	8 (88.9)	1 (11.1)			
Asthma	Yes	2 (50.0)	2 (50.0)	48	0.294	0.33 (0.04, 2.66)
	No	33 (75.0)	11 (25.0)			
ADHD	Yes	7 (77.8)	2 (22.2)	48	1.0	1.38 (0.25, 7.67)
	No	28 (71.8)	11 (28.2)			
Developmental delay	Yes	1 (50.0)	1 (50.0)	48	0.472	0.35 (0.02, 6.10)
	No	34 (73.9)	12 (26.1)			
Syndromic condition	Yes	1 (33.3)	2 (66.7)	48	0.174	0.16 (0.01, 1.96)
	No	34 (75.6)	11 (24.4)			
Craniofacial abnormality	Yes	17 (77.3)	5 (22.7)	48	0.746	1.51 (0.41, 5.54)
	No	18 (69.2)	8 (30.8)			

TABLE 7: Association between demographic factors with OMT compliance.

*P-value calculated using Fisher's exact test.

OMT: oromyofunctional therapy; ADHD: attention-deficit/hyperactivity disorder

Satisfactory compliance was similar between males and females (73.5% {25/34} vs. 71.4% {10/14}; p=1.0, OR=1.11, 95% CI: 0.28-4.45) and did not differ significantly by obesity status (81.0% {17/21} in patients with obesity vs. 66.7% {18/27} in those without obesity; p=0.338, OR=2.13, 95% CI: 0.55-8.21). No significant associations were found for medical or neurodevelopmental comorbidities. Satisfactory compliance was observed in 69.2% (27/39) of patients with allergic rhinitis and 88.9% (8/9) of those without (p=0.410, OR=0.28, 95% CI: 0.03-2.51). Satisfactory compliance was observed in 50.0% (2/4) and 75.0% (33/44) for patients with and without asthma (p=0.294, OR=0.33, 95% CI: 0.04-2.66), 77.8% (7/9) and 71.8% (28/39) for those with and without ADHD (p=1.0, OR=1.38, 95% CI: 0.25-7.67), and 50.0% (1/2) and 73.9% (34/46) for those with and without developmental delay (p=0.472, OR=0.35, 95% CI: 0.02-6.10).

Neither syndromic conditions nor craniofacial abnormalities were significantly associated with compliance. Satisfactory compliance was observed in 33.3% (1/3) of patients with a syndromic condition, compared with 75.6% (34/41) of those without (p=0.174, OR=0.16, 95% CI: 0.01-1.96). Among patients with and without craniofacial abnormalities, the corresponding rates were 77.3% (17/22) and 69.2% (18/26), respectively (p=0.746, OR=1.51, 95% CI: 0.41-5.54).

Association between compliance and outcomes

To observe potential differences in clinical outcomes based on OMT compliance, a subgroup analysis evaluated the association between compliance and both clinical symptoms and PSG parameters. In order to account for the confounding treatment effects from concurrent interventions other than OMT, this secondary analysis was restricted to the isolated OMT subgroup (n=32). Patients were excluded from this analysis if they experienced concurrent weight reduction, improvement in allergic rhinitis (AR), underwent

T&A during the OMT intervention period, or utilized nocturnal NIV during the OMT intervention period. Within this subgroup, 21 patients had satisfactory compliance and 11 had suboptimal compliance. Prior to OMT intervention, within this group, all 32 patients reported snoring, and 13 patients reported daytime sleepiness. Due to the small sample size, Fisher's exact test was used to test for association between compliance and observed improvement in symptoms of snoring and daytime sleepiness (Table *8*).

Clinical symptom	Satisfactory compliance	Suboptimal compliance	p-Value	Odds ratio (95% CI)
Snoring	n=21	n=11		
Improved, n (%)	20 (95.2)	10 (90.9)	1.0	2.0 (0.11, 35.85)
Not improved, n (%)	1 (4.8)	1 (9.1)		
Daytime sleepiness	n=8	n=5		
Improved, n (%)	7 (87.5)	5 (100.0)	1.0	N/A
Not improved, n (%)	1 (12.5)	0 (0)		

TABLE 8: Clinical symptom improvements between compliance groups within isolated OMT subgroup.

Values are presented as counts (percentages) of patients with available baseline symptom data. P-values were calculated using a two-tailed Fisher's exact test.

OMT: oromyofunctional therapy; N/A: not applicable/calculable due to a zero cell count in the non-improved group

Among patients with baseline snoring (n=32), snoring improvement was reported by 20 out of 21 (95.2%) patients in the satisfactory compliance group, and 10 out of 11 (90.9%) patients in the suboptimal compliance group; Fisher's exact test showed no statistically significant difference between groups (p=1.0, OR=2.00, 95% CI: 0.11, 35.85). Among patients with baseline daytime sleepiness (n=13), daytime sleepiness improved in seven out of eight (87.5%) patients with satisfactory compliance compared with five out of five (100.0%) patients with suboptimal compliance; Fisher's exact test showed no statistically significant difference between groups (p=1.0).

Median mESS (before and after OMT) was evaluated by the Wilcoxon signed-rank test in the satisfactory and suboptimal compliance groups, and results are shown in Table *9*. The median mESS significantly decreased from 5 (IQR: 2-7) to 2 (IQR: 0-3) after OMT intervention in the patients with satisfactory compliance (Z = -3.74, p≤0.001). The median mESS also significantly decreased from 4 (IQR: 1-7) to 1 (IQR: 0-2) after OMT intervention in the patients with suboptimal compliance (Z = -3.22, p=0.001).

Variables	Satisfactory compliance (n=21)	Suboptimal compliance (n=11)
Pre-OMT mESS score, median (IQR)	5 (2-7)	4 (1-7)
Post-OMT mESS score, median (IQR)	2 (0-3)	1 (0-2)
Median difference (95% CI)*	-3 (-4.75, -2)	-4 (-5, -0.25)
Z-statistic	-3.74	-3.22
P-value	<0.001	0.001
Effect size (r)	0.82	0.97

TABLE 9: Pre- and post-OMT mESS scores between compliance groups within isolated OMT subgroup.

*Values are presented as median (interquartile range) unless otherwise specified.

P-values were derived from the Wilcoxon signed-rank test. Median difference was calculated as the median of individual paired changes (post - pre).

mESS: modified Epworth Sleepiness Scale; OMT: oromyofunctional therapy

In the isolated OMT subgroup, 11 patients had complete paired pre- and post-intervention PSG data, including seven with satisfactory compliance and four with suboptimal compliance. Changes in PSG parameters according to compliance status are summarized in Table *10*.

PSG parameters	Satisfactory compliance (n=7)	Suboptimal compliance (n=4)
OAHI (events/h)		
Pre-OMT, median (IQR)	9.2 (5.8-12.8)	4.6 (3.3-11.8)
Post-OMT, median (IQR)	4.8 (1.6-7.8)	9.3 (2.3-15.8)
Median difference (95% CI)	-1.8 (-9.7, -1)	1.3 (-1.6, 9.3)
Z-statistic	-2.19	-1.09
P-value	0.028	0.273
Effect size (r)	0.83	0.55
SpO_2 nadir (%)		
Pre-OMT, median (IQR)	89 (88-92)	87 (78.3-92)
Post-OMT, median (IQR)	92 (90-95)	89 (86.8-90.5)
Median difference (95% CI)	3 (1, 6)	1.5 (-4, 13)
Z-statistic	-1.95	-0.73
P-value	0.051	0.465
Effect size (r)	0.74	0.37
Arousal index (events/h)		
Pre-OMT, median (IQR)	8.3 (7.2-10.2)	6.8 (5.2-13.5)
Post-OMT, median (IQR)	6.4 (4.4-8.3)	7.2 (4.7-10.9)
Median difference (95% CI)	-3.3 (-4.9, -0.3)	-0.7 (-6.6, 4.2)
Z-statistic	-1.863	-0.73
P-value	0.063	0.465
Effect size (r)	0.70	0.37

TABLE 10: Pre- and post-OMT PSG parameters between compliance groups within isolated OMT subgroup.

Values are presented as median (interquartile range) unless otherwise specified. P-values were derived from Wilcoxon signed-rank test. Median difference calculated as the median of individual paired changes (post - pre).

OMT: oromyofunctional therapy; PSG: polysomnography; OAHI: obstructive apnea-hypopnea index

Among patients with satisfactory compliance (n=7), median OAHI decreased significantly from 9.2 events/h (IQR: 5.8-12.8) at baseline to 4.8 events/h (IQR: 1.6-7.8) post-OMT (median paired difference: -1.8, 95% CI: -9.7 to -1.0; Z = -2.19, p=0.028, r=0.83). Median SpO_2 nadir increased from 89% (IQR: 88-92) to 92% (IQR: 90-95) (median paired difference: 3, 95% CI: 1-6; Z = -1.95, p=0.051, r=0.74), while median arousal index decreased from 8.3 events/h (IQR: 7.2-10.2) to 6.4 events/h (IQR: 4.4-8.3) (median paired difference: -3.3, 95% CI: -4.9 to -0.3; Z = -1.863, p=0.063, r=0.70). Neither change reached statistical significance.

Among patients with suboptimal compliance (n=4), none of the PSG parameters changed significantly after OMT. Median OAHI increased from 4.6 events/h (IQR: 3.3-11.8) to 9.3 events/h (IQR: 2.3-15.8) (median paired difference: 1.3, 95% CI: -1.6 to 9.3; Z = -1.09, p=0.273, r=0.55). Median SpO_2 nadir increased from 87% (IQR: 78.3-92) to 89% (IQR: 86.8-90.5) (median paired difference: 1.5, 95% CI: -4 to 13; Z = -0.73, p=0.465, r=0.37). Median arousal index changed from 6.8 events/h (IQR: 5.2-13.5) to 7.2 events/h (IQR: 4.7-10.9) (median paired difference: -0.7, 95% CI: -6.6 to 4.2; Z = -0.73, p=0.465, r=0.37).

Discussion

In this retrospective study of children with SDB who received OMT, snoring and daytime sleepiness

commonly improved, and mESS scores decreased significantly. Among patients with paired PSG data, the overall study group also showed significant improvements in the OAHI, SpO_2 nadir, and arousal index. However, these changes were not statistically significant in the isolated OMT subgroup. The findings suggested that symptomatic improvement was common in clinical practice, although the extent to which objective improvements could be attributed to OMT alone remained uncertain.

Our findings were broadly consistent with previous studies and systematic reviews reporting improvements in symptoms and PSG parameters following OMT [7,8,12]. In our study, the reported improvements in snoring and daytime sleepiness, together with the reduction in mESS scores, were encouraging. However, symptom outcomes were based on patient or caregiver reports and might have been influenced by recall bias or treatment expectations. In addition, some patients had relatively low baseline mESS scores, which might have limited the extent of measurable improvement.

In the overall study group with paired PSG data, OAHI and arousal index decreased, while SpO_2 nadir increased, with statistically significant changes in all three parameters. Among the 11 patients in the isolated OMT subgroup with complete paired PSG data, median OAHI and arousal index decreased, while median SpO_2 nadir increased. However, these changes did not reach statistical significance. The small sample size limited the precision of the estimates and the ability to detect potentially meaningful changes. Accordingly, these findings were inconclusive regarding the effect of isolated OMT on PSG parameters.

Several factors might have contributed to the differences between the overall study group and the isolated OMT subgroup. Some patients in the overall study group received additional treatments or experienced other clinical changes that could have affected SDB, including adenotonsillectomy, nocturnal non-invasive ventilation, significant weight reduction, or improvement in allergic rhinitis. The contribution of these factors could not be determined from the available data. The isolated OMT subgroup analysis was performed to examine whether the observed improvements persisted after excluding patients with potential co-interventions or other clinical changes. The absence of statistically significant changes in this subgroup left the independent effect of OMT uncertain. However, the small sample size and possible differences in patient characteristics also limited the conclusions that could be drawn from this analysis.

Approximately three-quarters of the patients met the study's operational definition of satisfactory compliance. Compliance was not significantly associated with age, sex, or the comorbidities examined. Within the isolated OMT subgroup, symptom improvement and mESS improvement were both observed in patients with satisfactory compliance and suboptimal compliance. Across both compliance groups, no significant overall changes in PSG parameters were observed following isolated OMT. While a statistically significant reduction in median OAHI was noted in the satisfactory compliance group, without accompanying changes in SpO_2 nadir or arousal index, this isolated finding could be due to higher baseline OAHI and regression to the mean rather than clinical efficacy. Similarly, the suboptimal compliance group exhibited no significant changes in any PSG parameters. It is important to note that due to the small sample size (n=4), bootstrap 95% confidence intervals for the suboptimal compliance subgroup demonstrated high sampling variability and were considered statistically unstable. Furthermore, the compliance threshold used in this study was an operational definition rather than an established standard for adequate adherence to OMT. In view of the above reasons, our study was unable to identify a meaningful relationship between compliance with OMT and observed clinical improvements.

Our study had several limitations. Its retrospective, single-center design and lack of a control group limited causal inference and generalizability. Paired PSG data were available for only a subset of patients because hospital restrictions during the COVID-19 pandemic limited testing capacity, and some patients postponed their post-intervention PSG. The resulting delay led to a relatively long interval between baseline and follow-up assessments, which may introduce confounding related to physical growth, age-related upper airway development, or natural disease progression. The small isolated OMT subgroup limited the precision of the estimates. Symptom outcomes were based on patient or caregiver reports, and patients reported changes in symptoms of SDB could be related to its natural course, regression to the mean, measurement variability, or other time-related factors. Concurrent interventions and other clinical changes in the overall study group introduced potential confounding. Excluding these patients from the sensitivity analysis might have introduced selection bias due to differences in patient characteristics between the overall study group and the isolated subgroup. Finally, in view of the small study sample size in this study, statistically significant findings should be interpreted cautiously.

Despite these limitations, this study provided observational data on the clinical outcomes of OMT in children with SDB in real-life clinical practice, which may help in further exploration in this area. Symptomatic improvements were frequently reported, and significant improvements in PSG parameters were observed in the overall study group. However, the isolated OMT subgroup findings did not establish whether these objective improvements could be attributed to OMT alone. Larger prospective controlled studies with standardized treatment protocols, together with complete pre- and post-intervention PSG assessments, are needed to clarify the independent effect of OMT. This study was conducted and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. The completed STROBE checklist is provided in the appendix.

Conclusions

In this retrospective study of children with SDB in a local tertiary care center, improvements in snoring and daytime sleepiness were commonly reported following OMT, accompanied by a significant reduction in mESS scores. Although significant improvements in PSG parameters were observed in the overall study group, these findings were not consistently demonstrated in the isolated OMT subgroup. Treatment compliance was acceptable in most patients, with no significant associations identified between baseline demographic factors and compliance. Clinical symptoms and mESS improvement were observed in both satisfactory compliant and suboptimal compliant groups. Given the retrospective design, small sample size, relatively long interval between pre- and post-intervention PSGs, and potential confounding from concurrent interventions, the independent efficacy of OMT could not be established from this study. Larger prospective controlled studies are needed to clarify the role of OMT in the management of pediatric SDB.

Appendices

Section/item	STROBE recommendation	Location in manuscript
Title and abstract 1(a)	1(a). Indicate the study's design with a commonly used term in the title or abstract.	Title and Abstract: identified the study as a retrospective review and summarized the design, population, intervention, principal outcomes, and findings.
Title and abstract 1(b)	1(b). Provide an informative and balanced summary of what was done and what was found.	Abstract: summarized the study context, principal methods, key results, and overall conclusion.
Introduction 2	2. Explain the scientific background and rationale for the investigation.	Introduction: described pediatric sleep-disordered breathing and the rationale for evaluating oromyofunctional therapy (OMT).
Introduction 3	3. State specific objectives, including any prespecified hypotheses.	Introduction: stated the study aims concerning outcomes after OMT and treatment compliance.
Methods 4	4. Present key elements of study design early in the paper.	Methods - Study Design and Setting: described the retrospective, single-center design, and clinical setting.
Methods 5	5. Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection.	Methods - Study Population and Data Collection; Results: described the study period, eligibility, and data collection, and reported the overall cohort and analysis subsets.
Methods 6(a)	6(a). Give eligibility criteria and the sources and methods of selection of participants; describe methods of follow-up	Methods - Study Population and Data Collection; Results; Figure 1: described eligibility and participant selection. Figure 1 showed selection into the isolated-OMT subgroup; paired-PSG availability was reported in the Results.
Methods 6(b)	6(b). For matched studies, give matching criteria and number of exposed and unexposed participants.	Not applicable: the study did not use a matched design.
Methods 7	7. Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers; give diagnostic criteria, if applicable.	Methods - Data Collection, Intervention and Outcome Measures: defined OMT, symptom-scale outcomes, and polysomnographic outcomes.
Methods 8	8. For each variable of interest, give sources of data and details of methods of assessment/measurement; describe comparability of assessment methods if there is more than one group.	Methods - Data Collection and Intervention: described the data sources, treatment components, and outcome assessment methods.
Methods 9	9. Describe any efforts to address potential sources of bias.	Methods; Discussion - Limitations: described the retrospective design and lack of a control group. The isolated-OMT subgroup analysis explored the potential influence of co-interventions.
Methods 10	10. Explain how the study size was arrived at.	Sample-size rationale: was not explicitly reported in the manuscript.
Methods 11	11. Explain how quantitative variables were handled in the analyses; if applicable, describe which groupings were chosen and why.	Methods - Statistical Analysis; Results tables: described the statistical tests and presentation of quantitative variables, with outcome summaries and effect estimates in the tables.
Methods 12(a)	12(a). Describe all statistical methods, including those used to control for confounding.	Methods - Statistical Analysis: described the statistical methods used for paired comparisons and effect estimates.
Methods 12(b)	12(b). Describe methods used to examine subgroups and interactions.	Methods - Outcome Measures and Statistical Analysis; Results: described the symptom and PSG outcomes, compliance assessment, subgroup analyses, and isolated-OMT sensitivity

		analysis.
Methods 12(c)	12(c). Explain how missing data were addressed.	Not applicable because there were no missing data.
Methods 12(d)	12(d). If applicable, explain how loss to follow-up was addressed.	Results: reported the participants contributing to the analyses. Discussion: provided the reason for unavailable follow-up or paired PSG data.
Methods 12(e)	12(e). Describe any sensitivity analyses.	Methods - Statistical Analysis; Results; Discussion: described and presented the isolated-OMT sensitivity analysis and discussed its interpretation.
Results 13(a)	13(a). Report numbers of individuals at each stage of the study - e.g., potentially eligible, examined for eligibility, confirmed eligible, included, completing follow-up, and analyzed.	Results - Baseline Patient Demographics; Figure 1; outcome tables: reported participant characteristics and the numbers contributing to the different analyses.
Results 13(b)	13(b). Give reasons for non-participation at each stage, where applicable.	Results - Baseline Patient Demographics and isolated-OMT subgroup description: reported baseline characteristics and subgroup counts. Not applicable, as there was no non-participation.
Results 13(c)	13(c). Consider use of a flow diagram.	Figure 1: showed participant selection for the isolated-OMT subgroup.
Results 14(a)	14(a). Give characteristics of study participants and information on exposures and potential confounders.	Results - Baseline Patient Demographics; Tables 1-3: presented demographic and clinical characteristics and relevant compliance-related characteristics.
Results 14(b)	14(b). Indicate the number of participants with missing data for each variable of interest.	Results and outcome tables: reported the numbers contributing to outcome analyses; variable-specific missing-data counts were not systematically summarized.
Results 14(c)	14(c). Summarize follow-up time (e.g., average and total amount).	Results; Table 1: reported the interval between baseline and post-intervention PSG for participants with paired studies.
Results 15	15. Report numbers of outcome events or summary measures over time.	Results; Tables 4-10: presented the principal symptom-scale and PSG outcomes, including pre/post summaries and statistical results.
Results 16(a)	16(a). Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% CI); make clear which confounders were adjusted for and why.	Results; Tables 4-10: presented unadjusted outcome estimates and subgroup results. Adjusted estimates were not reported.
Results 16(b)	16(b). Report category boundaries when continuous variables were categorized.	Methods; Results - Tables 1 and 7: described compliance categories and reported the related analyses, including odds ratios and confidence intervals where applicable.
Results 16(c)	16(c). If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period.	Not applicable to the principal paired continuous-outcome analyses. Odds ratios for compliance associations were reported in Tables 7-8; relative-risk estimates were not reported.
Results 17	17. Report other analyses done - e.g., subgroup analyses, interaction, and sensitivity analyses.	Results; Tables 7-10: reported subgroup and sensitivity analyses, including isolated-OMT and compliance analyses.
Discussion 18	18. Summarize key results with reference to study objectives.	Discussion; Conclusion: summarized and interpreted the principal symptom and PSG findings in relation to the study objectives.
Discussion 19.	19. Discuss limitations, taking into account sources of potential bias or imprecision; discuss direction and magnitude where possible.	Discussion - Limitations: discussed the retrospective single-center design, lack of a control group, limited paired-PSG data, small subgroups, and potential confounding.
Discussion 20.	20. Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	Discussion: interpreted the findings in the context of existing evidence and considered the study limitations and exploratory analyses.
Discussion 21	21. Discuss the generalizability (external validity) of the study results.	Discussion - Limitations: addressed generalizability and noted that the single-center clinical cohort might not have represented children in other settings or populations.

Other information 22	22. Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based.	Not applicable.

TABLE 11: STROBE checklist for retrospective cohort study.

PSG: polysomnography; STROBE: Strengthening the Reporting of Observational Studies in Epidemiology

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Tak Kong Tsui

Acquisition, analysis, or interpretation of data: Tak Kong Tsui

Drafting of the manuscript: Tak Kong Tsui

Critical review of the manuscript for important intellectual content: Tak Kong Tsui

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Hospital Authority Central Institutional Review Board issued approval #PAED-2026-064. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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