Philippine Academy of Pediatric Pulmonologists Inc.
Philippine Society of Sleep Medicine Inc.

PAPP AND PSSM JOINT POSITION STATEMENT

ON

CHILDHOOD OBSTRUCTIVE SLEEP APNEA SYNDROME

PAPP TASK FORCE ON SLEEP DISORDERED BREATHING 2021-2023

MESSAGE

Greetings!

The Philippine Academy of Pediatric Pulmonologists, Inc (PAPP) congratulates the Task Force on Sleep Disordered Breathing, headed by Dr. Shiela Monzon, for coming up with this very relevant and informative academic article entitled “PAPP and PSSM Joint Position Statement on Childhood Obstructive Sleep Apnea Syndrome”. Likewise, the academy thanks the Philippine Society of Sleep Medicine for its collaboration in the creation of this position statement.

Childhood snoring is a common complaint of parents or caregivers. But when should one be concerned? The aim of this position statement is to guide pediatricians and general practitioners in the approach to diagnosing and managing Childhood Obstructive Sleep Apnea Syndrome. As one goes through the material one will also realize the pulmonary and systemic complications of untreated Childhood OSAS. With this position statement we hope to empower our fellow pediatricians and general practitioners to be part of our advocacy to save our children's’ lungs.

Once again, thank you to the PAPP Task Force on Sleep Disordered Breathing.

My warmest regards to all.

Anna Marie Concepcion S. Putulin, MD
President
Philippine Academy of Pediatric Pulmonologists, Inc.

MESSAGE

The effects of sleep disorders have long been underestimated and overlooked. This is apparent in the pediatric population despite the mounting evidence of the negative effects in the growth and development of the young who have poor sleep quality or those who are sleep deprived. Though there has been progress in the awareness of pediatric obstructive sleep apnea syndrome over the past years, this must be sustained as there is an expected rise in its prevalence due to the increase in obesity among the younger population.

The creation of the Position Statement on Childhood Obstructive Sleep Apnea will be able to provide guidance to health providers in ensuring better sleep for the Filipino Child. In this era of evidence-based medicine, there will be no doubt in the reliability of the recommendations in this document as these are backed by scientific evidence.

On behalf of the Philippine Society of Sleep Medicine (PSSM), I would like to extend my acknowledgement and deep gratitude to the Philippine Academy of Pediatric Pulmonologists (PAPP) for initiating this project and reaching out to our Society to be proponents of this noble endeavor.

May the Filipino Child breathe comfortably – whether awake or asleep.

Rodolfo V. Dizon, Jr., MD, FPCP, FPCCP, FPSSM
President
Philippine Society of Sleep Medicine

MESSAGE

A deeper understanding of sleep-related breathing disorders among children was made possible in the Philippines by the foundations laid by our colleagues in Pediatric Pulmonology, Drs. Roland Dela Eva and Mary Therese Leopando. They were the first to have further training in pediatric sleep medicine abroad and returned to share their expertise. Members of this Task Force have followed in their footsteps, and we all share the same mission of creating awareness in the screening, diagnosing, and managing different sleep disorders, especially among children.

Although information about sleep and snoring is increasing in the general population, many parents still mistakenly perceive snoring as benign and a reflection of good sleep. It is, therefore, seldom the presenting complaint for a consultation with the doctor. It is important to note that nearly all children with OSA snore. Knowing the unwanted consequences of childhood OSAS, early diagnosis, and intervention is paramount. Our Task Force worked diligently and spent tireless hours to create this Position Statement to guide local pediatricians, general practitioners, and health professionals who see children with this sleep problem.

We dedicate this to all our mentors to whom we owe an immense debt of gratitude; to all our patients from whom we also learn so much; to our families, and most of all, to God Almighty, who made all these possible.

Our Task Force would also like to acknowledge the PAPP and PSSM Board of Trustees for their unwavering support; Dr. Yu-Shu Huang (Chang Gung Memorial Hospital, Taiwan) for critically reviewing this manuscript, and Dr. Pristine Marie Bernardo for her assistance in the preparation of this document.

Shiela De Luna Monzon, MD
Chair
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INTRODUCTION

Obstructive sleep apnea syndrome (OSAS) is included in the obstructive sleep-disordered breathing (SDB) spectrum (Table 1), which is defined as a syndrome of upper airway dysfunction during sleep, characterized by snoring and/or increased respiratory effort secondary to increased upper airway resistance and pharyngeal collapsibility. OSAS occurs when airflow is partially reduced (hypopnea) or almost completely ceased (apnea) and is associated with disruption of normal oxygenation, ventilation, and sleep pattern.[1]

The prevalence of childhood OSAS was reported to be 1-5.8% by definitive diagnostic procedure using polysomnography (PSG) and 4-11% based on parental questionnaire surveys.[2,3] Presently, there is no locally published research stating the prevalence of OSAS among Filipino children in the general population. However, in an unpublished sleep laboratory-based research in one medical center in 2016, the prevalence of childhood OSAS confirmed by PSG among habitually snoring Filipino children was high at 89%.[4]In two unpublished local studies, the prevalence among six- to twelve-year-old schoolchildren using the Filipino translated Pediatric Sleep Questionnaire (PSQ) was 16%[5] while in another study among two-to- eighteen year old children in one barangay the prevalence was 9.45%[6] using the Bisayan translation.

Childhood OSAS has a peak at pre-school age corresponding to the time of adenotonsillar hypertrophy and a later peak during adolescence when obesity becomes more prevalent. OSAS occurs equally among boys and girls in the prepubertal age group with male preponderance post-puberty. In children, as in adults, OSA results from a combination of abnormal neuromuscular control and anatomical narrowing of the collapsible portion of the upper airway. During sleep, there is a decrease in ventilatory drive and in neuromuscular tone facilitating upper airway collapse which may cause hypoxemia, hypercapnia, and sleep disruption.[7]

Standard management guidelines have been developed in the USA, Europe and Asia. In 2017, the Asian Paediatric Pulmonology Society (APPS) released their official position statement on Childhood OSAS [8] while on October 30, 2021, the Philippine Academy of Pediatric Pulmonologists (PAPP) Task Force on SDB, a subgroup of pediatric pulmonologists who are likewise fellows of the Philippine Society of Sleep Medicine (PSSM), prepared a position statement on Childhood OSAS based on current literature.

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The aim of this position statement is to guide local pediatricians, general practitioners and other health professionals in the proper approach to diagnosing and managing childhood OSA. This position statement will answer six clinical questions. An initial draft of the statement was presented at the PAPP Convention last May 2, 2023.

Table 1. Definitions of obstructive sleep disordered breathing (SDB) and its clinical entities (European Respiratory Society Task Force, 2017)

Obstructive sleep disordered breathing (SDB) **-** A syndrome of upper airway dysfunction during sleep characterized by snoring and/or increased respiratory effort that result from increased upper airway resistance and pharyngeal collapsibility

Obstructive SDB clinical entities

1. Primary snoring - Habitual snoring (>3 nights per week) without apneas, hypopneas, frequent arousals from sleep or gas exchange abnormalities
2. Upper airway resistance syndrome - Snoring, increased work of breathing, frequent arousals, but no recognisable obstructive events or gas exchange abnormalities
3. Obstructive hypoventilation - Snoring and abnormally elevated partial pressure of carbon dioxide in the absence of recognisable obstructive events
4. Obstructive sleep apnea syndrome **-** Recurrent events of partial or complete upper airway obstruction (hypopneas, obstructive or mixed apneas) with disruption of normal oxygenation, ventilation and sleep pattern

CQ1. What are the clinical signs and symptoms that would make you suspect OSAS?

Key Recommendations:

- Children's symptoms and signs are important bases for the initial diagnosis of childhood OSAS, but their diagnostic accuracy is low. Regarding symptoms, the presence and frequency of snoring should be considered first. Snoring ≥ 3 nights/week merits clinical attention. However, whether based on a single symptom/sign or a combination of multiple symptoms and signs, childhood OSAS cannot be reliably diagnosed without the use of polysomnography.
- Further considerations should include having at least one of the following:
    1. Sleep apnea
    2. Mouth breathing
    3. Laborious breathing
    4. Restless sleep
    5. Nocturnal enuresis
    6. Daytime drowsiness
    7. Attention deficit/hyperactivity
    8. Hypertension
    9. Excessive sweating during sleep
    10. Chronic non-rapid eye movement parasomnias
    11. Poor academic performance
- For young children, the following should receive clinical attention:
    1. Mouth breathing
    2. Repeated arousal
    3. Emotional and behavioral abnormalities
- Regarding physical signs, the following should be considered:
    1. adenoid hypertrophy
    2. tonsil hypertrophy
    3. adenoid face
    4. obesity
- Craniofacial morphology can be a basis for clinical suspicion if other clinical signs and symptoms are also present.

Context and considerations:

The recommendations above are based primarily on the evidence of symptoms and signs that occur with greater frequency. Some symptoms not included in the recommendations but observed in clinical practice (e.g. foaming at the mouth, prone position) are also worthy of clinical attention. Children with symptoms and signs of OSAS who are considered high-risk should be referred to a pediatric pulmonologist or sleep specialist if PSG is not readily available (Table 2). In addition, comprehensive assessment of the upper airway including the presence of allergic rhinitis, nasal septum deviation, nasopharyngeal mass, laryngeal space occupation, or tumor should be done.

Table 2. High-risk group (APPS, 2017)

Children with signs and symptoms of OSAS and considered high-risk should be referred to a pediatric pulmonologist/sleep specialist if PSG is not easily available.

- Aged < 3 years
- Obesity
- Chronic mouth breathing
- Syndromic or nonsyndromic craniofacial growth disorders
- Chronic gastroesophageal reflux
- Chronic upper airway allergies
- Trisomy 21
- Cerebral palsy
- Neuromuscular disorders
- Chronic lung disease
- Sickle cell disease
- Genetic/metabolic diseases

Review of evidence:

Author, Year	Study Design	Results
Fagundes et al. 2022	Meta-analysis N=9 studies	Due to the very low to moderate level of certainty, there is no sufficient evidence to support the presence or absence of association between OSAS and craniofacial features in children and adolescents such as mandibular retrognathia, reduced anteroposterior linear dimensions of the bony nasopharynx (decreased pharyngeal diameters at the levels of the adenoids), longer facial profile, and a narrower intercanine width.
Canto GDL, et al. 2014	Meta-analysis N=11 studies	The authors compared multiple physical examinations and questionnaires among four subgroups: questionnaire, questionnaire + physical examination, questionnaire + physical examination + other diagnostic methods, and physical examination + other diagnostic methods. Of the 11 included diagnostic tests, three assessed PSQ vs. PSG, PSQ + physical examination vs. PSG, and OSA-18 + physical examination + other diagnostic methods vs. PSG. The results suggested that the diagnostic accuracy of questionnaire-based assessment was insufficient to replace PSG or other objective examinations as an independent approach.

Certal et al. 2012	Meta-analysis N=10 studies	The findings suggested that, compared with PSG, clinical symptoms and signs are not effective for diagnosis of OSAS in 1,525 patients. Heterogeneity was observed among the included studies. Only six studies defined AHI > 1/h as the threshold for diagnosis of pediatric OSA; no study described identification of symptoms and signs, nor did any study assess the consistency between observers. The systematic review results suggested that tonsil hypertrophy and snoring were highly sensitive parameters, but were not specific for OSA; daytime sleepiness, apnea, and nocturnal dyspnea were highly specific parameters, but were not sensitive for OSAS. The sensitivity and specificity ranges of the seven assessed models (using combinations of symptoms and signs) were 4%−94% and 28%−99%, respectively. Area under the receiver operating characteristic curve (AUROC) results indicated that symptoms and signs have poor diagnostic ability for childhood OSAS. Therefore, compared with PSG, neither a single symptom/sign nor a combination of multiple symptoms and signs can effectively diagnose pediatric OSA; other diagnostic models are needed to improve the accuracy of diagnosis.

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CQ 2. What is the approach to the diagnosis of childhood OSAS?

1. Overnight Polysomnography

Key Recommendations:

Overnight Polysomnography (PSG) is the standard diagnostic method for childhood OSAS. The parameters monitored include but are not limited to the following:

- electroencephalogram derivations
- electrocardiogram tracing
- oxygen saturation
- end-tidal CO2 ($PETCO_2$)
- body positioning and movements
- stages of sleep
- apnea episodes (obstructive, mixed, and central)

Context and considerations:

The diagnostic criteria for childhood OSAS are shown in Table 3 and published in the International Classification of Sleep Disorders – Third Edition – Text Revision (ICSD3-TR), 2023. The diagnosis of childhood OSAS requires that criteria A-C must be met (Table 3). The current definition does not cover children younger than 1 year old as infants, especially those younger than 3 months, who have different types of breathing disorders during sleep.

Table 3. Diagnostic Criteria of Obstructive Sleep Apnea (Pediatric) based on the ICSD3-TR, 2023

Criteria A-C must be met

A. The presence of one or more of the following:
    1. Snoring
    2. Labored, paradoxical, or obstructed breathing during the child's sleep
    3. Sleepiness, hyperactivity, behavioral problems, or learning and other cognitive problems.

B. Polysomnography demonstrates one of the following:
    1. One or more obstructive apneas, mixed apneas, or hypopneas per hour of sleep.
    2. A pattern of obstructive hypoventilation, defined as at least 25% of total sleep time with hypercapnia ($PaCO_2$ > 50 mm Hg) in association with one or more of the following:
        a. Snoring.
        b. Flattening of the inspiratory nasal pressure waveform.
        c. Paradoxical thoracoabdominal motion.

C. The symptoms are not better explained by another current sleep disorder, medical disorder, medication or substance use.

Commonly used classifications of severity in children are as follows: Apnea-hypopnea index (AHI) of 1 to 4.9 events/hour suggesting mild OSA, 5 to 9.9 events/hour for moderate, and 10 and above events/hour for severe. AHI is the number of apneas and hypopneas per hour during sleep.

Review of Evidence:

Author, Year	Study Design	Results
Xu et al. 2016	Cross-sectional, n=1115 children with and without snoring	PSG was applied to children who met the diagnosed criteria of American Thoracic Society (ATS) (AHI > 5/h or OAI > 1/h) and who were between the International Classification of Sleep Disorders (ICSD) and ATS thresholds (OAHI ≥ 1/h, while AHI ≤ 5/h and OAI ≤ 1/h), and to children who met the ICSD criteria for primary snoring (OAHI < 1/h). The mean and longest durations of obstructive apnea were significantly longer in children between ICSD and ATS thresholds than in the ICSD primary snoring group ($P < 0.01$); moreover, LSaO2 was lower in children between ICSD and ATS thresholds than in the primary snoring group ($P < 0.05$). Children between ICSD and ATS thresholds demonstrated significant nocturnal symptoms, their daytime behavior was affected, and their PSG parameters were comparable to those of children with OSAS. Consequently, OAHI ≥ 1/h should be considered as the diagnostic threshold for childhood OSAS. This method is more conducive to the early identification of children with SDB who require care.
Brockmann et al. 2013	Systematic review, n=33 studies	The authors identified several index tests and compared their diagnostic test accuracy (DTA) to polysomnography in children. Sleep lab-based polygraphy, rhinomanometry, and urinary biomarkers showed excellent DTA. However, their apparently high DTA should be confirmed by subsequent studies. It was concluded that there is still insufficient evidence to recommend alternative tests to PSG for the diagnosis of childhood OSAS.

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2. Nocturnal pulse oximetry

Key Recommendations:

- Nocturnal pulse oximetry is an alternative to screen for OSA when PSG is not available.
- Only when OSAS is combined with substantial oxygen desaturation is nocturnal pulse oximetry an effective diagnostic tool.
- The McGill Oximetry score (MOS) was developed (see Table 4) to evaluate patients referred for investigation of possible OSA secondary to adenotonsillar hypertrophy. It has also been used to evaluate OSA in patients with Down syndrome (DS)
- Three or more desaturation clusters (defined as five or more desaturations to <90% occurring within 10 to 30 minutes) indicate a positive finding for childhood OSAS
- It requires a minimum of 4-6 hours of recording. Performing three nights of oximetry instead of one increases the screening yield for OSA

Context and considerations:

Pulse oximetry is a widely available simple tool. The McGill oximetry score (MOS) demonstrated low specificities and lower positive predictive values for children with comorbidities in a recent retrospective study. This is presumably due to the increased likelihood of oxygen desaturations in children with pre-existing low baseline oxygen saturations and the increased prevalence of co-existent non- obstructive desaturations in these cohorts of children.

Table 4. McGill Oximetry Scoring (APPS, 2017)					
Score	**Comment**	**Number of drops in SaO_2 <90%**	**Number of drops in SaO_2 <85%**	**Number of drops in SaO_2 <80%**	**Others**
1	Inconclusive for OSA	<3	0	0	Baseline: Stable (<3 clusters of desaturations) and >95%
2	Mild OSA	≥3	≤3	0	3 or more clusters of desaturation events
3	Moderate OSA	≥3	>3	≤3	3 or more clusters of desaturation events
4	Severe OSA	≥3	>3	>3	3 or more clusters of desaturation events

Review of evidence:

Author, Year	**Study Design**	**Results**
Gao et al. 2021	Meta-analysis n=20 studies	Meta-analysis showed a pooled sensitivity of 74% (95% confidence interval [CI]: 66–80%), pooled specificity of 90% (95% CI: 85–94%), and area under the receiver operating characteristic (AUROC) curve of 0.89 (95% CI: 24 0.86–0.92) for nocturnal pulse oximetry. The studies had moderate heterogeneity.
Galway et al. 2021	Cohort, n=329 children with suspected OSAS	On the initial screening night, 38% of 126 patients tested positive for OSA. When three nights of oximetry were performed, 195 patients (or 59%) tested positive at least once. There were 48 patients who underwent 4- to 6-hour studies on one or more evenings. Twenty patients (42%) would test positive for OSA on at least one night based solely on the scoring of these investigations.

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3. Pulse Transit Time

Key Recommendations:

- The pulse transit time arousal (PTT) index may be useful for the detection of respiratory events.
- Pulse transit time is the interval between the R wave of the electrocardiogram and the arrival of the photoplethysmographic pulse at the finger. The pulse transit time arousal index is defined as the frequency (number/hour) of a defined decrease in PTT which may serve as a marker for respiratory events and associated arousals which may occur in patients with OSA.

Context and considerations:

Pulse transit time has been used accurately to detect arousals and, when scored in combination with respiratory events, has been shown to more accurately reflect the PSG-determined AHI. Several studies in which PTT was used alongside PSG supported the potential of PTT to detect central apneic events in both infants and children and obstructive events in children, with implications for use as a screening tool for OSA, albeit with some limitations.

Review of evidence:

Author, Year	Study Design	Results
Yanney et al. 2020	Cross-sectional study, n= 521 children with sleep disordered breathing	PTT is more sensitive but less specific than oximetry. PTT arousal index of 16.06/ hour identified SDB with 85% sensitivity (95% C.I. 0.67–0.92) and 37 % specificity (95% C.I. 0.17–0.48). Oximetry identified SDB (OSA) with 38 % sensitivity (C.I. 0.31–0.46) and 98 % specificity (C.I. 0.97–1.00). The additional use of video and sound improved detection in twice as many children as oximetry alone.
Garcia T, et al 2019	Descriptive study n=137 patients under 18 with PSG	When PSG is not available, the ability of PTT index to discriminate severe OSA was acceptable while pulse oximetry has an almost perfect ability to discriminate severe OSA.
Smith et al. 2018	Systematic review, n=21 studies	In every study, PTT was utilized alongside polysomnography (PSG). Multiple studies supported the potential of PTT to detect central apneic events in

		neonates and children, as well as obstructive events in children, despite certain limitations. Only one study validated PTT against blood pressure, and only against systolic arterial pressure (SAP); significant negative correlations were found between PTT and SAP. PTT is straightforward to administer, economical to maintain, and more tolerable than alternative methods for measuring continuous blood pressure in children. However, its potential as a fundamental clinical instrument remains undetermined.
Bradley et al. 2012	Cohort study, n=51 children and adolescents with sleep disordered breathing	The study showed a significant correlation between the AHI and PTT ($r = 0.55$; p-value < .001). The relationship between the AHI and PTT was significantly better when the AHI was greater than 3. They also found significant correlations between the PTT and the total clinical score ($r = 0.38$; p-value= 0.008) and the examination score ($r = 0.44$; p-value=.002).
Katz et al. 2003	Cross-sectional study, n= 24 children with sleep disordered breathing and 10 controls	Apnea, hypopnea, and respiratory effort-related arousal events terminated in a PTT arousal were 91%, 83%, and 80% of the time. On the other hand, EEG arousal was 55%, 51%, and 43% (all $p < 0.05$), respectively. The PTT arousal index was significantly greater in children with UARS (6.8 events/h) than primary snoring (2.2 events/h) ($p < 0.05$). The authors concluded that in children, PTT arousals are a more sensitive measure of obstructive events than visible EEG arousals.

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4. Pediatric Sleep Questionnaires

Key Recommendations:

This position statement only considers the use of two questionnaires: the Pediatric Sleep Questionnaire (PSQ) and the OSA-18, which have been scientifically validated and are extensively used in a number of countries. However, PSQ and OSA-18 are not recommended as diagnostic tests for childhood OSAS when used alone. It is advised that a combination of

medical history, physical examination (PE), PO, and sleep monitoring data be used to enhance the specificity of questionnaire-based diagnosis especially if PSG is not available.

Context and considerations:

PSQ scores 22 items that investigate presence and intensity of snoring, presence of obstructive apneas and breathing difficulties, sleepiness and other symptoms that correlate with pediatric OSA. For children aged 2-18 years, the PSQ has good internal consistency with a sensitivity of 85 % and specificity of 87% for identifying children with sleep related breathing disorders. A Filipino (Appendix 1) and Cebuano (Appendix 2) translation of this questionnaire was created and validated.

The OSA-18 has 18 questions encompassing 5 domains: sleep disorder, physical distress, emotional distress, diurnal problems and caretaker preoccupation. It has a sensitivity of 40% and a negative predictive value of 73% for detecting an abnormal McGill oximetry score.

Review of evidence:

Author, Year	**Study Design**	**Results**
Wu et al. 2020	Meta-analysis n=39 studies	The PSQ showed the best sensitivity (74%) for detecting symptoms of mild childhood OSAS. The PSQ and pulse oximetry had similar high sensitivities in diagnosing moderate and severe childhood OSAS (82% and 89 % vs 83% and 83%, respectively). Pulse oximetry significantly had the best specificity in detecting mild, moderate, and severe childhood OSAS (86%, 75%, and 83%, respectively) compared to the PSQ and OSA-18 (all $p < 0.05$). Combined use of PSQ and pulse oximetry is recommended when polysomnography is not available.
De Luca et al. 2014	Meta-analysis n=11 studies	The authors compared multiple PE and questionnaires among four subgroups: questionnaire, questionnaire + PE, questionnaire + physical examination + other diagnostic methods, and PE + other diagnostic methods. Of the 11 included diagnostic tests, three assessed PSQ vs. PSG, PSQ + PE vs. PSG, and OSA-18 + physical examination + other diagnostic methods vs. PSG. The results suggested that the diagnostic accuracy of questionnaire-based assessment was insufficient to replace PSG or other objective examinations as an independent approach.

References:

Abonitalla R and Alvarez M. The prevalence and profiling of sleep disordered breathing as measured by SRBD-PSQ among children aged two-to- eighteen years old in Bgy. Sambag1,Cebu City, Philippines. Unpublished

Chervin RD, Hedger K, et al. Pediatric sleep questionnaire (PSQ): validity and reliability of scale for sleep disordered breathing, snoring, sleepiness, and behavioral problems. Sleep Med 2000;1: 21-32

Constantin E, Tewfik T, et al. Can the OSA-18 Quality of life questionnaire detect obstructive sleep apnea in children: Pediatrics 2010 125 (1): e162-e168.

De Luca Canto G, Pacheco-Pereira C, Aydinoz S, Major PW, Flores-Mir C, Gozal D. Diagnostic capability of questionnaires and clinical examinations to assess sleep-disordered breathing in children: a systematic review and meta -analysis. J Am Dent Assoc. 2014 Feb

Hasukic B. OSA-18 survey in evaluation of sleep disordered breathing in children with adenotonsillar hypertrophy. Med Arch 2013

Llobrera A and Dela Cruz B. Prevalence and risk factors of sleep related breathing disorders among grade school students in public school at Tala Caloocan City. Unpublished

Wu CR, Tu YK, Chuang LP, Gordon C, Chen NH, Chen PY, Hasan F, Kurniasari MD, Susanty S, Chiu HY. Diagnostic meta-analysis of the Pediatric Sleep Questionnaire, OSA-18, and pulse oximetry in detecting pediatric obstructive sleep apnea syndrome. Sleep Medicine Reviews. 2020 Dec 1; 54:101355.

5. Cephalometry

Key Recommendation:

Cephalometry can be used to assess adenoid hypertrophy.

Context and considerations:

Cephalometry is a standardized lateral radiographic view of the head incorporating skeletal and soft tissue structures and may be useful for the evaluation of pharyngeal airway size in selected cases.

Review of evidence:

Author, Year	Study Design	Results
Fagundes et al. 2022	Meta-analysis n=9 studies	This was done to assess the association between craniofacial features in children and adolescents with pediatric obstructive sleep apnea syndrome (OSAS). Five of nine studies did not show significant association while four studies reported significant findings but the level of certainty was low to moderate only. The meta-analysis showed no significant association between childhood OSAS diagnosis and cephalometric angles.

Reference:

Fagundes NC, Gianoni-Capenakas S, Heo G, Flores-Mir C. Craniofacial features in children with obstructive sleep apnea: a systematic review and meta-analysis. Journal of Clinical Sleep Medicine. 2022 Jul 1;18(7):1865-75.

6. Drug-induced sleep endoscopy (DISE)

Key Recommendations:

The performance and interpretation of DISE are subjective and based on practice variation. Therefore, it cannot be used alone to diagnose childhood OSAS in general. It may be used in those without tonsillar hypertrophy, at high risk for persistent OSAS, and cases of persistent OSAS after adenotonsillectomy (AT).

Context and considerations:

DISE is a diagnostic tool for evaluating the anatomical site of airway obstruction. There is a lack of consensus on its scoring system to define abnormality.

Review of evidence:

Author, Year	Study Design	Results
Baldassari et al. 2021	Expert consensus	A recent consensus statement made by experts in pediatric DISE through systematic reviews and Delphi survey identified the indications for DISE as the following: (1) children with OSAS and small tonsils, (2) children with persistent OSAS following AT, and (3) at the time of AT for children at high risk of persistent OSAS. Also, the authors of the consensus statement mentioned that there are several advantages to confirming the diagnosis and severity of OSAS by PSG prior to performing pediatric DISE: "Because a child who has infrequent obstructive respiratory events during PSG is unlikely to exhibit a repetitive obstructive breathing pattern during DISE, DISE was not felt to be appropriate for children with an AHI <2 events/hour. In addition, these children may be managed with watchful waiting or anti-inflammatory medications.".

Reference:

Baldassari CM, Lam DJ, Ishman SL, Chernobilsky B, Friedman NR, Giordano T, Lawlor C, Mitchell RB, Nardone H, Ruda J, Zalzal H. Expert consensus statement: pediatric drug-induced sleep endoscopy. Otolaryngology–Head and Neck Surgery. 2021 Oct;165(4):578-91.

7. Artificial Intelligence (AI) and Machine Learning (ML)

Key Recommendations:

AI and ML showed good reliability in predicting the following:

- severe childhood OSAS,
- candidates for AT
- those in need of postoperative overnight monitoring following AT.

Context and considerations:

Recent research has looked for ways to improve the diagnostic accuracy of pulse oximeters for OSA using other parameters that can be calculated from the pulse oximetry trace. One of which is AI, an umbrella term for computer software that mimics human cognition in order to perform complex tasks and learn from them. ML is a subfield of AI that uses algorithms trained on data. Applying machine learning approaches can detect OSA with increased sensitivity and specificity versus standard pulse oximetry trace.

Review of evidence:

Author, Year	Study Design	Results
Liu et al. 2022	Randomized controlled trial, n=323 children for AT	A data-driven analysis revealed that AT aids in reversing and preventing the progression of pathophysiological symptoms in children with OSAS. Using multiple pathophysiological markers in conjunction with machine learning, it is possible to gather more comprehensive data on childhood OSAS. Children with modest physiological and neurophysiological symptoms may be able to avoid AT, whereas children with upper airway obstruction symptoms following AT may have sleep-related hypoventilation disease, which warrants further investigation. In addition, the findings may help surgeons predict more precisely which children should undergo AT.
Gutiérrez-Tobal et al. 2021	Meta-analysis, n= 19 studies	The authors determined the reliability of artificial intelligence or machine-learning-based methods to detect childhood OSAS. They observed that machine learning improved diagnostic performance for AHI = 10 events per hour (sensitivity=0.652; specificity=0.931; and accuracy=0.940).
Bertoni et al. 2020	Cohort, n=190 children undergoing AT.	Combining oximetry and actigraphy in machine learning models improved the predictive accuracy to 87–89% for AHI > 2 and 95–96% for AHI > 10. The authors concluded that machine learning with oximetry and actigraphy identifies most children needing postoperative overnight monitoring as determined by polysomnographic severity of OSAS, supporting a potential screening pathway for children undergoing AT.

References:

Bertoni D, Sterni LM, Pereira KD, Das G, Isaiah A. Predicting polysomnographic severity thresholds in children using machine learning. Pediatric research. 2020 Sep;88(3):404-11.

Gutiérrez-Tobal GC, Álvarez D, Kheirandish-Gozal L, Del Campo F, Gozal D, Hornero R. Reliability of machine learning to diagnose pediatric obstructive sleep apnea: Systematic review and meta-analysis. Pediatric Pulmonology. 2022 Aug;57(8):1931-43.

Liu X, Pamula Y, Immanuel S, Kennedy D, Martin J, Baumert M. Utilisation of machine learning to predict surgical candidates for the treatment of childhood upper airway obstruction. Sleep and breathing. 2022 Jun 1:1-3.

8. Biomarkers

Key Recommendation:

There is no sufficient evidence to recommend the use of biomarkers in the diagnosis of childhood OSAS.

Context and considerations:

Although some studies have shown elevated levels of certain cytokines like HS-CRP, IL 17 and IL 23 in childhood OSAS, there is no sufficient evidence to recommend their use.

Review of evidence:

Author, Year	Study Design	Results
Huang et al. 2016	Case-controls n=79 children aged 4 to 12 years old.	An abnormal increase in interleukins 17 and 23 was associated with childhood OSAS. The authors recommend that further studies need to be done to validate the use of these diagnostic tools.
De Luca et al. 2015	Meta-analysis and Systematic Review n=1 study on children	The authors found only one study done in 2009 among children (n=60) which assessed the utility of biomarkers in diagnosing OSA. Kallikrein-1, uromodulin, urocortin- 3 and orosomucoid-1 were deemed to have enough accuracy (75%) to be used as a OSA diagnostic test in children when used in combination with history and physical examination. However, these findings are not validated in future studies.

References:

De Luca Canto G, Pacheco-Pereira C, Aydinoz S, Major PW, Flores-Mir C, Gozal D. Diagnostic capability of biological markers in assessment of obstructive sleep apnea: a systematic review and meta-analysis. Journal of Clinical Sleep Medicine. 2015 Jan 15;11(1):27-36.

Huang YS, Guilleminault C, Hwang FM, Cheng C, Lin CH, Li HY, Lee LA. Inflammatory cytokines in pediatric obstructive sleep apnea. Medicine. 2016 Oct;95(41).

9. Watch-PAT (Peripheral Arterial Tonometry) and Smart Phone Applications

Key Recommendations:

There remains an evidence gap in the utility and accuracy of these devices in the diagnosis of childhood OSAS. Larger studies designed for children across all age ranges are still needed.

Context and considerations:

Watch-PAT is an innovative home sleep apnea device that utilizes peripheral arterial signal for OSA diagnosis. A study has shown that children with Watch-AHI (W-AHI) ≥ 10 had a high specificity for the diagnosis of severe OSA.

Certain smartphone applications were created to detect screen and diagnose sleep apnea. However there remains an evidence gap in the utility and accuracy of these devices in the diagnosis of childhood OSAS.

Review of Evidence:

Author, Year	Study Design	Results
Tanphaichitr A, et al. 2018	Prospective diagnostic study N=36 children aged 8 to 15 years	From the ROC curve constructed to assess PAT diagnostic capability, W-AHI at a cutoff of 3.5 events/h provided the highest accuracy (76.9% sensitivity, 78.3% specificity), while W-AHI at 10 events/h yielded 91.3% specificity for diagnosing severe OSA.

References:

Garde AJ, Gibson N, et al. Advances in paediatric sleep disordered breathing. Breathe 2022; 18: 220151

Giuca MR, Carli E, Lardani L, Pasini M, Miceli M, Fambrini E. Pediatric obstructive sleep apnea syndrome: emerging evidence and treatment approach. The Scientific World Journal. 2021 Apr 23;2021.

Tanphaichitr A, et al. Watch Peripheral Arterial Tonometry in the Diagnosis of Pediatric Obstructive Sleep Apnea Otolaryngol Head neck Surg 2018 Jul

Thomas RJ, et al. Smartphone videos to predict the severity of obstructive sleep apnoea. Arch Dis Child Feb 2022; 107 (2):148-152

10. Respiratory Polygraphy (RP)

Key Recommendations:

The American Academy of Sleep Medicine in its position paper do not recommend the use of home sleep apnea test (HSAT) which do not include EEG or end-tidal or transcutaneous CO_2 monitoring in the diagnosis of childhood OSAS.

It is necessary for a patient with suspected OSAS but with a negative RP to perform PSG for further diagnostic evaluation. Apnea-hypopnea index is underestimated in RP and the disparity in AHI-RP and AHI-PSG can significantly affect clinical management decisions, particularly in children with mild and moderate OSA. Among patients where the probability of OSAS is high, RP may be sufficient for screening childhood OSAS. More research is recommended to assess its diagnostic utility in children.

Context and Considerations:

Overnight respiratory polygraphy is a type 3 portable monitor and represents a continuous recording during the night of several parameters: nasal airflow, thoracic and abdominal movements, heart rate and oxygen saturation. It can also be performed at home. Unlike PSG, RP does not include EEG, so it cannot differentiate between awake and sleep periods and therefore the number of apneas and hypopneas must be divided by the total recording time instead of total sleep time (TST). This results in systematic underestimation of AHI so RP tends

to underestimate OSAS diagnosis and severity. Unlike PSG, RP doesn`t measure the CO_2, so it cannot distinguish if a low SpO_2 is related to hypoventilation.

One study concluded that RP was more useful for screening patients with highly suspected moderate to severe OSAS. Another study demonstrated some agreement between RP and PSG in measuring AHI however the sample size was small. Despite all the studies performed till now, more research is required to assess the utility of RP for the diagnosis of OSAS in children.

Review of Evidence:

Author, Year	**Study Design**	**Results**
Gudnadottir G et al., 2019	Randomized controlled trial n=113 children aged 4 to 10 years old	Smaller children have difficulties in accepting the nasal cannula, so that will influence the results of RP. Majority of home RP done in the study were unsuccessful and this was due to the loss of the nasal flow signal.
Tan HL et al., 2014	Cohort n=100 children	100 children who were assessed for possible OSA and underwent PSG were identified. EEG, EOG and EMG channels were deleted from their original unscored PSG recordings to transform them into RP and then rescored in random sequence. Analysis showed that in lab RP underestimated the AHI despite more accurate estimates of TST. This underestimation was due to missed hypopneas causing arousals without desaturation. Basing the therapeutic management decision on RP instead of PSG results changed the clinical management in 23% of all patients.

References:

Chiner E, Canovas C, Molina V, et al. Home respiratory polygraphy is useful in the diagnosis of childhood obstructive sleep apnea syndrome. Journal of Clinical medicine 2020, 9(7), 2067

Gudnadottir G, Hafsten L, Redfors S, et al. Respiratory polygraphy in children with sleep-disordered breathing. Journal of Sleep Research. 2019 December; 28(6)

Hammoudi L, Heraut F, Bour F, et al. Respiratoty polygraphy versus polysomnography for the diagnosis of obstructive sleep apnoeas in children. European respiratory Journal 38 (2011)

Kirk V, Baughn J, D` Andrea L, et al. American academy of sleep medicine position paper for the use of home sleep apnea test for the diagnosis of OSA in children. J Clin Sleep Med 13, 1199-1203 doi:10.5664/jcsm.6772

Tan HL, Gozal D, Ramirez H, Bandla H, Gozal L. Overnight polysomnography versus respiratory polygraphy in the diagnosis of pediatric obstructive sleep apnea. Sleep volume 37, Issue 2, 1 February 2014

Tiboc C, Man S, Sas V, Filip G. Home respiratory polygraphy-An alternative for the diagnosis of Pediatric Obstructive Sleep Apnea Syndrome. Journal of Pediatrics, Perinatology and Child Health. January 2019

Zucconi M, Calori G, Castronovo V et al. Respiratory monitoring by means of unattended device in children with suspected uncomplicated obstructive sleep apnea: a validation study. Chest 124 (2003): 602-607

CQ 3. What are the complications associated with untreated childhood OSAS?

Key Recommendations:

There is limited evidence on the complications of untreated childhood OSAS because of the available study designs. However, it is recommended that childhood OSAS be diagnosed and treated early as it may lead to cardiovascular conditions, impaired neurocognitive performance and behavioral functioning, metabolic disorders, growth impairment, excessive daytime sleepiness, and nocturnal enuresis.

1. Cardiovascular conditions

Context and Considerations:

Childhood OSAS has been associated with higher risk for cardiovascular morbidities. It has been reported that children with OSA have increased prevalence of systemic hypertension, cardiomyopathy, left ventricular hypertrophy and higher QT dispersion on electrocardiogram. The increase in sympathetic nerve activation in response to hypoxia and hypercapnia that occur secondary to airway obstruction may contribute to the development of the cardiovascular complications.

Review of evidence:

Childhood OSAS was significantly associated with increased blood pressure, childhood hypertension and major cardiovascular events. The presence of a significant risk for cardiovascular diseases in childhood OSAS was also supported by a scientific statement by the American Heart Association (AHA, 2021).

Author, Year	**Study Design, Country, Sample**	**Results**
Ai et al. 2022	Meta-analysis n= 14 studies	Mean systolic blood pressure was significantly higher in children with mild or moderate-to-severe OSAS compared to the healthy controls. Moderate-to-severe childhood OSAS was associated with a risk of elevated systolic blood pressure when they become adults (Mean Difference = 4.02 mm Hg, 95% CI = 1.32 to 6.72).
Chuang et al. 2021	Cross-sectional Taiwan n=396 children with OSAS aged 2 to 17 years	Severe OSAS (OR=2.38, 95%CI=1.48–3.81) was an independent predictor of pediatric hypertension.
Tzeng et al. 2019	Cohort Taiwan n=6,535 children and adolescents (<20 years) with OSAS and 19,605 without OSAS	The risk of major adverse cardiovascular events among children and adolescents with OSAS was significantly higher than those with OSAS (HR= 2.0, 95%CI=1.3–3.1).

References:

Ai S, Li Z, Wang S, Chen S, Chan JW, Au CT, Bao Y, Li AM, Zhang J, Chan KC, Wing YK. Blood pressure and childhood obstructive sleep apnea: A systematic review and meta-analysis. Sleep Medicine Reviews. 2022 Aug 20:101663.

Baker-Smith CM, Isaiah A, Melendres MC, Mahgerefteh J, Lasso- Pirot A, Mayo S, Gooding H, Zachariah J. Sleep Disordered breathing and cardiovascular disease in children and adolescents. A scientific statement from the American heart Association. Journal of American Heart Association 2021

Capdevila O.S. et al. Pediatric obstructive sleep apnea: complications, management, and long-term outcomes. Proc. Am. Thorac. Soc (2008)

Chuang HH, Hsu JF, Wang CY, Chuang LP, Chen MC, Chen NH, Huang YS, Li HY, Lee LA. Hypertension in Children with Obstructive Sleep Apnea Syndrome—Age, Weight Status, and Disease Severity. International Journal of Environmental Research and Public Health. 2021 Sep 12;18(18):9602.

Hoorenbeeck, K.V et al Metabolic Complications and Obstructive Sleep Apnea in Obese Children: Time to Wake Up! American Journal of Respiratory and Critical Care Medicine Jan 2014

Tzeng NS, Chung CH, Chang HA, Chang CC, Lu RB, Yeh HW, Chiang WS, Kao YC, Chang SY, Chien WC. Obstructive sleep apnea in children and adolescents and the risk of major adverse cardiovascular events: a nationwide cohort study in Taiwan. Journal of Clinical Sleep Medicine. 2019 Feb 15;15(2):275-83.

Verhulst, S.L et al. Sleep Disordered breathing and the metabolic syndrome in overweight and obese children and adolescents. The Journal of Pediatrics 2007 June

2. Reduced Neurocognitive performance

Context and Considerations:

SDB has been associated with different forms of neurocognitive consequences in children. Intermittent hypoxia and sleep fragmentation may lead to inflammation, autonomic dysregulation, endothelial dysfunction and oxidative stress leading to reduced school performance, hyperactivity, inattention and behavioral and cognitive deficits.

Review of evidence:

Childhood OSAS was significantly associated with decreased neurocognitive performance. However, this does not necessarily translate to a diagnosis of delayed neurocognitive development since the performance of children with OSAS remain within normal range.

Author, Year	Study Design	Results
Menzies et al. 2022	Meta-analysis n= 15	In children with mild OSAS cognitive deficits were found in two domains: Performance intelligence quotient (IQ) (-0.15, 95%CI= -0.29 to -0.01), and visual-spatial skills (-0.22, 95%CI= -0.35 to -0.09). The studies investigating children with

	studies	moderate OSAS revealed significantly lower scores for Full-scale IQ (-0.38, 95%CI= -0.64 to -0.11), Verbal IQ (-0.33, 95%CI= -0.58 to -0.08), Performance IQ (-0.27, 95%CI= -0.54 to 0.00), problem-solving (-0.41, 95%CI= -0.65 to -0.16), language (-0.24, 95%CI= -0.45 to -0.02), and visual-spatial skills (-0.31, 95%CI= -0.55 to -0.07) but not attention, working memory, inhibition, processing speed or verbal memory.
Mohammed et al. 2021	Systematic Review n= 5 studies	Speech and language difficulties are common in children with OSAS, in addition to neurocognitive and/or neurobehavioral issues.
Cardoso et al. 2018	Systematic review n= 34 studies	Overall, there is evidence supporting the association between decreased intellectual performance and childhood OSAS. However, there is no sufficient evidence to conclude that childhood OSAS can lead to neurocognitive disorders since intellectual performance, although decreased, remains within average range. There is no consistent evidence that childhood OSAS negatively affects attention, memory, executive functions, or language.

References:

Brockmann, P.E, Gozal, D Neurocognitive Consequences in Children with Sleep Disordered Breathing: Who is at risk? Children 2022, 9,1278

Cardoso TD, Pompéia S, Miranda MC. Cognitive and behavioral effects of obstructive sleep apnea syndrome in children: a systematic literature review. Sleep Medicine. 2018 Jun 1; 46:46-55.

Menzies B, Teng A, Burns M, Lah S. Neurocognitive outcomes of children with sleep disordered breathing: A systematic review with meta-analysis. Sleep Medicine Reviews. 2022 Mar 31:101629.

Mohammed D, Park V, Bogaardt H, Docking K. The impact of childhood obstructive sleep apnea on speech and oral language development: a systematic review. Sleep Medicine. 2021 May 1; 81:144-53.

Urbano, G.L. et al, The Link between Pediatric OSA and Attention Deficit hyperactivity Disorder. Children (Basel) 2021

3. Behavioral disorders

Context and Considerations:

Attention deficit hyperactivity disorder (ADHD) specifically has been linked to OSA in children and research has shown that children with SDB particularly OSA display ADHD symptoms more often than those without SBD symptoms. Studies which have linked ADHD and OSA do share other common mitigating factors that may contribute to both conditions. Sleep deprivation, either as fragmented sleep or as reduced total sleep time has also been linked to worse OSA symptoms as well as more severe ADHD behaviors.

The underlying etiological mechanisms for the relationship between depressive symptoms and OSA remain poorly understood, although there are several possible explanations.

OSA is associated with blood oxygen desaturation, which may cause micro-awakenings at night, decrease the slow wave stage, and cause restless sleep, thus leading to daytime fatigue and depressive symptoms. Hypoxia from desaturation and hormonal changes might also lead to structural changes in the brain that in turn lead to depressive symptoms.

Review of evidence:

Childhood OSAS was significantly associated with ADHD and depressive symptoms.

Author, Year	**Study Design**	**Results**
Sedky et al. 2014	Meta-analysis n= 18 studies	A meta-analysis was undertaken to assess the association between SDB and ADHD symptoms in children and to determine whether there is improvement in ADHD symptoms after AT. The authors observed a significant relationship between ADHD symptoms and SDB (Hedges' g = 0.57, 95% CI: 0.36–0.78; p = 0.000001). They also observed a decrease in ADHD symptoms at 2–13 months post-surgery (Hedges' g = 0.43, 95% CI: 0.30–0.55; p < 0.001). The authors recommended that patients with ADHD symptoms should receive SDB screening.
Yilmaz et al. 2013	Meta-analysis n= 11 studies	A meta-analysis was conducted to determine the association between depressive symptoms and childhood OSAS. The authors found a significant association between depressive symptoms and OSAS (Hedges' g = 0.43, 95% CI: 0.22-0.64; p = 0.0005). Also, significant improvement in depressive symptoms was found at follow-up after adenotonsillectomy (Hedge's g = 0.41, 95% CI: 0.20-0.62; p < 0.001). The authors recommended that patients with depressed symptoms should be screened for sleep breathing disorders and that the treatment of OSAS with AT may reduce clinical symptoms of depression.

References:

Sedky K, Bennett DS, Carvalho KS. Attention deficit hyperactivity disorder and sleep disordered breathing in pediatric populations: a meta-analysis. Sleep Med Rev. 2014 Aug 1;18(4):349-56.

Urbano, G.L. et al, The Link betweeen Pediatric OSA and Attention Deficit hyperactivity Disorder. Children (Basel) 2021

Yilmaz E, Sedky K, Bennett DS. The relationship between depressive symptoms and obstructive sleep apnea in pediatric populations: a meta-analysis. Journal of Clinical Sleep Medicine. 2013 Nov 15;9(11):1213-20.

Yimar, E, et al. The relationship between Depressive symptoms and obstructive sleep Apnea in pediatric populations: A meta-analysis. Journal of Clinical Sleep Medicine. 2013 Nov 15

4. Metabolic disorders

Context and Considerations:

High fasting insulin levels and increased BMI during childhood are strong predictors of metabolic syndrome in adulthood and children with insulin resistance. Mechanism by which SDB may disturb metabolic control include increased sympathetic activity, higher serum cortisol

levels, the formation of reactive oxygen species resulting in increased inflammation and impairment of glucose tolerance and appetite regulation resulting from secondary sleep debt.

Review of evidence:

Childhood OSAS increases the risk for dyslipidemia and insulin resistance especially among obese children.

Author, Year	Study Design	Results
Patinkin et al. 2017	Systematic review (n=16) and Meta-analysis (n= 10 studies)	Among obese adolescents, OSAS was significantly associated with dyslipidemia (Hedges' g = 0.29, 95% CI: 0.07-0.52; p = 0.02) and insulin resistance (Hedges' g = 0.78, 95% CI: 0.25-1.31; p = 0.02). The authors also compared patients with and without OSAS all eight metabolic indicators (triglycerides, total cholesterol, HDL-C, HOMA-IR, SBP, DBP, ALT, and AST) and a statistically significant association was found (g = 0.44, 95% CI = 0.15–0.73, p < 0.01).

References:

Patinkin ZW, Feinn R, Santos M. Metabolic consequences of obstructive sleep apnea in adolescents with obesity: a systematic literature review and meta-analysis. Childhood Obesity. 2017 Apr 1;13(2):102-10.

Hoorenbeeck, K.V et al Metabolic Complications and Obstructive Sleep Apnea in Obese Children: Time to Wake Up! Americal Journal of Respiratory and Critical Care Medicine Jan 2014

Verhulst, S.L et al. Sleep Disordered breathing and the metabolic syndrome in overweight and obsessed children and adolescents. The Journal of Pediatrics 2007 June

5. Growth impairment

Context and Considerations:

Several mechanisms have been proposed to explain growth retardation in children with OSA. Among them are the presence of systemic inflammation that is well documented in children with OSA and dysphagia from hypertrophied tonsils which obstructs food entry, thus reducing caloric intake. Hyperactive behavior which results in increased motor activity increases energy expenditure, thus contributing to growth failure. Another possible mechanism is interruption of sleep architecture that interferes with growth hormone secretion.

Review of evidence:

OSAS impairs growth in children.

Author, Year	Study Design	Results
Zhang et al. 2014	Case-control twin studies	Before adenotonsillectomy (AT), the OSAS group had lower height and weight than the control group. Height and weight increased during the follow-up period after

	(n=17 pairs)	treatment, but at a slower rate than the control group. Prior to AT, serum levels of insulin-like growth factor 1 were lower in the OSAS group than in the control group. The level increased significantly three months after AT.

References:

Capdevila O.S. et al. Pediatric obstructive sleep apnea: complications, management, and long-term outcomes. Proc. Am. Throc. Soc (2008)

Nachalon Y et al. Inflammation and growth in young children with obstructive sleep apnea syndrome before and after adenotonsillectomy. Mediators Inflamm. 2014

Shan S et al. Effects of adenotonsillectomy on growth and comprehensive cognitive abilities of children with OSA. A prospective single arm study. BMC Pediatr 22, 41 (2022)

Zhang XM, Shi J, Meng GZ, Chen HS, Zhang LN, Wang ZY, Wu H. The effect of obstructive sleep apnea syndrome on growth and development in nonobese children: a parallel study of twins. The Journal of pediatrics. 2015 Mar 1;166(3):646-50.

6. Nocturnal enuresis

Context and considerations:

Studies have shown that approximately 10%-40% of children with OSAS have enuresis. The underlying mechanism has not been elucidated but several mechanisms have been discussed. Children with OSA have increased negative intrathoracic pressure because of increased inspiratory effort during sleep. The continual swing in intrathoracic pressure causes cardiac distension that can lead to release of atrial natriuretic peptide, triggering enuresis. Other scholars report that an increased awakening threshold during sleep cause enuresis.

Review of evidence:

Childhood OSAS increases the risk for nocturnal enuresis

Author, Year	Study Design	Results
Shafiek et al. 2019	Cross sectional (n=54 children)	In 54 children with nocturnal enuresis, 68.5% had OSAS with median obstructive AHI of 6.1 (3.7–13.2) episodes/h, median oxygen saturation of 97% and nadir of 88%. The authors concluded that nocturnal enuresis is commonly associated with OSAS especially in obese children.
Su et al. 2018	Systematic review (n=12 studies)	There is evidence from published studies that the risk of nocturnal enuresis in children with OSAS was greater than that of their healthy peers. This elevated risk may be linked to sleep disturbances, bladder instability, detrusor hyperactivity, nocturnal polyuria, endocrine and metabolic abnormalities, and inflammation.

References:

Kuwertz-Bröking E, Von Gontard A. Clinical management of nocturnal enuresis. *Pediatr Nephrol* 2017

Nevéus T. The role of sleep and arousal in nocturnal enuresis. *Acta Paediatr* 2003; 92: 1118–1123.

Shafiek H, Evangelisti M, Abd-Elwahab NH, Barreto M, Villa MP, Mahmoud MI. Obstructive sleep apnea in school-aged children presented with nocturnal enuresis. Lung. 2020 Feb; 198:187-94.

Su MS, Li AM, So HK, et al. Nocturnal Enuresis in Children: Prevalence, Correlates, and Relationship with Obstructive Sleep Apnea. *J Pediatr* 2011; 159: 238–242.e1.

Sun, Chen et al. Relationship between enuresis and obstructive sleep apnea-hypopnea syndrome in chidren. J Int Med Res 2020, Dec

Tsai JD, Chen HJ, Ku MS, et al. Association between allergic disease, sleep-disordered breathing, and childhood nocturnal enuresis: a population-based case-control study. *Pediatr Nephrol* 2017; 32:

7. Parasomnias

There is an evidence gap in the association between parasomnias and childhood OSAS.

Context and considerations:

Sleepwalking, sleep terrors, and sleep talking are parasomnias associated with arousal that usually occur during the first third of sleep. There have only been few studies investigating parasomnias in children with OSA. One study reported that pre-adolescent children with SDB experienced more parasomnias than those without SDB. More studies designed for children are still needed.

References:

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CQ 4. What are the approaches to treatment for childhood OSAS?

1. Surgical

1.a. Adenotonsillectomy (AT)

Key Recommendations:
AT is the first line of treatment for children with OSAS who have adenoid and/or tonsil hypertrophy and do not have surgical contraindications.

Context and considerations:
AT is the primary treatment for children diagnosed with OSAS due to enlarged adenoids and tonsils and in the absence of any surgical contraindication.
A follow up is required after six to eight weeks post AT. This is to re-assess if the signs and symptoms of OSAS have completely or partially resolved. Repeat PSG is indicated for those with persistent signs and symptoms of upper airway obstruction, those at high risk with co-existing cardiac comorbidities, congenital syndromes, craniofacial deformities, neurologic disorders and those with severe OSA on preoperative PSG.

Watchful waiting for 6 months and supportive care is a reasonable approach for otherwise healthy children with mild and moderate forms of OSAS and for those with surgical contraindication. Supportive care entails medical management in controlling symptoms of coexisting comorbidities such as asthma and allergic rhinitis. This approach was based on the outcomes for children 5-9 years old who were followed with watchful waiting in the Childhood Adenotonsillectomy Trial (CHAT) and a similar trial in younger children 2-4 years old. In both studies, adenotonsillectomy compared with watchful waiting with supportive care (WWSC) led to better improvement in daytime behavior, sleep apnea symptoms, and subjective sleepiness and quality of life. Normalization of polysomnographic findings was observed in a larger proportion of children 5-9 years old who had early adenotonsillectomy group compared to WWSC (79% vs 46%). On the other hand, there were only small differences in the mean OAHI score change between AT and WWSC in children 2-4 years old . A subgroup analysis of children 2 to 4 years old with moderate OSA showed a meaningful difference in mean OAHI score change in favor of AT which suggest that children in this age group with moderate OSA should be considered for AT. Limitation of both studies is the short follow up period. Additional research is required.

If watchful waiting is to be observed, the child should be reevaluated clinically within six months or reevaluated sooner if symptoms worsen.

Review of evidence:

Author, Year	Study Design	Results
Kang et al. 2021	Meta-analysis n=12 studies	The apnea-hypopnea index significantly reduced by 9.4 events/h (95% CI, −12.0 to −6.8) after AT. Office systolic blood pressure (−0.24 mmHg; 95% CI, −1.64 to 1.16) and diastolic blood pressure (−1.65 mmHg; 95% CI, −3.47 to 0.17) did not decrease significantly after surgery. No significant decreases were observed in 24-h ambulatory blood pressure after TA.
Lin et al. 2020	Network meta-analysis n=14 studies	AT + pharyngoplasty (ranking score= 95.1%) was ranked as the best intervention in reducing AHI, followed in order by AT (72.4%), LTRAs (64.4%), antimicrobial therapy (63.9%), adenotonsillotomy (57.7%), steroids (47.3%), rapid maxillary expansion (44.9%), and steroids + LTRAs (23.6%). LTRAs (71.9%), steroids (67.5%), and adenotonsillectomy (66.4%) were ranked as better interventions than adenotonsillotomy (50%) in reducing ODI. RME (77%), surgical interventions (adenotonsillotomy at 78.2%, AT at 75%, AT + pharyngoplasty at 73.5%), and LTRAs (70.1%) ranked better than the other interventions in improving lowest SaO2.
Fehrm et al. 2020	RCT, n=60 children with OSAS	This randomized clinical trial found only minor differences between the groups in terms of OAHI changes, but additional research is required. However, after AT, there were significant improvements in quality of life. These findings imply that otherwise healthy children with mild OSA and a mild impact on quality of life may benefit from cautious waiting, whereas children with moderate OSA should be considered for AT.
Lee et al. 2019	Meta-analysis n=6 studies	The mean change in the AHI among Children with Prader-Willi Syndrome (PWS)who had OSAS was a significant reduction of 8.0 events per hour (95% CI, −10.8 to −5.1). The overall success rate was 21% (95% CI, 11%-38%) for a postoperative AHI <1 and 71% (95% CI, 54%-83%) for a postoperative AHI <5. AT was associated with OSAS improvement among children with PWS.
Scheffler et al. 2019	Meta-analysis n=11 studies	Improvements in the following were observed: apnea-hypopnea index (22.9 to 8.1 events/h, p-value<0.001), respiratory disturbance index (24.8 to 10.4 events/h, p-value<0.001), and oxygen saturation nadir (78.4% to 87.0%, p-value<0.001). Persistent OSAS ranged between 51% to 66%.
Todd et al. 2017	Meta-analysis n= 3 studies	In the preoperative versus short-term and long-term comparisons, all five quality of life subdomains (sleep disturbance, physical symptoms, emotional distress, daytime function, and caregiver concerns) and the total score significantly improved (MD for short-term outcomes=37.70, 95% CI= 28.65 to 46.74, p-value<0.001) (MD for long-term outcomes=33.65, 95% CI= 27.76 to 39.53, p-value<0.001).
Yu et al. 2017	Meta-analysis n=11 studies	The effect sizes of general intelligence, memory, attention-executive function, and verbal ability after AT compared to baseline level were –0.37 (p-value=0.008), –0.36 (p-value=0.0005), –0.02 (p-value=0.88), and –0.45 (p-value=0.009), respectively. Comparing the cognitive ability between OSAS children after AT and healthy controls showed that the effect sizes were –0.54 (p-value=0.0009), –0.24 (p-value=0.12), –0.17 (p-value=0.35), and –0.45 (p-value=0.009) in general intelligence, memory, attention-executive function, and verbal ability, respectively. After 6–12 months of observation, significant improvement in attention-executive function and verbal ability were found in OSAS children treated with AT compared to their baseline level; restoration of attention-executive function and memory were observed in OSAS children after AT in comparison to healthy controls.
Marcus et al. 2013	RCT, n=464 children with OSAS	The change from baseline to follow-up Developmental Neuropsychological Assessment scores did not differ significantly between the two groups (mean [±SD] improvement, 7.1±13.9 in the early-AT group and 5.1±13.4 in the watchful-waiting group; p-value=0.16). In contrast, there were significantly greater improvements in behavioral, quality-of-life, and polysomnographic findings and significantly greater

		reduction in symptoms in the early-AT group than in the watchful-waiting group. Normalization of polysomnographic findings was observed in a larger proportion of children in the early-AT group than in the watchful-waiting group (79% vs. 46%).

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1.b. Adjuvant surgical procedures

Key Recommendations:

Surgical procedures other than adenotonsillectomy are sometimes considered in children with OSAS without significant adenotonsillar hypertrophy, or with residual OSA. These adjuvant surgical procedures may also be beneficial in patients with a high probability that OSA is due to factors other than adenotonsillar hypertrophy alone. They include the following:

- tongue base procedures
- hypoglossal nerve stimulation
- expansion sphincter pharyngoplasty
- lateral pharyngoplasty
- tracheostomy

Context and Considerations:

These adjuvant surgical procedures can alleviate the other sites of the upper airway obstruction aside from the existing adenotonsillar hypertrophy.

Tracheostomy is an uncommon treatment approach for childhood OSA. It is reserved surgical treatment approach for severe childhood OSAS mostly associated with syndromes, and those who have treatment failure with all other surgical and medical measures.

Review of evidence:

Author, Year	**Study Design**	**Results**
Liu et al. 2022	Meta-analysis n=9 studies	The pooled AHI was significantly lower in patients following hypoglossal nerve stimulation (mean AHI reduction 17.43 events/h, 95% confidence interval 13.98–20.88 events/h, p< 0.001). The pooled OSA-18 were significantly decreased in 88 patients after treatment (mean OSA-18 reduction 1.67, 95% confidence interval 1.27–2.08, p< 0.001). The most common adverse event was pain or discomfort in the tongue or mouth.
Fray et al. 2018	Systematic review n=11 studies	A total of 196 patients underwent tracheostomy. Apnea/hypopnea index showed a 97% decrease (n = 2) and apnea index showed a 98% decrease (n = 3). Lowest oxygen saturation showed a significant reduction by 34 points (n = 3). All identified patients in the studies were syndromic, had significant co-morbidities or had severe OSAS.
Camacho et al. 2017	Meta-analysis n=11 studies	The pre- and post-tongue reduction surgeries decreased apnea–hypopnea index (AHI) from a mean (M) and standard deviation (SD) of 16.9 ± 12.2/h to 8.7 ± 10.6/h (48.5% reduction) in 114 children with OSAS. Also, those with a body mass index <25 kg/m^2 and non-syndromic children have had the greatest improvement in AHI after tongue reduction surgery.
Ulualp et al. 2014	Cohort, n=25 children with OSAS	The average (SD) postoperative AHI of the modified expansion sphincter pharyngoplasty (ESP) group (2.4 [3.9]) was lower than that of the TA group (6.2 [6.0]) (P < .001). Cure rates for the modified ESP group (AHI <1, 64%; AHI <2, 72%; and AHI <5, 80%) were significantly higher than those for the TA group (AHI <1, 8%; AHI <2, 44%; and AHI <5, 60%).
Wootten et al. 2010	Cohort, n=31 children and young adults with OSAS	The overall success rate of Combined genioglossus advancement and radiofrequency ablation was 61% (19 of 31). Overall, the mean apnea-hypopnea index improved from 14.1 to 6.4 events per hour (P < .001); the mean nadir oxygen saturation as measured by pulse oximetry during apnea improved from 87.4% to 90.9% (P = .07).

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2. Non-surgical

2.a. Positive Airway Pressure

Key Recommendations:

Continuous Positive Airway Pressure (CPAP) and Bilevel Positive Airway Pressure (BiPAP) can be considered as second line treatment modality in the following:

- moderate/severe OSAS after surgery
- severe preoperative OSAS with coexisting morbidities such as cor pulmonale, morbid obesity, neuromuscular disorders, and craniofacial abnormalities
- mild OSAS with minimal adenotonsillar tissue
- strong preference for a nonsurgical approach

Context and Considerations:

Positive Airway Pressure (PAP) acts as a pneumatic splint that maintains the patency of the upper airway during sleep. CPAP delivers a fixed pressure while a BiPAP has a dual pressure setting namely Inspiratory Positive Airway Pressure (IPAP) and Expiratory Positive Airway Pressure (EPAP). BiPAP is recommended for patients who cannot tolerate high pressure on CPAP and for cases of hypoventilation syndromes.

PAP therapy can be considered for short term use on patients waiting for surgical intervention, while prolonged use is expected for persistent OSAS. A minimum of 4 hours/night and 5 days a week use of PAP treatment is required to be clinically effective.

Another PAP therapy which was introduced recently was Nasal Expiratory Positive Airway Pressure (NEPAP). It is a device with two adhesive valves applied to both nares. It has a promising potential use in the future as an alternative PAP therapy. However, no

recommendation can be made at this time, due to insufficient evidence supporting its use in childhood OSAS.

High-flow nasal cannula (HFNC) has generated interest as an alternative PAP treatment. Limited number of heterogeneous and uncontrolled titration studies documented that HFNC improves OAHI and minimum oxygen saturation in childhood OSAS. However, additional research is required on the long-term effectiveness and adherence among the different pediatric age groups.

Review of evidence:

Author, Year	**Study Design**	**Results**
Du et al. 2022	Meta-analysis n= 6 studies	There was a statistically significant reduction in OAHI with HFNC therapy (MD: 15.58 95% CI: 8.30, 22.86 p=0.001). Also, OHI (MD: 12.35 95% CI: 0.78, 23.92 I2=98% p=0.04) and OAI (MD: 7.54 95% CI: 2.10, 12.98 I2=79% p=0.007) were significantly reduced with HFNC treatment. HFNC led to statistically significant improvement in SPO2 nadir values (MD: -8.17 95% CI: -10.40, -5.94 I2=21% p<0.00001).
Benke et al. 2021	Cohort n= 19 children aged 5 to 15 years children	The median OAHI was 12.3/h on baseline PSG and the 30-day auto-titrating PAP AHI decreased to 1.7/h. No adverse outcomes were identified. The average difference between 95th percentile auto-titrating PAP pressure and PAP titration pressure was 0.89 cmH_20. The study suggests auto-titrating PAP is effective, time-efficient, and safe for the treatment of OSAS in children with obesity.
Chen et al. 2020	Meta-analysis n= 19 studies	When supervised PAP titration and auto-titrating PAP were compared, they did not exhibit significantly different levels of CPAP compliance (MD −0.34 h, 95% CI −0.72–0.05 h, I2 = 91%). Also, there were no between-group differences in either long-term (MD = 0.56 h, 95% CI = 1.39–0.26 h, I2 = 91%), or short-term (MD = 0.34 h, 95% CI = 0.26–0.27 h, I2 = 14%) follow up between the two. Auto-titrating PAP was not inferior to SPT for CPAP compliance.
Cielo et al. 2020	Cohort n= 41 infants and 109 school-aged children with OSAS	After positive airway pressure, OAHI was reduced by a median of 92.1% in infants, similar to the median 93.4% reduction in school-aged children. PAP is effective at well-tolerated in infants and school-aged children.
Khaytin et al. 2020	Cohort n= 110 children aged 9.9 to 16.7 years children	PPSG median (interquartile range) was 8 (7–11) cmH2O, mean auto-titrating PAP was 6.2 (5.6–7.6) cmH2O, peak mean pressure was 9.4 (7.7–11.1) cmH2O, and average device pressure ≤ 90% of the time was 8.1 (7.2–9.7) cmH2O. Auto-titrating PAP-derived pressures correlated with PPSG (P < .05). Median regression analysis demonstrated that auto-titrating PAP-derived pressures remained significant predictors of PPSG (P < .05).
Lynch et al. 2017	Cohort n= 42 children aged 8 to 16 years	Fifteen youth were adherent to CPAP therapy and 10 were not adherent. CPAP-adherent youth demonstrated significant changes in two domains of OSAS-specific QoL when compared to nonadherent youth: decreased sleep disturbance (64.37% improvement) and decreased caregiver concern (55.67% improvement).

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2.b. Orthodontics

2.b.1. Rapid maxillary expansion (RME)

Key Recommendation:

RME can be considered as a treatment option among childhood OSAS associated with constricted maxillary arches.

Context and Considerations:

RME is a non-invasive orthodontic procedure. It is primarily used as an optional treatment in pre pubertal children with OSA and maxillary skeletal constriction such as dental crowding and malocclusion, and for high arched or narrow hard palates. This orthodontic appliance reduces

upper airway obstruction by increasing upper airway volume, reducing nasal resistance, and changing tongue posture.

In our review of evidence, the studies reported a reduction in AHI and clinical improvement on the daytime and nocturnal symptoms after RME treatment.

Review of evidence:

Author, Year	Study Design	Results
Quinzi et al. 2020	Meta-analysis n=6 studies	A meta-analysis was conducted to compare AHI values before and after the treatment with RME based on a follow-up duration of ≤3 year in 79 children and >3 years in 23 children. AHI improved from a 7.5 ± 3.2/h to 2.5 ± 2.6/h after RME. The authors concluded that reduction in the AHI was detected in all 102 children with OSAS that underwent RME, with or without an adenotonsillectomy. Moreover, better reduction in AHI was observed in children with small tonsils or no tonsils. A general improvement on the symptoms of OSAS after RME therapy was noted in all the included studies, which supports the effectiveness of this treatment.
Vale et al. 2017	Meta-analysis n=5 studies	This was conducted to determine the effectiveness of RME in the treatment of childhood OSAS. Results showed an overall reduction in after RME therapy (mean improvement= 3.24, 95%CI=0.34 to 6.15). The authors concluded that RME therapy is beneficial for childhood OSAS.

References:

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2.b.2. Mandibular advancement device (MAD)

Key Recommendation:

MAD can be considered as an alternative treatment in patients with mild to severe OSA before the end of pubertal peak and childhood OSA if with mandibular insufficiency.

Context and Considerations:

MAD include dental appliances or oral mandibular advancement devices that prevent the tongue from blocking the throat and/or advance the lower jaw forward. This device helps keep the airway open during sleep.

Review of evidence:

Author, Year	Study Design	Results
Yanyan et al. 2019	Meta-analysis n=7 studies	The authors evaluated the effect of mandibular advancement devices for childhood OSAS. They observed that the mean difference in AHI change for mandibular advancement group compared with control group was −1.75 events/h (95%CI=−2.07, −1.44), $p < 0.00001$ in favor of the device. The authors recommended that mandibular advancement device is effective for mild to severe patients before the end of their pubertal peak. Also, at least 6 months of treatment may be more effective than short-term treatment.

Reference:

Yanyan M, Min Y, Xuemei G. Mandibular advancement appliances for the treatment of obstructive sleep apnea in children: a systematic review and meta-analysis. Sleep medicine. 2019 Aug 1; 60:145-51

2.c. Intranasal corticosteroids and/or Leukotriene Receptor Antagonist (LTRA)

Key Recommendation:

Children with mild or moderate OSA and nasal obstruction due to adenoidal hypertrophy, especially those with seasonal allergies, may be candidates for treatment with intranasal corticosteroids and/or LRTA.

Context and Considerations:

Review of evidence reported improvement of both objective and subjective parameters after treatment with intranasal steroid and/or LTRA among children with OSA. This medical therapy benefits mostly children with mild to moderate OSAS associated with adenoidal hypertrophy and allergic rhinitis. Moreover, this medical approach is considered as an alternative or adjunct to adenotonsillectomy and as a temporary measure during the watchful waiting period prior to other interventions. A two- to four-week trial of the medication is initiated prior to a clinical decision on its long-term use. *Use of LRTA is limited by the possible increased risk of neuropsychiatric events associated with this class of drugs hence patients/caregivers should be counseled about these risks.*

Review of evidence:

Author, Year	Study Design	Results
Ji et al. 2021	Meta-analysis n= 4 studies	In children with OSA, oral montelukast (OM) significantly improved PSG monitoring parameters, characteristic and pertinent symptoms such as snoring and mouth breathing, and adenoid morphology. In individuals with OSAS treated with a combination of OM and conventional medications, not only PSG monitoring parameters and adenoid morphology, but also sleep-disordered breathing (SDB)-related questionnaire scores, improved in comparison to conventional drugs. In addition, compared to a single mometasone furoate nasal spray, the present study demonstrated that OM in combination with mometasone furoate nasal spray significantly improved PSG monitoring parameters, symptoms of snoring and mouth breathing, and reduced tonsil morphology in childhood OSAS.
Kuhle et al. 2020	Meta-analysis n= 5 studies	The evidence is uncertain on the difference in AHI (MD −3.18, 95% CI −8.70 to 2.35) between children receiving intranasal corticosteroids compared to placebo. In contrast, there is moderate-level evidence that those receiving oral montelukast had a lower AHI (MD −3.41, 95% CI −5.36 to −1.45) compared to placebo (2 studies, 103 participants). The is low evidence on whether the following outcomes are different between intranasal corticosteroids compared to placebo: desaturation index (MD −2.12, 95% CI −4.27 to 0.04; 2 studies, 75 participants; moderate-certainty evidence), respiratory arousal index (MD −0.71, 95% CI −6.25 to 4.83; 2 studies, 75 participants), and nadir oxygen saturation (MD 0.59%, 95% CI −1.09 to 2.27; 2 studies, 75 participants). Children receiving oral montelukast had a lower respiratory arousal index (MD −2.89, 95% CI −4.68 to −1.10; 2 studies, 103 participants) and nadir of oxygen saturation (MD 4.07, 95% CI 2.27 to 5.88; 2 studies, 103 participants) compared to placebo. Evidence is uncertain, however, on the difference in desaturation index (MD −2.50, 95% CI −5.53 to 0.54; 2 studies, 103 participants) between montelukast and placebo. The authors concluded that there is insufficient evidence for the efficacy of intranasal corticosteroids. They may have short-term benefit on the desaturation index and oxygen saturation in mild to moderate OSAS but the certainty of the benefit on AHI, as well as the respiratory arousal index, was low. Montelukast has short-term benefit in healthy, non-obese, surgically untreated children.
Liming et al. 2018	Meta-analysis n= 5 studies	Montelukast alone as treatment for childhood OSAS showed a 55% improvement in the apnea-hypopnea index (AHI) (mean [SD] 6.2 [3.1] events/h pre-treatment and 2.8 [2.7] events/h post-treatment; mean difference [MD] of 22.7 events/h; 95% confidence interval [CI], –5.6 to 0.3) with improvement in lowest oxygen saturation (LSAT) from 89.5

		(6.9) to 92.1 (3.6) (MD, 2.2; 95% CI, 0.5-4.0). Two studies (502 children) observing the effects of montelukast with intranasal corticosteroids on childhood OSAS found a 70% improvement in AHI (4.7 [2.1] events/h pre-treatment and 1.4 [1.0] events/h post-treatment; MD of 24.2 events/h; 95% CI, –6.3 to 22.0), with an improvement in LSAT from 87.8 (3.1) to 92.6 (2.2) (MD, 4.8; 95% CI, 4.5-5.1).
Zhang et al. 2017	Meta-analysis n= 7 studies	Pairwise meta-analysis results revealed that therapeutic effect of intranasal mometasone furoate, montelukast, budesonide and fluticasone were significantly better than placebo concerning apnea hypopnea index (AHI) value [WMD=1.40, 95% confidence interval (CI)=1.17–1.63; WMD=2.80, 95% CI=1.01–4.59; WMD=3.50, 95% CI=3.34–3.66; WMD=7.20, 95% CI=5.26–9.14, respectively], and fluticasone is better than placebo concerning sleep efficiency (WMD=3.50, 95% CI=2.42–4.58). The relative efficacy of fluticasone and budesonide in the treatment of OSAHS in children has crucial implications for the treatment of OSAS in children.

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2.d. Adjunct therapies

2.d.1. Weight loss

Key Recommendation:

Weight loss is recommended as adjunct treatment in obese children with OSA.
Context and Considerations:

Multidisciplinary weight loss programs are considered adjunct treatment for children who are diagnosed to have OSA associated with obesity. In the review of evidence, objective parameters in PSG revealed significant reduction in AHI and Oxygen desaturation index and an increase in duration of total sleep time after weight loss.

Review of evidence:

Author, Year	Study Design	Results
Roche et al. 2020	Meta-analysis n=10 studies	Ninety percent of the included studies reported a decrease in OSA prevalence after weight loss intervention, and OSA was normalized for 46.2–79.7% of the youth. Significant reductions in apnea–hypopnea index (effect size: −0.51, 95%CI −0.94 to −0.08, p = 0.019), and oxygen desaturation index (effect size: −0.28, 95%CI = −0.50 to −0.05, p = 0.016) was observed post intervention. Seventy-five percent of the studies reported improved duration of sleep. .

Reference:

Roche J, Isacco L, Masurier J, Pereira B, Mougin F, Chaput JP, Thivel D. Are obstructive sleep apnea and sleep improved in response to multidisciplinary weight loss interventions in youth with obesity? A systematic review and meta-analysis. International Journal of Obesity. 2020 Apr;44(4):753-70.

2.d.2. Positional therapy

There remains an evidence gap in the use of positional therapy in the treatment of childhood OSAS.

Context and Considerations:
One study in children with obesity and OSA demonstrated that positional OSA (POSA) occurs frequently among these group of patients. Identifying POSA allows for targeted positional therapy for children with obesity.
Review of evidence:

Author, Year	Study Design	Results
Selvadurai, S., et al. 2020	Cross-sectional study n=112 obese children with PSG	Of the 112 children with obesity with a diagnostic PSG, 38 % had OSA. Among those with OSA, 58% had POSA. Among those with POSA, 52% had mild OSA, 28% had moderate OSA and 20% had severe OSA.

References:

Selvadurai, S., Voutsas, G., Massicotte, C., Kassner, A., Katz, S.L., Propst, E.J. and Narang, I., 2020. Positional obstructive sleep apnea in an obese pediatric population. Journal of Clinical Sleep Medicine, 16(8), pp.1295-1301.

Xiao L, et al. Positional device therapy for the treatment of positional obstructive sleep apnea in children: a pilot study. Sleep Medicine. 2021

2.d.3. Myofascial re-education

Key Recommendation:

Myofascial re-education can be used as adjunct treatment in mild to moderate childhood OSAS

Context and considerations:

The respiratory muscle therapy encompasses a diversity of myofunctional/oropharyngeal exercises which can be considered adjuvant treatment for childhood OSAS. These include speech therapy and tongue exercises involving the upper airway muscles; plus, breathing exercises and musical instrument playing which appears to have some benefit on lower airway muscles. In the review of evidence, studies revealed that these exercises decrease AHI and increase mean oxygen saturations in children with mild to moderate OSA. However, due to its limitation, further research studies are required to determine which specific exercise among the various interventions is considered as the best adjuvant treatment.

Review of evidence:

Author, Year	Study Design	Results
Bandyopadhyay et al. 2020	Meta-analysis n=10 studies	The AHI reduced from an average of 4.32 to 2.48 events/hr (43% reduction). Mean difference post-intervention showed AHI reduction of −1.54 (95% CI -2.24, -0.85)/hr, (p-value< 0.0001). Mean oxygen saturation increased by 0.37 (95% CI 0.06,0.69) percent, (p-value= 0.02). There was no significant increase in nadir O2. Despite variation in exercises, myofunctional therapy significantly decreased AHI, and increased mean oxygen saturations in mild to moderate OSAS. Thus, it can be used as an adjunct treatment.
Hsu et al. 2020	Systematic review n=2 studies	Although two studies were included, one study did not report AHI after treatment. In the study where AHI was measured, there was a significant decrease in AHI from baseline in the intervention group by −2.6 events/h (95% CI −4.7 to −0.5; p-value= 0.016) compared with controls. In another study by the same author, there was a significant

		difference in the change in minimum SaO2% from baseline compared to control group of −2.4% (95 CI = −4.6 to −0.2; p-value= 0.032). No significant difference was observed in the change in average SaO2% (p-value= 0.063).

References:

Bandyopadhyay A, Kaneshiro K, Camacho M. Effect of myofunctional therapy on children with obstructive sleep apnea: a meta-analysis. Sleep medicine. 2020 Nov 1; 75:210-7.

Hsu B, Emperumal CP, Grbach VX, Padilla M, Enciso R. Effects of respiratory muscle therapy on obstructive sleep apnea: a systematic review and meta-analysis. Journal of Clinical Sleep Medicine. 2020 May 15;16(5):785-801.

2.d.4. Supplemental oxygen

Key Recommendations:

Nocturnal supplemental oxygen can be used with caution to temporarily treat patients with severe hypoxemia associated with OSAS until definitive therapy can be provided, as well as to support medically complicated patients who are poor candidates for surgical treatment and are unable to tolerate or use positive airway pressure.

Context and considerations:

To avoid the risk for hypoventilation, it is not recommended to use supplemental oxygen without first conducting PSG to titrate for the appropriate flow and without first evaluating pCO2.

Review of evidence:

Author, Year	Study Design	Results
Brockbank et al. 2019	Cohort, n=59 infants with OSAS	After treatment, the obstructive AHI decreased from 19.7 ± 13.0 during RA-PSG to 10.6 ± 11.7 during O2-PSG (P <.001). Also, the longest obstructive apnea increased from 11.0 ± 4.2 seconds to 13.4 ± 7.4 seconds (P =.01) while the lowest saturation increased from 80.7 ± 6.8% to 90.0 ± 6.7% (P < .001). The authors concluded that infants with OSA who received supplemental oxygen had a significant reduction in the frequency of obstructive respiratory events and improved oxygenation without adverse effects.
Das et al. 2018	Cohort, n=23 infants with OSAS	The median apnea hypopnea index decreased from a baseline of 18 (7–43) to 3 (1–19) (p-value=0.001) on oxygen. The baseline median obstructive/mixed apnea index reduced from 2 (1–16) to 1 (0-1) during oxygen therapy (p-value=0.003). Moreover, a significant reduction in central apnea index (1 (0–2) vs. 0 (0–1), p-value 0.002) was observed.

References:

Brockbank J, Leon-Astudillo C, Che D, Tanphaichitr A, Huang G, Tomko J, Simakajornboon N. Supplemental oxygen for treatment of infants with obstructive sleep apnea. Journal of Clinical Sleep Medicine. 2019 Aug 15;15(8):1115-23.

Das P, Kashyap R, Kotagal S. Impact of supplemental oxygen on obstructive sleep apnea of infants. Children. 2018 Mar 2;5(3):34.

CQ 5. What are the clinical features that predispose a child with OSAS to a higher risk for post-surgery complications?

Key Recommendations:

Patients with severe OSAS (OAHI > 10/h), those aged below 3 years, lower oxygen saturation and those with congenital craniofacial anomalies, neuromuscular disorders, comorbid medical conditions and severe obesity or underweight are at higher risk for post-surgery complications. Evidence on risk factors for non-surgery-related complications is lacking.

Context and considerations:

Comorbidities are more closely linked with postoperative respiratory complications (PoRCs) after adenotonsillectomy in children with obstructive sleep apnea than OSA severity. In children without comorbidity, PoRCs are associated with OSA severity and usually occur within the first 2 hours after intervention. PoRCs may include desaturation, exacerbation of apnea, laryngospasm, bronchospasm, pulmonary edema and atelectasis, pneumothorax, pneumomediastinum and pleural exudates.

Review of evidence:

Author, Year	**Study Design**	**Results**
Lim et al. 2022	Cohort n=887 children with OSAS after tonsillectomy	The following risk factors were found to be most significant with postoperative respiratory event: % sleep time with O_2 < 90% (95% CI = 1.07–1.14, OR = 1.10, p < 0.001), Black race (95% CI = 1.53–3.58, OR = 2.34, p < 0.001), primary neurologic co-morbidity (1.67–6.32, OR = 3.27, p < 0.001), DS (1.25–5.94, OR = 2.72, p = 0.01), and age (0.84–0.94, OR = 0.88, p < 0.001).
Than et al. 2022	Cohort n=278 children with severe OSAS (AHI ≥10) and/or post-operative PICU admission	PSG Peak end-tidal CO2 ($ETCO_2$) ≥ 60 mmHg (OR= 5.31, 95% CI = 1.84–15.36, P < 0.01) existence of neuromuscular disease (OR= 5.43, 95% CI=1.91–15.45, P < 0.01), and occurrence of intraoperative complication (OR= 3.45, 95% CI=1.46–8.17, P < 0.01), were identified as significant factors associated with post-operative airway escalation or prolonged PICU stay.
Saur et al.	Systematic review	Well known to be predictive of a post- adenotonsillectomy respiratory

2017	n= 22 randomized and observational studies	complications, including age less than 2, comorbid medical conditions, syndromic diagnosis, extreme high or low weight for age, etc. Moreover, while several studies specifically included only patients at known high risk (AHI > 10, those requiring PICU admission, etc).
Martins et al. 2015	Cross-sectional n=53 children with OSAS after adenotonsillectomy	A high apnea-hypopnea index (AHI; p = 0.0269), a high oxygen desaturation index (ODI; p = 0.0082), a low SpO_2 nadir (p = 0.0055), prolonged orotracheal intubation (p = 0.0011), and rhinitis (p = 0.0426) were found to be independent predictors of respiratory complications.

References:

Benedek P, Keseru F, et al. Postoperative respiratory complications in children with obstructive sleep apnoea syndrome. Acta Otorhinolaryngol Ital. 2022 Apr; 42 (2) 162-168

Hill CA, et al. A pilot study to identify pre- and peri-operative risk factors for airway complications following adenotonsillectomy for treatment of severe pediatric OSA. Int J pediatr Otorhinolaryngol 2011; 75; 1385-1390

Lim J, Garigipati P, Liu K, Johnson RF, Liu C. Risk Factors for Post-Tonsillectomy Respiratory Events in Children with Severe Obstructive Sleep Apnea. The Laryngoscope. 2022 Aug 6.

Martins RO, Castello-Branco N, Barros JL, Weber SA. Risk factors for respiratory complications after adenotonsillectomy in children with obstructive sleep apnea. Jornal Brasileiro de Pneumologia. 2015 May; 41:238-45.

Moroco A, Saadi R, Wilson M. Post-tonsillectomy respiratory complications in children with sleep disordered breathing. International Journal of Pediatric Otorhinolaryngology. Volume 131, April 2020, 109852

Patino M, et al. Obstructive sleep apnea in children; perioperative considerations. Br J Anaesth 2013; 111 (Suppl 1);i83-i95

Saied N, Solis RN. Clinical characteristics and Post Operative Outcomes in Children with Very Severe Obstructive Sleep Apnea. Children 2022,9, 1396

Saur JS, Brietzke SE. Polysomnography results versus clinical factors to predict post-operative respiratory complications following pediatric adenotonsillectomy. International Journal of Pediatric Otorhinolaryngology. 2017 Jul 1; 98:136-42.

Than K, Mun-Price C, Klein MJ, Ross PA, Gomez G, Nagoshi M. PICU admission and complications following adenotonsillectomies in pediatric patients: A retrospective cohort study. International Journal of Pediatric Otorhinolaryngology. 2022 Jul 1; 158:111166.

CQ 6. What are the risk factors for residual childhood OSAS?

Key Recommendations:

The following are risk factors for residual childhood OSAS:

- Severe OSAS prior to treatment
- Obesity
- Weight gain after adenotonsillectomy
- Neurological, neuromuscular, developmental, craniofacial, dentofacial abnormalities
- Increasing age, which could be linked to late diagnosis
- Large adenoid size
- Asthma
- Enuresis
- Allergic Rhinitis

Context and considerations:

The prevalence of residual OSAS after adenotonsillectomy ranged from 34-87% in the literature. Residual OSA or persistent OSA is defined as having apnea hypopnea index (AHI) greater than 2 after adenotonsillectomy in some studies. To date, no consensus exists on the threshold value of AHI to determine residual OSA in children.

Review of evidence:

Author, Year	Study Design	Results
Working group of Chinese guideline for the diagnosis and treatment of childhood OSAS. 2021	Clinical practice guideline, n=12 studies	Ten prospective cohort studies and two retrospective cohort studies (n = 1655 patients) were systematically reviewed. Three risk factors for postoperative treatment failure in pediatric patients were reviewed. 1) Postoperative persistent OSAS was more prevalent in obese children with OSAS compared to children of normal weight (odds ratio [OR]: 4.11, 95% confidence interval [CI]: 1.68–10.02, p-value< 0.01). Preoperative obesity is a risk factor for persistent OSAS after surgery based on separate diagnostic criteria: AHI 1/h (OR: 3.77, 95% CI: 1.57–9.05, p-value<0.01), AHI 2/h (OR: 7.96, 95% CI: 2.76–22.92, p-value<0.01), and AHI 5/h (OR: 8.73, 95% CI: 4.76–16.92, p-value<0.01). Being overweight, but not obese, was not a risk factor for postoperative treatment failure (OR: 0.76, 95% CI: 0.20–2.95, p-value= 0.70). 2) Asthma (OR: 1.31, 95% confidence interval: 0.50–3.41, p-value= 0.58) and allergic rhinitis (one study, n = 85 patients (OR: 0.96, 95% confidence interval: 0.39–2.39, p-value= 0.93) were not associated with an increased risk of postoperative persistent OSAS. 3) Medical history of family SDB (OR: 1.35, 95% CI: 0.62–2.91, p-value= 0.45) and allergies (OR: 2.24, 95% CI: 0.95–5.28, p-value= 0.07), were not linked with an increased risk of postoperative treatment failure. These results suggested that obesity is a risk factor for persistent postoperative OSAS in pediatric patients.
Bae and Kim 2020	Cohort study,	The authors observed that older age, large adenoid size, and

	n= 62 children with and without residual breathing after adenotonsillectomy	presence of dentofacial abnormalities were significantly associated with residual mouth breathing after surgery (adjusted coefficient estimates = 0.3890, 2.3611, and 2.8615, respectively).
Lee et al. 2016	Meta-analysis, n=51 studies	The overall success rate for postoperative AHI <1 after adenotonsillectomy was 34% for obese versus 49% in non-obese. The overall success rate for AHI <5 was 61% for obese versus 87% in non-obese. Meta-regression analyses demonstrated that postoperative AHI was positively correlated with AHI and body mass index prior adenotonsillectomy.
Imanguli and Ulualp 2016	Cohort study, n= 169 children with and without residual OSAS after adenotonsillectomy	The prevalence of residual OSA in obese patients (49%) was significantly higher than that of non-obese patients (27%) (p-value= 0.02). Patients with neurological/ developmental/ craniofacial abnormalities had significantly higher prevalence of residual OSA (44%) than patients without comorbidities (33%) (p-value<0.05). Teenage patients (67%) had a higher prevalence of residual OSA than toddlers (27%), preschooler (33%), and middle childhood groups (29%) (p-value=0.03).
Huang et al. 2014	Cohort study, n= 135 children with residual OSAS	The residual pediatric OSA after AT was significantly associated with BMI, AHI, enuresis, and allergic rhinitis before surgery. From 6 to 36 months after AT, recurrence of pediatric OSA was significantly associated with enuresis, age (for the 24- to 36-mo period), postsurgery AHI (severity), and the rate of change in BMI and body weight.

References:

Bae J, Kim DK. Risk factors for residual mouth breathing in children who had completely resolved obstructive sleep apnea after adenotonsillectomy. European Archives of Oto-Rhino-Laryngology. 2020 Oct; 277:2913-9.

Huang YS, Guilleminault C, et al. Treatment Outcomes of Adenotonsillectomy for children with Obstructive Sleep Apnea: A Prospective Longitidinal Study. SLEEP 2014; 37 (1): 71-76

Imanguli M, Ulualp SO. Risk factors for residual obstructive sleep apnea after adenotonsillectomy in children. The Laryngoscope. 2016 Nov;126(11):2624-9.

Lee CH, Hsu WC, Chang WH, Lin MT, Kang KT. Polysomnographic findings after adenotonsillectomy for obstructive sleep apnea in obese and non-obese children: a systematic review and meta-analysis. Clinical Otolaryngology. 2016 Oct;41(5):498-510.

Working group of Chinese guideline for the diagnosis and treatment of childhood OSA; Subspecialty Group of Pediatrics, Society of Otorhinolaryngology Head and Neck Surgery, Chinese Medical Association; Subspecialty Group of Respiratory Diseases, Society of Pediatrics, Chinese Medical Association;, Society of Pediatric Surgery, Chinese Medical Association;, Editorial Board of Chinese Journal of Otorhinolaryngology Head and Neck Surgery. Chinese guideline for the diagnosis and treatment of childhood obstructive sleep apnea (2020). Pediatric Investigation. 2021 Sep 1;5(03):167-87.

CONCLUSION

This position statement was created by the PAPP Task Force on Sleep Disordered Breathing to provide a guideline for local pediatricians and general practitioners based on the latest literature.

The journey of understanding childhood OSAS is ongoing, and we continue to progress forward. The medical literature regarding childhood obstructive sleep apnea is expanding and has changed at a rapid pace in the past 10 years. Surgical management of the airway and adjunct therapies based on severity are essential components of OSAS treatment. Evolving technology that is accessible, portable, user-friendly, robust and has a high degree of validity is being developed not only to screen for OSAS but also to diagnose it with ease. In the next few years, the field of pediatric sleep medicine will undergo profound changes as the effects of artificial intelligence, machine learning, wearable technology for diagnosis and accessible pathways for diagnosis and management continue to accelerate. Diagnosis and treatment of pediatric OSA are anticipated to evolve as we continue to develop individualized and innovative solutions to the problem.

Researchers are highly encouraged to look at the knowledge gaps identified in this position statement.

Summary of Recommendations

- Children's symptoms and signs are important bases for the initial diagnosis of childhood OSAS, but their diagnostic accuracy is low. Regarding symptoms, the presence and frequency of snoring should be considered first. Snoring ≥ 3 nights/week merits clinical attention.

- Overnight Polysomnography (PSG) is the standard diagnostic method for childhood OSAS.

- Nocturnal pulse oximetry is an alternative to screen for OSA when PSG is not available. Only when OSAS is combined with substantial oxygen desaturation is nocturnal pulse oximetry an effective diagnostic tool.

- Pulse transit time has been used accurately to detect arousals and, when scored in combination with respiratory events, has been shown to more accurately reflect the PSG-determined AHI.

- PSQ and OSA-18 are not recommended as diagnostic tests for childhood OSAS when used alone.

- DISE cannot be used alone to diagnose childhood OSAS in general. It may be used in those without tonsillar hypertrophy, at high risk for persistent OSAS, and cases of persistent OSAS after adenotonsillectomy (AT).

- AI and ML showed good reliability in predicting severe childhood OSAS, candidates for AT and those in need of postoperative overnight monitoring following AT.

- There is no sufficient evidence to recommend the use of biomarkers in the diagnosis of childhood OSAS.

- The American Academy of Sleep Medicine in its position paper do not recommend the use of home sleep apnea test (HSAT) which do not include EEG or end-tidal or transcutaneous CO_2 monitoring in the diagnosis of childhood OSAS.

- There is limited evidence on the complications of untreated childhood OSAS because of the available study designs. However, it is recommended that childhood OSAS be diagnosed and treated early as it may lead to cardiovascular conditions, impaired neurocognitive performance and behavioral functioning, metabolic disorders, growth impairment, excessive daytime sleepiness, and nocturnal enuresis.

- AT is the first line of treatment for children with OSAS who have adenoid and/or tonsil hypertrophy and do not have surgical contraindications.

- Watchful waiting for 6 months and supportive care is a reasonable approach for otherwise healthy children with mild and moderate forms of OSAS and for those with surgical contraindication.

- If watchful waiting is to be observed, the child should be reevaluated clinically within six months or reevaluated sooner if symptoms worsen.

- Surgical procedures other than adenotonsillectomy are sometimes considered in children with OSAS without significant adenotonsillar hypertrophy, or with residual OSA. These adjuvant surgical procedures may also be beneficial in patients with a high probability that OSA is due to factors other than adenotonsillar hypertrophy alone.

- Continuous Positive Airway Pressure (CPAP) and Bilevel Positive Airway Pressure (BiPAP) can be considered as second line treatment modality in the following moderate/severe OSAS after surgery; severe preoperative OSAS with coexisting morbidities such as cor pulmonale; morbid obesity, neuromuscular disorders, and craniofacial abnormalities; mild OSAS with minimal adenotonsillar tissue; strong preference for a nonsurgical approach.

- RME can be considered as a treatment option among childhood OSAS associated with constricted maxillary arches.

- MAD can be considered as an alternative treatment in patients with mild to severe OSA before the end of pubertal peak and childhood OSA if with mandibular insufficiency.

- Children with mild or moderate OSA and nasal obstruction due to adenoidal hypertrophy, especially those with seasonal allergies, may be candidates for treatment with intranasal corticosteroids and/or LRTA.

- Weight loss is recommended as adjunct treatment in obese children with OSA.

- There remains an evidence gap in the use of positional therapy in the treatment of childhood OSAS. One study in children with obesity and OSA demonstrated that positional OSA (POSA) occurs frequently among these group of patients. Identifying POSA allows for targeted positional therapy for children with obesity.

- Myofascial re-education can be used as adjunct treatment in mild to moderate childhood OSAS.

- Nocturnal supplemental oxygen can be used with caution to temporarily treat patients with severe hypoxemia associated with OSAS until definitive therapy can be provided.

- Patients with severe OSAS (OAHI > 10/h), those aged below 3 years, lower oxygen saturation and those with congenital craniofacial anomalies, neuromuscular disorders, comorbid medical conditions and severe obesity or underweight are at higher risk for post-surgery complications.

- Risk factors for residual childhood OSAS include severe OSAS prior to treatment, obesity, weight gain after adenotonsillectomy, neurological, neuromuscular, developmental, craniofacial, dentofacial abnormalities, increasing age which could be linked to late diagnosis, large adenoid size, asthma, enuresis, Allergic Rhinitis.

Appendix 1. PEDIATRIC SLEEP QUESTIONNAIRE (FILIPINO TRANSLATION)

Sagutin ang mga sumusunod batay sa karanasan ng inyong anak sa **nakalipas na buwan**.

	Oo	Hindi	Hindi alam
1. HABANG NATUTULOG, ANG ANAK MO BA AY:			
Naghihilik nang higit sa kalahating oras ng kanyang pagtulog?	☐	☐	☐
Laging naghihilik?	☐	☐	☐
Naghihilik nang malakas?	☐	☐	☐
May mabigat o mabilis na paghinga?	☐	☐	☐
2. NAKITA MO BANG HUMINTO SA PAGHINGA ANG IYONG ANAK KUNG GABI?	☐	☐	☐
3. ANG ANAK MO BA AY:			
Humihinga sa pamamagitan ng kanyang bibig kung araw?	☐	☐	☐
May nanunuyong bibig pagkagising sa umaga?	☐	☐	☐
Naiihi sa higaan paminsan-minsan?	☐	☐	☐
4. ANG ANAK MO BA AY:			
Nagigising nang hindi maganda ang pakiramdam sa umaga?	☐	☐	☐
May problema sa pagkaantok kung araw?	☐	☐	☐
5. NASABIHAN KA NA BA NG GURO O TAGABANTAY NG IYONG ANAK NA INAANTOK ANG IYONG ANAK KUNG ARAW?	☐	☐	☐
6. MAHIRAP BANG GISINGIN ANG IYONG ANAK SA UMAGA?	☐	☐	☐
7. NAGIGISING BA ANG IYONG ANAK SA UMAGA NG MAY PANANAKIT NG ULO?	☐	☐	☐
8. HUMINTO BA SA PAGLAKI NG NORMAL ANG IYONG ANAK SA ANOMANG PAGKAKATAON MATAPOS SIYANG IPANGANAK?	☐	☐	☐
9. SOBRA BA SA TIMBANG ANG IYONG ANAK?	☐	☐	☐
10. MADALAS, ANG IYONG ANAK AY:			
Tila hindi nakikinig kapag direktang kinakausap?	☐	☐	☐
Nahihirapang magsaayos ng mga Gawain	☐	☐	☐
Madaling nagugulo ng mga estimulo mula sa labas	☐	☐	☐
Naglilikot gamit ang mga paa o kaya'y hindi mapakali sa kinauupuan	☐	☐	☐
Palaging aktibo o masyadong maraming sinasabi	☐	☐	☐
Gumagambala ng ibang tao (hal. sumusumbat sa mga usapan o laro)	☐	☐	☐

Appendix 2. PEDIATRIC SLEEP QUESTIONNAIRE (CEBUANO TRANSLATION)

Instruksyon: Palihog og tubag sa mga pangutana kabahin sa nilihokan/kinaiya sa imong anak sa panahon sa pagkatulog ug pagmata. Kani nga mga pangutana magamit kung unsay mga nilihokan sa imong anak sa kinatibuk-an sa miagingbulan, dili lang atong sa miaging pipila ka mga adlaw, kay pwede nga ang iya nilihokan dili mao iyang kasagaran, labaw na kung naa siyay gipamati atong panahona.

Palihog taronga ug itsek (✓) ang mga kahon (☐) nga gihatag. Nay tulo ka pili-anan. “Oo”, “Dili”, o “Wala ko kabalo”

	Oo	**Dili**	**Wala ko kabalo**
1. SAMTANG NATULOG, ANG BATA:			
Maghagok sa sobra sa katunga sa oras sa pagkatulog?	☐	☐	☐
Kanunaymaghagok?	☐	☐	☐
Kusogmuhagok?	☐	☐	☐
Adunay "bug-at" o kusogngapagginhawa?	☐	☐	☐
Naglisud sa pagginhawa o nanlimbasug ug ginhawa?	☐	☐	☐
2. NAKAKITA BA KA SA BATA NGA NIHUNONG SA PAGGINHAWA SA GABII?	☐	☐	☐
3. ANG BATA:			
Kasagarangmoginhawapinaagi sa baba sa buntag?	☐	☐	☐
Uga ang baba pagmata sa buntag?	☐	☐	☐
Panagsamaka-ihi sa higdaanan?	☐	☐	☐
4. ANG BATA:			
Kapoy ang gibatipagmata sa buntag?	☐	☐	☐
Katulgon sa buntag?	☐	☐	☐
5. NAA BAY TEACHER OR SUPERVISOR NAKAINGON NGA MURAG PIRMI KATULGON ANG BATA TIBUOK ADLAW?	☐	☐	☐
6. LISOD BA PUKAWON ANG BATA SA BUNTAG?	☐	☐	☐
7. MAGSAKIT BA ANG ULO SA BATA PAGMUMATA SA BUNTAG?	☐	☐	☐
8. NIHUNONG BA OG TUBO ANG BATA SA NORMAL NGA PAGTAAS BISAN UNSANG PANAHONA GIKAN SIYA NATAWO?	☐	☐	☐
9. SOBRA BA SA NORMAL ANG TIMBANG SA BATA?	☐	☐	☐
10. ANG BATA KASAGARAN:			
Murag dili maminaw bisag ikaw mismo nakigstorya niya	☐	☐	☐
Adunay kalisud sa pag-organisar sa mga buluhaton	☐	☐	☐
Dali mabalda o malinga ang atensyon sa mga gubot o saba nga gikan sa gawas	☐	☐	☐
Dili mahimutang ang mga kamot o tiil, o dili mahimutang sa lingkuranan	☐	☐	☐
Kanunay nga naglihok, labihan ka kiat ug kalihokan	☐	☐	☐
Hilig mag-apil-apil o magsinamok sa mga gipangbuhat sa uban (sa dula ug sa mga istoryahanay)	☐	☐	☐

Appendix 3. Management algorithm of children with suspected obstructive sleep apnea syndrome (Modified from Ng et al., 2019. Asian Paediatric Pulmonology Society (APPS) Position Statement). Additional diagnostic and treatment options were included in this updated flowchart.

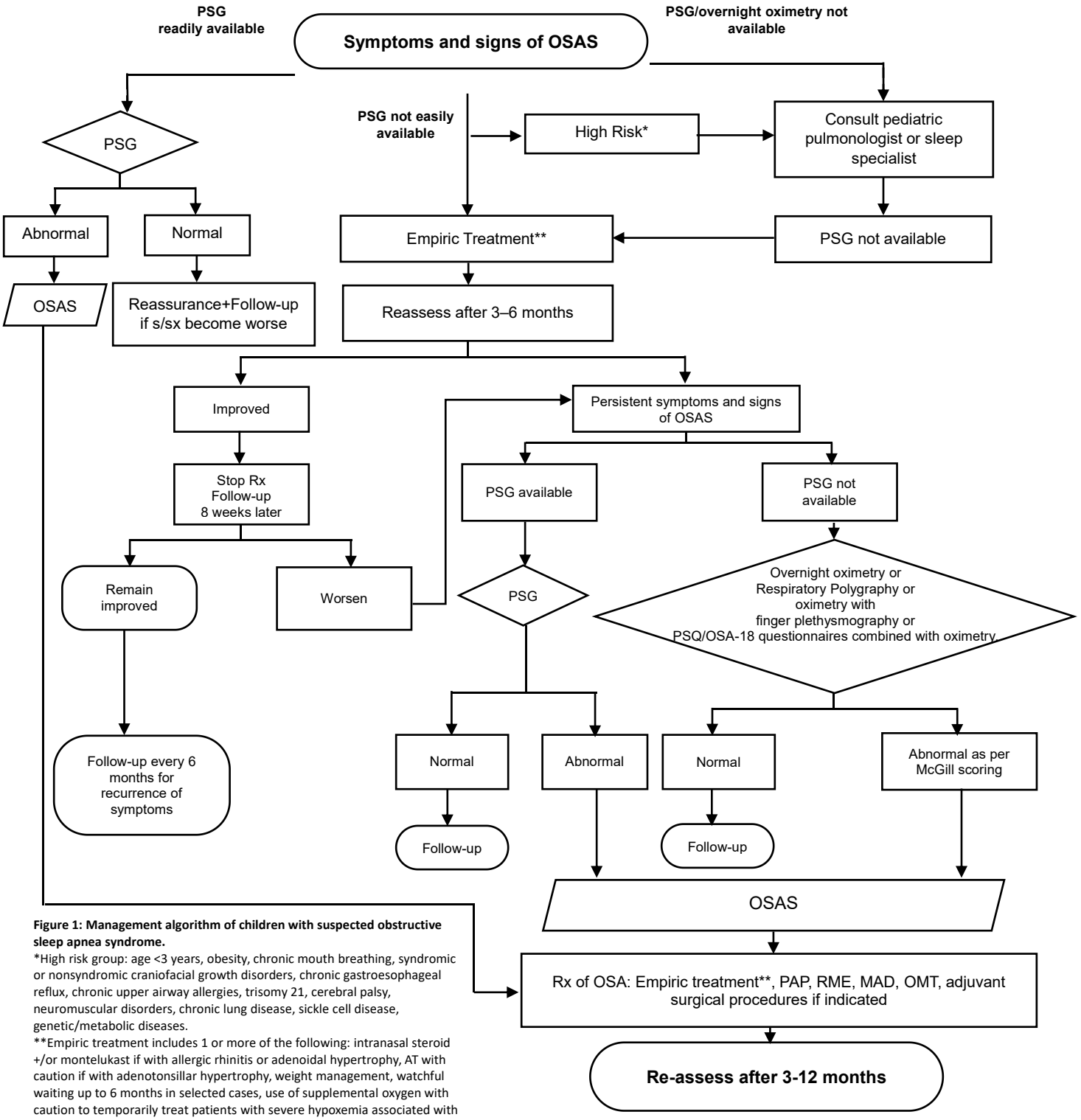

Figure 1: Management algorithm of children with suspected obstructive sleep apnea syndrome.

*High risk group: age <3 years, obesity, chronic mouth breathing, syndromic or nonsyndromic craniofacial growth disorders, chronic gastroesophageal reflux, chronic upper airway allergies, trisomy 21, cerebral palsy, neuromuscular disorders, chronic lung disease, sickle cell disease, genetic/metabolic diseases.

**Empiric treatment includes 1 or more of the following: intranasal steroid +/or montelukast if with allergic rhinitis or adenoidal hypertrophy, AT with caution if with adenotonsillar hypertrophy, weight management, watchful waiting up to 6 months in selected cases, use of supplemental oxygen with caution to temporarily treat patients with severe hypoxemia associated with OSAS

Abbreviations: AT: Adenotonsillectomy; PAP: Positive airway pressure; RME: Rapid maxillary expansion; MAD: Mandibular advancement device; OMT: Orofacial myofunctional therapy; Rx: Treatment; s/sx: signs and symptoms