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# Multidisciplinary Approach to the Management of Pediatric Sleep-Disordered Breathing



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Pediatric OSA is characterized by episodes of partial or complete airway obstruction during sleep

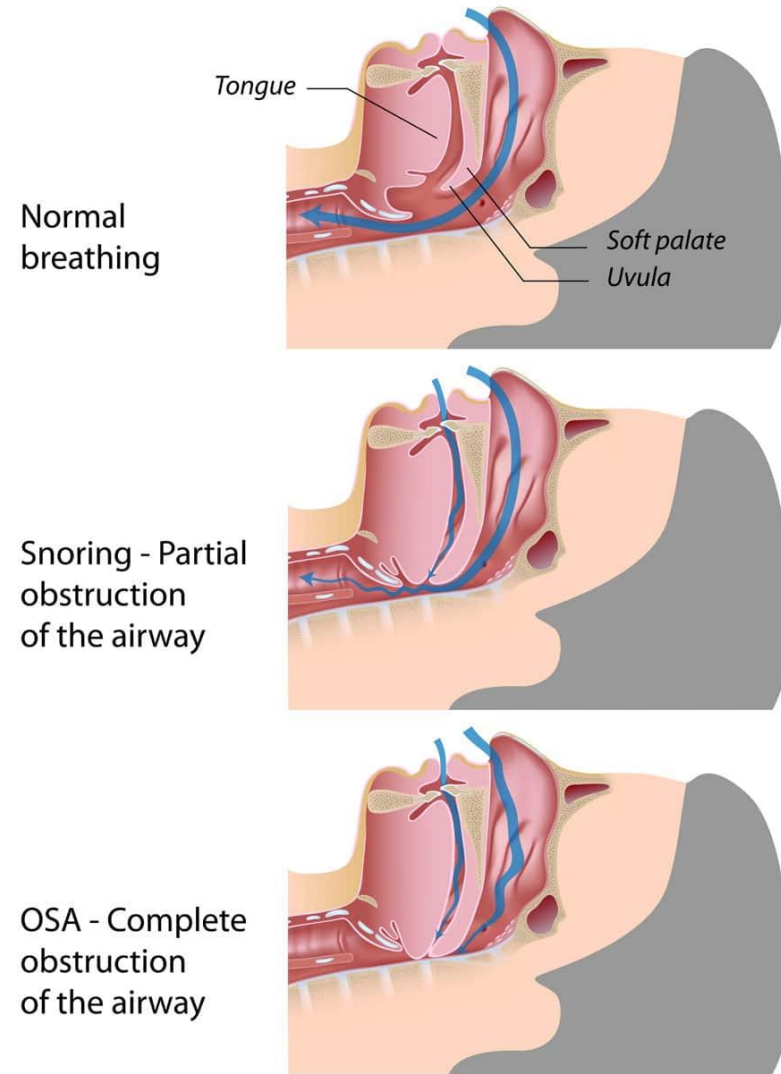
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- This condition occurs when there is an intermittent closure of the upper airways during inspiration, blocking the passage of air.
- These repeated episodes are associated with a reduction in blood oxygen saturation and a decrease in the quantity or quality of sleep

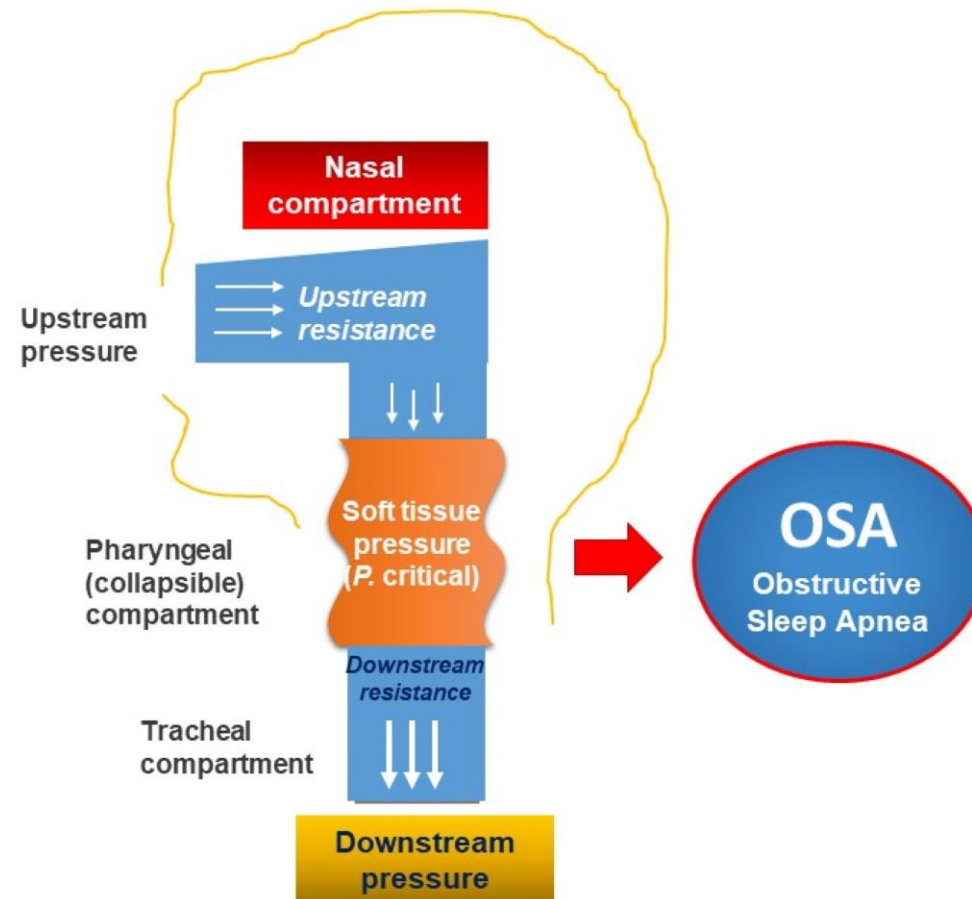


# Increased resistance in the nasal airways

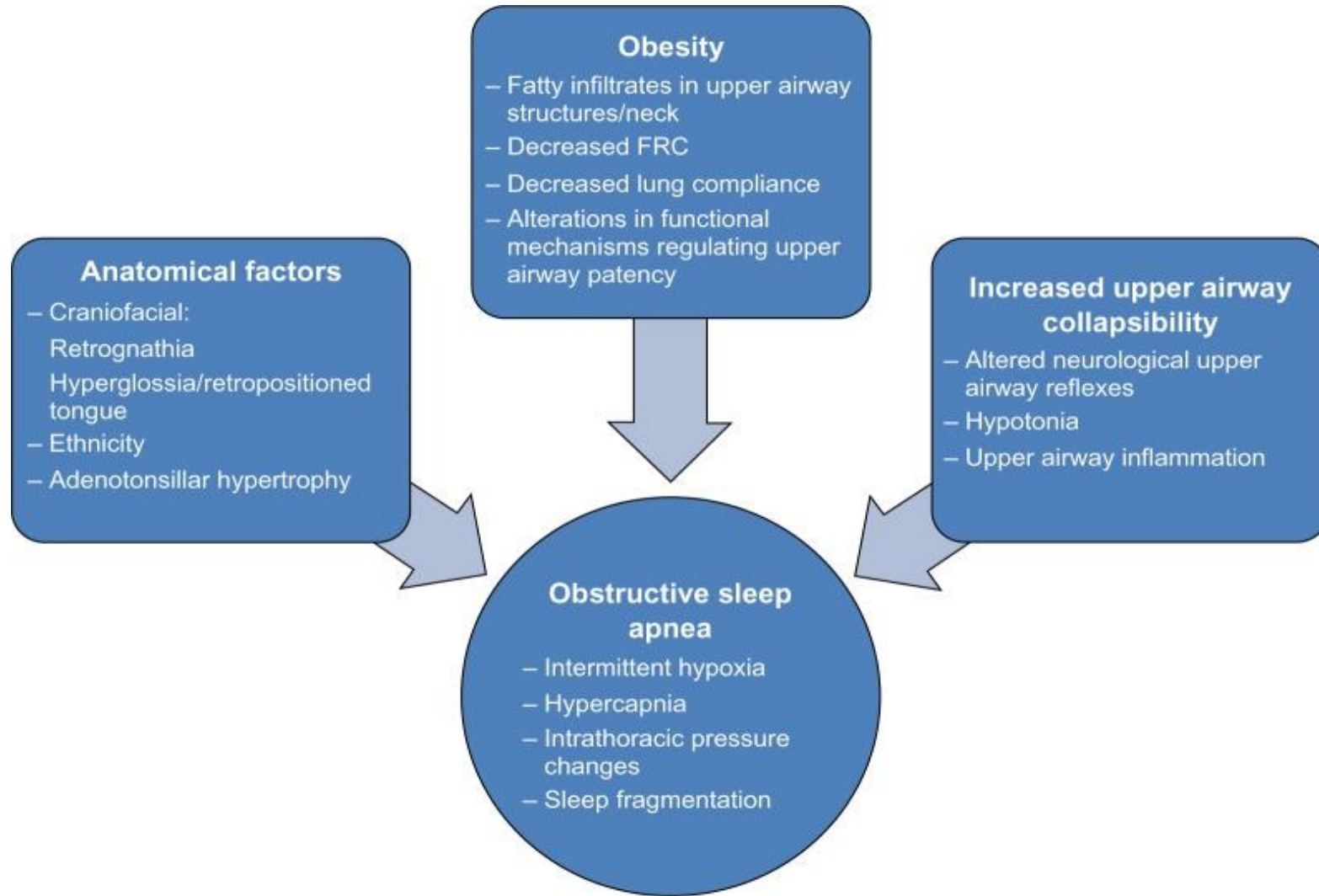
- Patients with OSA exhibit increased resistance in the nasal airways, often leading to a switch from nasal to oral breathing due to nasal obstruction.
- This obstruction can contribute to SDB through various pathophysiological mechanisms, including the Starling resistor model
- The interplay between nasal obstruction and the Starling resistor model illustrates how increased resistance in the nasal airways can significantly impact breathing patterns and contribute to SDB in patients with OSA



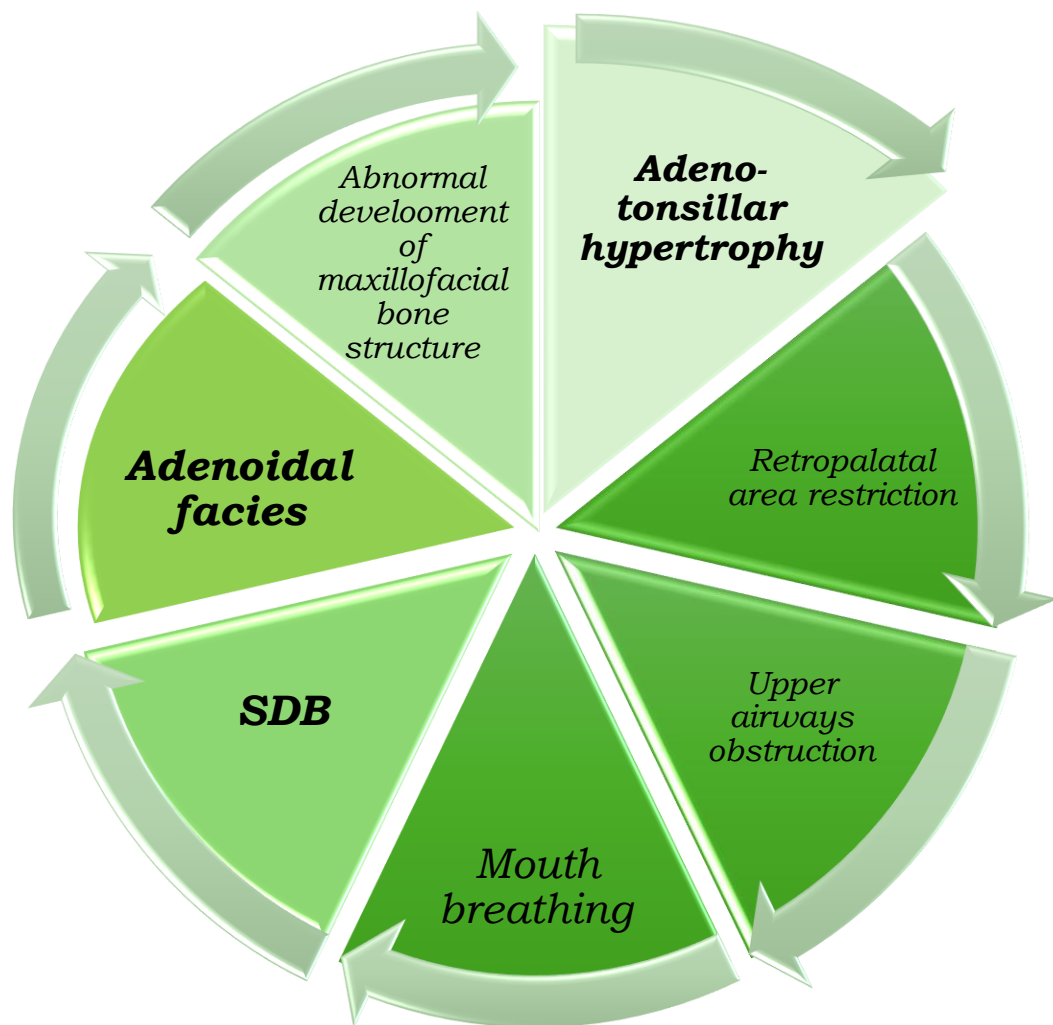
# Pathophysiology of OSA through three compartments



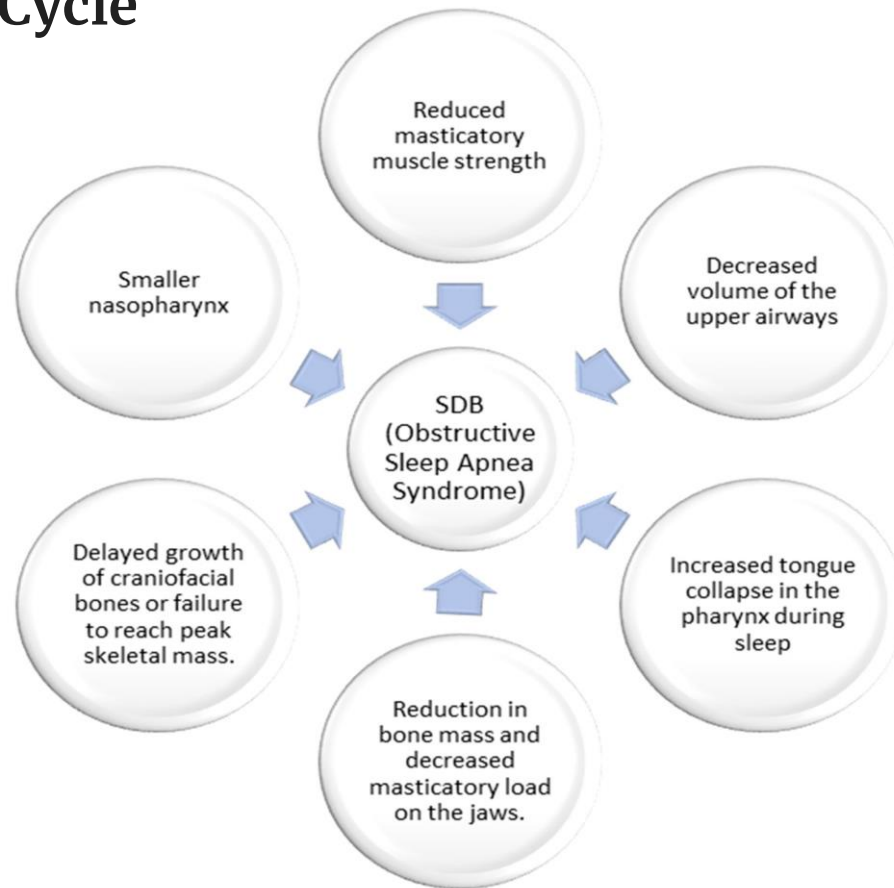
# What are the risk factors of OSA in children?



# Link Between Craniofacial Development, Adeno-Tonsillar Hypertrophy, and Mouth Breathing in Children with SDB (Nosetti et al. 2023)



## Vicious Cycle



# Pediatric Profile of the 'Adenoid Face': Facial Characteristics Associated with Mouth Breathing in Children

The "adenoid facies" refers to the characteristic facial features associated with chronic mouth breathing in children, often due to adenoid hypertrophy:

- Long, narrow face
- Maxillary constriction and associated dental crossbite
- Increased overjet (overbite)
- Weak chin projection (retrognathic mandible)
- Incompetent lip closure (open-mouth posture)
- Increased lower anterior face height

Patient with "adenoid facies" (open lip posture, mouth breathing, hypotonia)

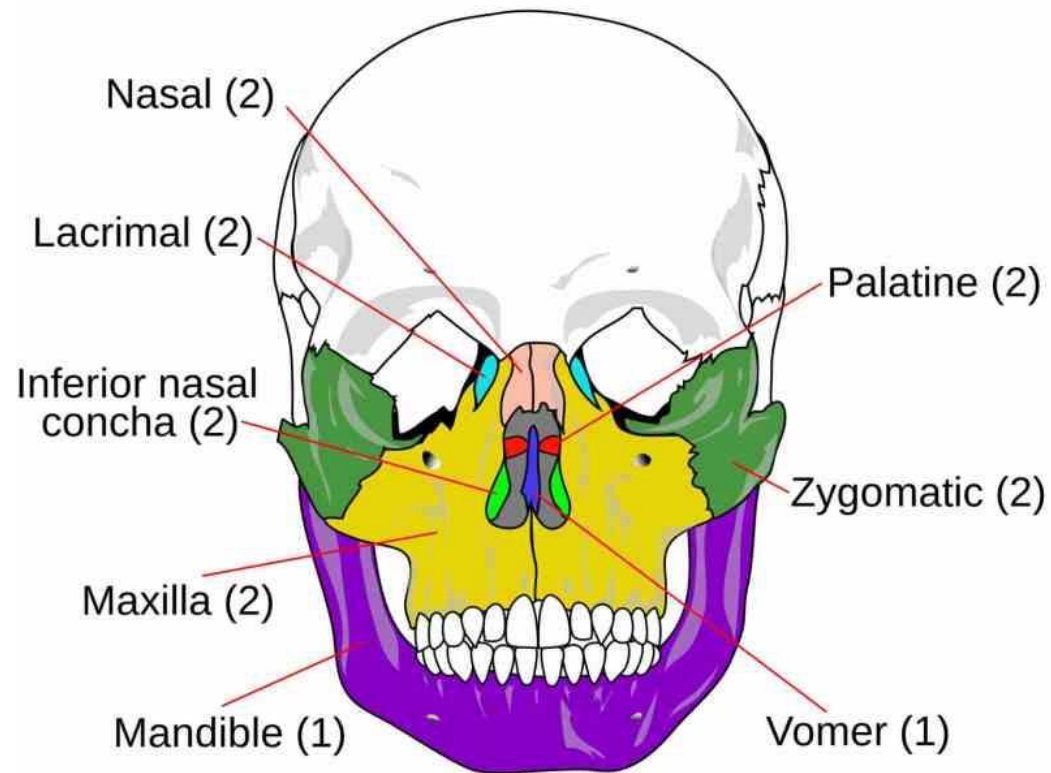
Stellzig-Eisenhauer A, Meyer-Marcotty P. Interaction between otorhinolaryngology and orthodontics: correlation between the nasopharyngeal airway and the craniofacial complex. *GMS Curr Top Otorhinolaryngol Head Neck Surg.* 2010;9:Doc04.

Lan Y, et al. Influences of Adenoid Hypertrophy on Children's Maxillofacial Development. *Healthcare (Basel).* 2023 Oct 24;11(21):2812.

Capistrano Aet al. Facial morphology and obstructive sleep apnea. *Dental Press J Orthod.* 2015 Nov-Dec;20(6):60-7

Murat Enoz, MD, Otorhinolaryngology, Head and Neck Surgeon - ENT Doctor in Istanbul

# The facial mass (splanchnocranium) is an integrated anatomical structure



## 14 Facial Bones

- The structure extends from the base of the skull to the jaw.
- It comprises bones and soft tissues that collectively contribute to the form and function of the face and upper airways.
- The structure includes the maxillary bones (n.2), the mandible, the zygomatic bones (n.2), nasal bones, lacrimal bones, and soft tissues such as muscles, gums, and ligaments.

During childhood, the facial skeleton is in a state of dynamic development, shaped by growth forces and the interaction between bony elements and soft tissues

- This period is characterized by rapid growth and reshaping of the face and surrounding structures.
- This complex system, composed of both bones and soft tissues, plays a fundamental role in vital functions related to respiration.
- This process is crucial for the proper formation of the facial structure in children

# Craniofacial characteristics provide important clues for assessing the presence and severity of OSA in children

Craniofacial Trait	Description	Relevance to OSA
<b>Retrognathic Mandible and Inclined Mandibular Plane</b>	A smaller or backward-positioned mandible with a steeper mandibular plane angle.	Leads to a reduction in airway size, increasing the risk of airway obstruction during sleep.
<b>Alterations in Mandibular Ramus Growth and Orofacial Hypotonia</b>	Underdeveloped mandibular ramus or reduced muscle tone in the orofacial region.	Contributes to airway collapse during sleep due to inadequate structural support.
<b>Increased Facial Height and Lip Incompetence</b>	Vertical overdevelopment of the facial skeleton, often accompanied by inability to fully close the lips.	Results in mouth breathing, which can exacerbate airway obstruction and OSA symptoms.
<b>Altered Cephalometric Angles</b>	Deviations in cephalometric measurements (e.g., SNA, SNB, ANB angles) from normal values.	May indicate craniofacial disproportions that reduce airway patency.

	Descrizione
<b>Midfacial hypoplasia</b>	Midfacial hypoplasia is a condition in which the bones of the midface are underdeveloped. This can reduce the space for the airways and increase the risk of OSA
<b>Micrognathia</b>	Micrognathia is a condition in which the mandible is too small. This can cause the tongue to fall backward during sleep, blocking the airways and leading to OSA.
<b>Macroglossia</b>	Macroglossia is a condition in which the tongue is too large. This can cause the tongue to fall backward during sleep, blocking the airways and leading to OSA

# Is there an interaction between facial growth and upper airway patency? (Katz et al 2008)

## **Upper Airway Patency**

- Increased overjet, reduced overbite, narrower upper and shorter lower dental arches
- Abnormal maxilla-mandibular relationships

## **Impact on Breathing**

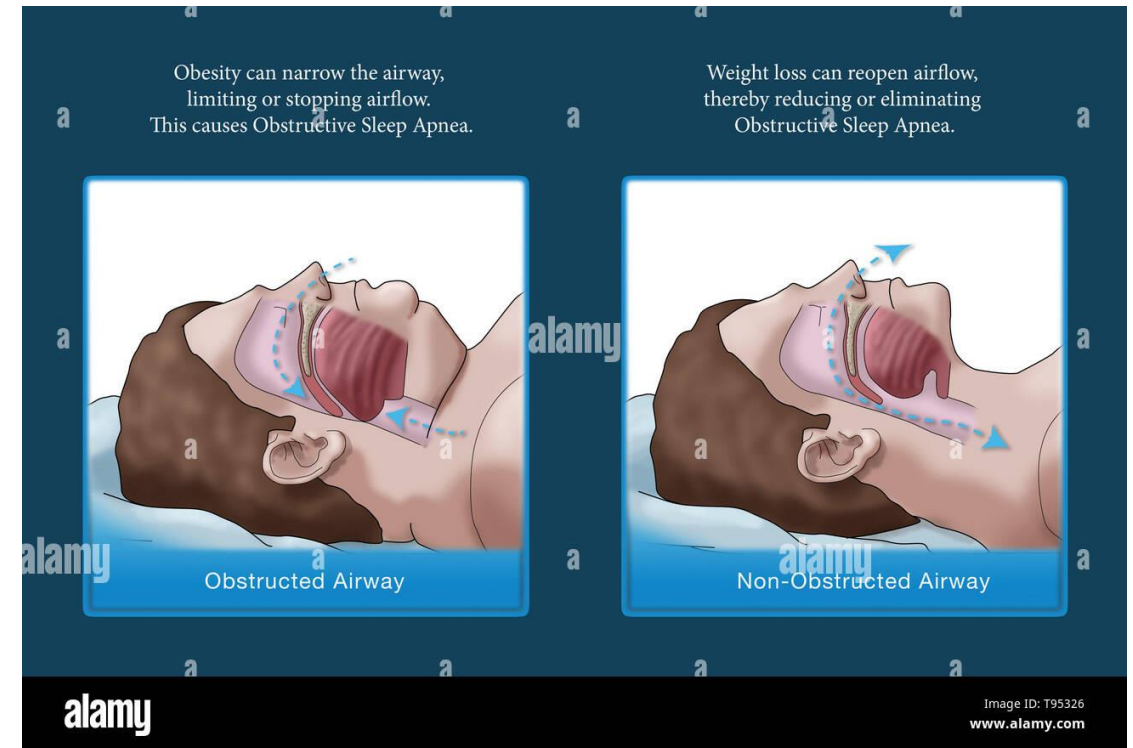
- decrease in upper airway muscle tone, resulting in airway collapse

# Risk factor: Obesity

- Several studies indicate that obesity is a major risk factor for developing OSAS, with an odds ratio of approximately 4.69 for obese children compared to their non-obese counterparts.
- The severity of OSAS often correlates with the degree of obesity; as body mass index (BMI) increases, so does the likelihood and severity of sleep apnea.
- The accumulation of adipose tissue, particularly around the neck and throat, reduces the airway lumen size, increasing the likelihood of airway collapse during sleep

# The Persistent Challenges of Obstructive Sleep Apnea in Obese Children: The Role of Fat Deposits and Adenotonsillar Hypertrophy

- Furthermore, adenotonsillar hypertrophy is common in this population, affecting about 45% of obese children with OSAS.
- Even after surgical interventions like adenotonsillectomy, up to 50% of these children may continue to experience OSAS.



Kohler MJ, et al. Differences in the association between obesity and obstructive sleep apnea among children and adolescents. J Clin Sleep Med. 2009 Dec 15;5(6):506-11.

# The Interconnection Between Childhood Obesity, Allergies, and Obstructive Sleep Apnea

**Association with Sleep Disorders and Allergies:** Often linked to conditions such as asthma and allergic rhinitis.

obesity, and obstructive sleep apnea due to their interconnection.

Types of Obesity:

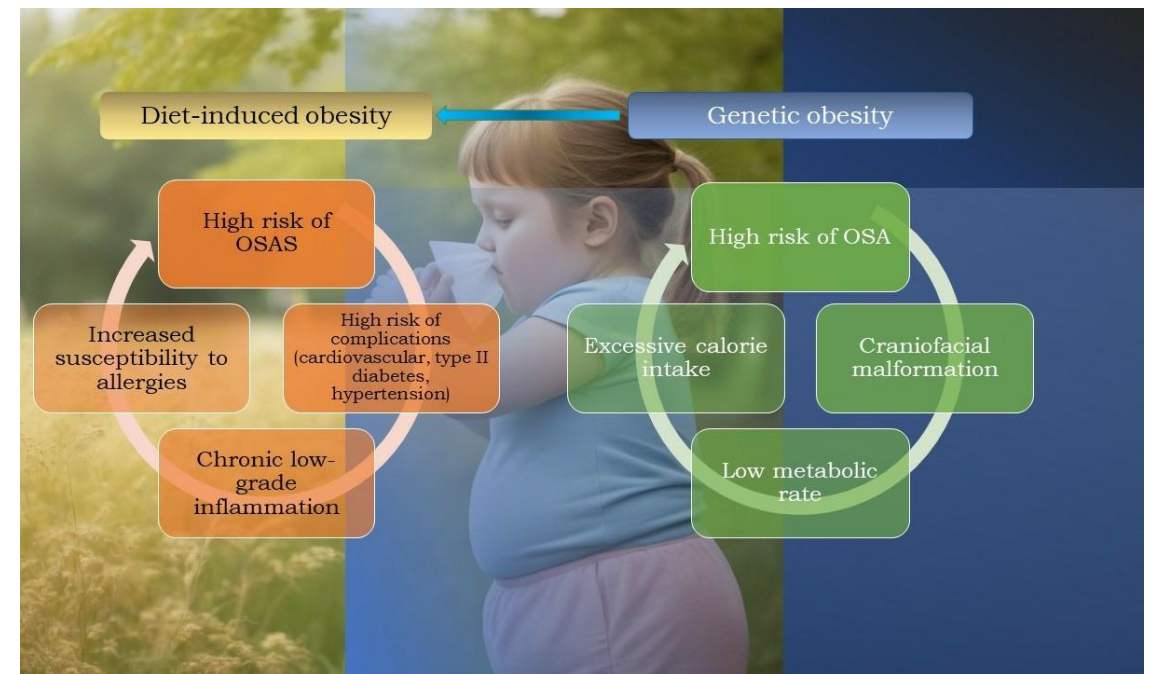
- **Diet-Induced Obesity:** Resulting from excessive eating and physical inactivity.
- **Genetic Obesity:** Observed in syndromes like Down syndrome and Prader-Willi syndrome.

**Impact of Diet-Induced Obesity:** Chronic inflammation related to weight can worsen allergies. Increases the risk and severity of asthma and rhinitis.

**Nasal Congestion and OSA:** Rhinitis contributes to airway obstruction and OSA.

There is a bidirectional relationship between obesity and OSAS

Need for integrated evaluation and management of allergies,



## In summary, the «main macro-areas»

- Tonsillar and adenoidal hypertrophy 🤒
- Obesity ⚖️
- Non-syndromic craniofacial anomalies 👶
- Genetic syndromes 🧬

<b>Factor</b>	<b>Associated with OSAS</b>
Snoring occurring for $\geq 3$ months	Yes
Tonsillar hypertrophy	Yes
Adenoid hypertrophy	Yes
Obesity	Yes
Neck circumference $\geq 30$ cm	Yes
Waist/hip ratio $\geq 0.95$	Yes
Preterm birth	Yes

# Management Approaches: Multidisciplinary Diagnosis

Pediatricians  

Otolaryngologists (ENT Specialists)   

Pulmonologists and Sleep Medicine Specialists  







Dentists and Orthodontists  

# Management Approaches

- **Non-Surgical Treatments**

- Pharmacotherapy 
- Weight Management  
- Orthodontic Treatment  
- Myofunctional Therapy  

- **Surgical Interventions**

- Adenotonsillectomy  
- Maxillofacial Surgery  
- Lingual Tonsillectomy  

# What are the non-surgical therapies for pediatric OSA?

- **Nasal Corticosteroids:** Intranasal corticosteroids either alone or combined with other anti-inflammatory agents.[Gozal D, 2020)]
- **Montelukast:** Montelukast, a leukotriene receptor antagonist, either alone or in combination with intranasal corticosteroids.
- **A combination** of intranasal corticosteroid + oral montelukast as initial treatment of mild OSA appears to provide an effective alternative to A&T, particularly in younger and nonobese children (Leila Kheirandish-Gozal, 2014)
- **Other Non-Surgical Approaches:** Additional non-surgical approaches for pediatric OSA include orthodontic therapy rapid, maxillary expansion, and myofunctional therapy. .
- **Weight Loss:** Weight loss can be beneficial in managing OSA, particularly in cases where obesity contributes to the condition.
- **Positive Airway Pressure Therapy:** CPAP therapy is a non-surgical approach that can treat pediatric OSA, especially when other treatments are ineffective.

## Mild OSA

- AT or watchful waiting for 6 months
- Intranasal corticosteroid
- Weight management, if overweight/obese

## Moderate OSA

- Specialist referral (e.g., sleep medicine, otolaryngology)
- AT
- CPAP therapy
- Weight management, if overweight/obese

## Severe OSAS

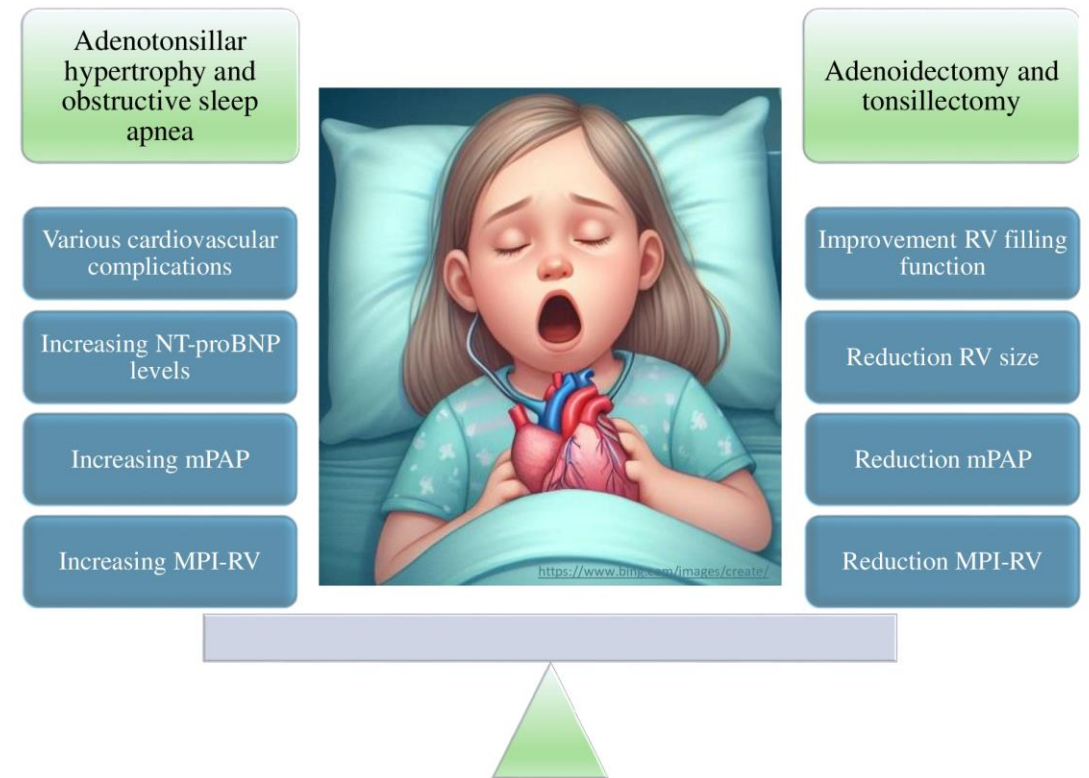
- Specialist referral (e.g., sleep medicine, otolaryngology)
- Cardiology evaluation
- AT with overnight observation
- CPAP therapy
- Weight management, if overweight/obese

Mussi, N.; et al. The First-Line Approach in Children with Obstructive Sleep Apnea Syndrome (OSA). *J. Clin. Med.* **2023**, *12*, 7092

# What are the surgical therapies for pediatric OSA?

- **Adenotonsillectomy (AT):**
  - **Indication:** First-line treatment for moderate to severe obstructive sleep apnea syndrome (OSAS) in children.
  - **Benefits:** Significant improvement in:
    - Symptoms
    - Behavior
    - Quality of life (QOL)
- **Outcomes**
  - **Post-surgery improvements:**
    - Increase in oxygen saturation (e.g., from 89% to 94%)
    - Decrease in apnea-hypopnea index (AHI)
  - **Residual OSAS:**
    - Occurs in 18% to 50% of cases

- More likely in children with severe OSAS or obesity



# Evaluating the Efficacy of Adenoidectomy Alone in the Treatment of Pediatric Obstructive Sleep Apnea in Non-Obese Children

## • Current Knowledge/Study Rationale

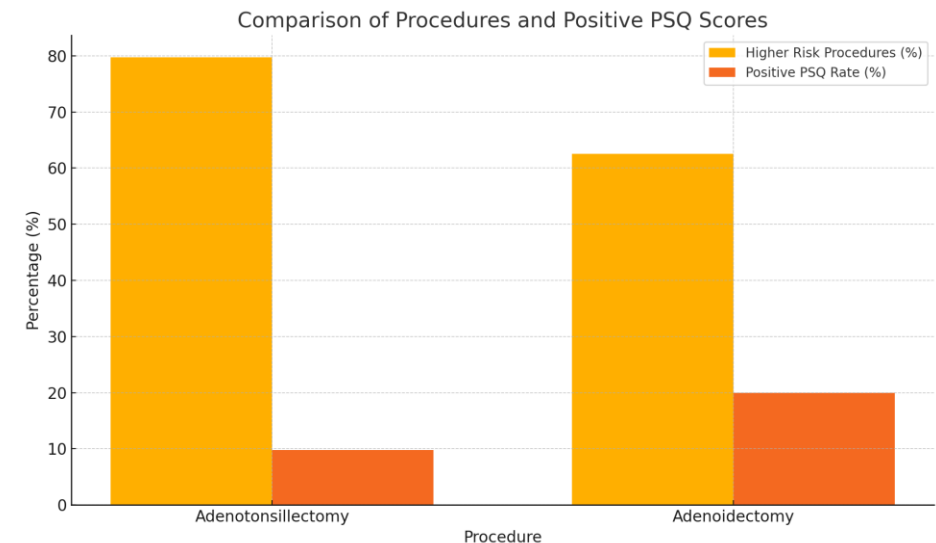
- Adenotonsillectomy is currently the recommended treatment for pediatric OSA.
- Adenoidectomy alone has been proposed as a potentially less invasive option, associated with:
  - Lower morbidity
  - Reduced mortality
  - Lower overall cost
  - The study's objective is to explore whether adenoidectomy alone could be an appropriate and effective treatment for non-obese children with OSA.

## • Study Impact

- In non-obese children with moderate OSA and smaller tonsils, adenoidectomy alone appears to be a reasonable treatment option.
- This study suggests a potential shift in

treatment strategies for this subgroup of patients.

- **Future research:** Prospective, randomised controlled studies must confirm these findings and guide treatment protocols.



# What are the treatment options for facial changes associated with OSA?

Treatment	Rapid Maxillary Expansion (RME)	Mandibular Advancement Devices (MAD)	Tongue-Stabilizing Device (TSD)	Myofunctional Therapy
<b>Objectives</b>	Expand the maxilla and increase the size of the nasal and upper airway	Advance the mandible to widen the upper airway	Stabilize the tongue in a forward position to prevent airway blockages	Strengthen the oropharyngeal muscles through specific exercises
<b>Mechanism of Action</b>	Uses an orthodontic device to separate palatal sutures, widening the palate and increasing nasal airflow	Shifts the mandible forward to improve tongue position and pharyngeal patency	A soft, suction-based appliance that holds the tongue in place, preventing it from collapsing back	Isotonic and isometric exercises to improve tone, endurance, and coordination of oropharyngeal structures
<b>Effect on the Airway</b>	Increases nasal width and improves nasal and upper airway dimensions	Increases retrolingual and pharyngeal space, enhancing airway patency	Prevents tongue collapse into the airway, maintaining airway openness	Increases muscle tone and reduces airway collapsibility
<b>Clinical Use</b>	Used in children with a narrow palate, maxillary constriction, or nasal obstruction	Mild to moderate obstructive sleep apnea (OSA) or retrognathia	Limited data for pediatric use; more commonly used in adults	Used as an adjunctive therapy in cases of mild to moderate SDB or as a preventive measure
<b>Age Group</b>	Pre-adolescence (7-12 years old)	Older children and adolescents	Limited use in children; more suitable for adolescents	All age groups, depending on compliance and indication
<b>Duration of Treatment</b>	Generally 6-12 months	Often used long-term, depending on severity of SDB	Continuous use during sleep	Variable, depending on the severity of the dysfunction
<b>Advantages</b>	- Non-invasive - Improves nasal breathing and facial growth	- Non-surgical - Enhances airway stability	- Non-invasive - Can be used in patients with poor dental alignment	- Non-invasive - Can complement other therapies
<b>Disadvantages</b>	- Discomfort during application - Requires orthodontic follow-up	- Continuous nightly use - Potential mandibular discomfort	- Limited data in children - Potential for compliance issues	- Requires regular sessions and compliance - Limited long-term data
<b>Efficacy in SDB</b>	Effective in cases of maxillary constriction and nasal obstruction	Effective in mild to moderate OSA, particularly in retrognathia cases	Limited evidence in pediatric SDB	Emerging evidence in improving muscle tone and airway stability

# Is myofunctional therapy a treatment option for pediatric OSA?

- MFT involves exercises targeting the upper airway muscles, which can improve facial growth and treat OSA in children
- Studies have found that MFT can decrease the AHI by 43% in children with OSA and increase mean oxygen saturation levels.
- MFT appears to be particularly effective for children with mild to moderate OSA.

Moeller, Joy Lea et al. "Myofunctional Therapy: A Novel Treatment of Pediatric Sleep-Disordered Breathing." *Sleep Medicine Clinics* 9 (2014): 235-243.

# SDA severity, different treatment options

## Severità OSA

### Primary snoring

### Mild OSA

### Moderate/severe OSA

### Craniofacial abnormalities

### Obesity

### Residual OSA

## Opzioni di Trattamento

Watch and wait / Dental appliances, mandibular advancement splints, rapid maxillary expansion

Corticosteroids and/or leukotriene modifiers

Surgery: adenotonsillectomy, tonsillectomy alone, adenoidectomy alone

Surgery / CPAP (Continuous Positive Airway Pressure)

Surgery / CPAP (Continuous Positive Airway Pressure)

Corticosteroids and/or leukotriene modifiers / CPAP


Walter, Lisa M. et al. “Treatment of obstructive sleep apnea in children.” (2013).

# Conclusions

- A holistic assessment of factors such as child age, OSA severity, and treatment compliance is imperative to optimize outcomes.
- The collaborative approach between specialists emphasizes the importance of a personalized treatment strategy, which is crucial for the long-term well-being of young OSA patients.
- The goal of research and interdisciplinary collaboration must guide towards increasingly effective and customized solutions to address this complex challenge.

# Key Factors for Therapeutic Success

A multidisciplinary approach is essential to identify the optimal therapeutic strategy for each patient.



Collaborative interaction between pediatricians, orthodontists, and sleep specialists is essential.



This collaborative interaction facilitates the personalization of the treatment according to the peculiarities of each patient, improving the overall effectiveness of the treatment plan.



# Thanks for your attention

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