ReGeo ISSN: 2177-3246

FACTORS ASSOCIATED WITH PERSISTENT OBSTRUCTIVE SLEEP APNEA AFTER ADENOTONSILLECTOMY IN CHILDREN

FATORES ASSOCIADOS À APNEIA OBSTRUTIVA DO SONO PERSISTENTE APÓS ADENOTONSILECTOMIA EM CRIANÇAS

FACTORES ASOCIADOS CON LA APNEA OBSTRUCTIVA DEL SUEÑO PERSISTENTE DESPUÉS DE ADENOTONSILECTOMÍA EN NIÑOS

https://doi.org/10.56238/revgeov17n10-089

Data de submissão: 14/09/2026 **Data de publicação:** 14/10/2026

Fernando Haraoui Scaff[1], Caio Mancilha Pivato Villela[2], Igor Diniz Gonçalves[3], Giovanna Cristina Rocha Machado[4], Victor Corrêa de Andrade Rodrigues da Silva[5], Maria Eduarda Bertaia Stefanini Matos[6], Rodrigo Lepera Ramires[7]

ABSTRACT

Background: Adenotonsillectomy improves pediatric obstructive sleep apnea, but postoperative normalization is inconsistent. Identifying factors associated with persistence can guide counseling, objective reassessment, and long-term surveillance. Objective: To critically synthesize evidence on demographic, anthropometric, respiratory, syndromic, anatomical, and polysomnographic factors associated with persistent obstructive sleep apnea after adenotonsillectomy in children. Methods: A structured narrative review was conducted using PubMed searches completed on October 6, 2026, supplemented by reference screening. Pediatric studies reporting postoperative respiratory outcomes and relevant clinical associations were prioritized. Bibliographic records and available abstracts were verified in PubMed, and accessible full texts were examined. Definitions, follow-up intervals, adjusted associations, and study limitations were compared qualitatively; no pooled estimate was calculated. Results: Obesity and greater baseline severity showed the most consistent associations with persistence. Age, asthma, allergic rhinitis, Down syndrome, multisystem chronic disease, and craniofacial restriction provided additional risk information, with varying independence from confounding. Postoperative weight trajectory was associated with residual or recurrent disease, but evidence that surgery causes excessive adiposity was inconsistent. Rapid eye movement predominance did not consistently predict surgical nonresolution. Estimates depended on diagnostic thresholds, referral selection, and objective versus symptom-based endpoints. Conclusion: Risk assessment should integrate adiposity, baseline polysomnographic severity, airway inflammation, comorbidity, and anatomy. A substantial reduction in respiratory events does not establish cure, and symptom improvement alone is insufficient to exclude persistent disease in high-risk children. Planned

[1] Institution: Universidade Anhembi Morumbi. E-mail: drfernando.h.scaff@gmail.com
[2] Institution: Universidade Anhembi Morumbi. E-mail: Caio.mancilha@gmail.com
[3] Institution: Universidade Anhembi Morumbi. E-mail: i_diniz99@hotmail.com
[4] Institution: Universidade Anhembi Morumbi. E-mail: Giovanna.crm5@gmail.com
[5] Institution: Universidade Anhembi Morumbi. E-mail: dr.victorcorrea@gmail.com
[6] Institution: Universidade Anhembi Morumbi. E-mail: mariaedstefanini@outlook.com
[7] Institution: Universidade Anhembi Morumbi. E-mail: rodrigo_lepera@icloud.com

objective reassessment and continued surveillance are especially relevant when several risk factors coexist.

Keywords: Sleep Apnea. Obstructive. Adenotonsillectomy. Child. Risk Factors.

RESUMO

Contexto: A adenotonsilectomia melhora a apneia obstrutiva do sono pediátrica, mas a normalização pós-operatória é inconsistente. Identificar fatores associados à persistência pode orientar aconselhamento, reavaliação objetiva e vigilância a longo prazo. Objetivo: Sintetizar criticamente a evidência sobre fatores demográficos, antropométricos, respiratórios, sindrômicos, anatômicos e polissonográficos associados à apneia obstrutiva do sono persistente após adenotonsilectomia em crianças. Métodos: Uma revisão narrativa estruturada foi conduzida utilizando buscas no PubMed completadas em 6 de outubro de 2026, suplementada pela triagem de referências. Estudos pediátricos relatando desfechos respiratórios pós-operatórios e associações clínicas relevantes foram priorizados. Registros bibliográficos e resumos disponíveis foram verificados no PubMed, e textos completos acessíveis foram examinados. Definições, intervalos de acompanhamento, associações ajustadas e limitações do estudo foram comparadas qualitativamente; nenhuma estimativa agrupada foi calculada. Resultados: Obesidade e maior gravidade basal mostraram as associações mais consistentes com persistência. Idade, asma, rinite alérgica, síndrome de Down, doença crônica multissistêmica e restrição craniofacial forneceram informações adicionais de risco, com independência variável de confundimento. A trajetória de peso pós-operatória foi associada à doença residual ou recorrente, mas a evidência de que a cirurgia causa adiposidade excessiva foi inconsistente. A predominância do movimento rápido dos olhos não previu consistentemente a não resolução cirúrgica. As estimativas dependeram de limiares diagnósticos, seleção por referência e desfechos objetivos versus baseados em sintomas. Conclusão: A avaliação de risco deve integrar adiposidade, gravidade polissonográfica basal, inflamação das vias aéreas, comorbidade e anatomia. Uma redução substancial em eventos respiratórios não estabelece cura, e a melhora de sintomas isoladamente é insuficiente para excluir doença persistente em crianças de alto risco. Reavaliação objetiva planejada e vigilância contínua são especialmente relevantes quando vários fatores de risco coexistem.

Palavras-chave: Apneia do Sono. Obstrutiva. Adenotonsilectomia. Criança. Fatores de Risco.

RESUMEN

Antecedentes: La adenotonsilectomía mejora la apnea obstructiva del sueño pediátrica, pero la normalización postoperatoria es inconsistente. Identificar factores asociados con la persistencia puede orientar el asesoramiento, la reevaluación objetiva y la vigilancia a largo plazo. Objetivo: Sintetizar críticamente la evidencia sobre factores demográficos, antropométricos, respiratorios, sindrómicos, anatómicos y polisomnográficos asociados con la apnea obstructiva del sueño persistente después de la adenotonsilectomía en niños. Métodos: Se realizó una revisión narrativa estructurada utilizando búsquedas en PubMed completadas el 6 de octubre de 2026, complementada por cribado de referencias. Se priorizaron estudios pediátricos que informaban resultados respiratorios postoperatorios y asociaciones clínicas relevantes. Los registros bibliográficos y resúmenes disponibles se verificaron en PubMed, y se examinaron los textos completos accesibles. Las definiciones, intervalos de seguimiento, asociaciones ajustadas y limitaciones del estudio se compararon cualitativamente; no se calculó ninguna estimación agrupada. Resultados: La obesidad y la

mayor gravedad basal mostraron las asociaciones más consistentes con la persistencia. La edad, el asma, la rinitis alérgica, el síndrome de Down, la enfermedad crónica multisistémica y la restricción craneofacial proporcionaron información de riesgo adicional, con independencia variable del confundimiento. La trayectoria de peso postoperatoria se asoció con enfermedad residual o recurrente, pero la evidencia de que la cirugía causa adiposidad excesiva fue inconsistente. La predominancia del movimiento ocular rápido no predijo consistentemente la no resolución quirúrgica. Las estimaciones dependieron de los umbrales diagnósticos, la selección por derivación y los puntos finales objetivos versus basados en síntomas. Conclusión: La evaluación del riesgo debe integrar adiposidad, gravedad polisomnográfica basal, inflamación de las vías respiratorias, comorbilidad y anatomía. Una reducción sustancial en eventos respiratorios no establece curación, y la mejoría de síntomas sola es insuficiente para excluir enfermedad persistente en niños de alto riesgo. La reevaluación objetiva planificada y la vigilancia continua son especialmente relevantes cuando coexisten varios factores de riesgo.

Palabras clave: Apnea del Sueño. Obstructiva. Adenotonsilectomía. Niño. Factores de Riesgo.

1 INTRODUCTION

Pediatric obstructive sleep apnea (OSA) reflects recurrent upper-airway obstruction during sleep and may affect behavior, growth, cardiovascular function, and quality of life. Adenotonsillectomy is recommended as initial treatment when adenotonsillar hypertrophy is an important contributor, but removal of lymphoid tissue does not address every mechanism of airway collapse. Consequently, postoperative follow-up is necessary to determine whether improvement represents adequate disease control or whether additional assessment is required.[1]

Persistent OSA is increasingly recognized as a distinct clinical problem requiring individualized evaluation. The American Thoracic Society guideline estimates that up to 40% of children may retain OSA after adenotonsillectomy and emphasizes the particular burden in those with obesity, severe baseline disease, and medical complexity. This proportion is useful for contextualizing the problem, but it should not be interpreted as a uniform probability applicable to every surgical population.[2]

The clinical meaning of persistence depends on respiratory-event frequency, gas exchange, symptoms, and associated vulnerability. Expert consensus acknowledges disagreement about the significance and management of mildly abnormal postoperative indices in asymptomatic children, while supporting more deliberate assessment in those with important comorbidities. The central prognostic question is therefore which preoperative and evolving postoperative characteristics identify children who are unlikely to achieve satisfactory normalization.[3]

Randomized evidence demonstrates substantial benefits from surgery without establishing universal cure. In the Childhood Adenotonsillectomy Trial (CHAT), polysomnographic normalization occurred in 79% of children assigned to early surgery and 46% assigned to watchful waiting at seven months, while symptoms and several secondary outcomes improved more after surgery. These results concern a selected school-age population and cannot be extrapolated directly to children with profound hypoxemia, major syndromic disease, or extreme obesity.[4]

Observational cohorts provide a complementary picture of children referred for preoperative and postoperative sleep studies. Bhattacharjee and colleagues reported complete normalization in only 27.2% of 578 children using a postoperative apnea-hypopnea index (AHI) below 1 event/h, whereas Imanguli and Ulualp reported 38% residual disease using an AHI above 2 events/h in a different cohort. Such contrasts illustrate why thresholds,

baseline severity, patient selection, and follow-up practices must accompany any quoted prevalence.[5,6]

A recent systematic review identified obesity, age, comorbidity, craniofacial characteristics, and baseline AHI as recurring risk domains across heterogeneous studies. Its findings support a multifactorial approach, but they also show that apparently similar outcome labels may represent different endpoints and populations. An updated critical synthesis should therefore consider both the direction of associations and the strength of the underlying evidence rather than simply list possible predictors.[7]

2 OBJECTIVE

To evaluate factors associated with persistent OSA after adenotonsillectomy in children, with particular attention to obesity, baseline disease severity, age, inflammatory airway disease, syndromic and complex chronic conditions, craniofacial anatomy, and postoperative weight trajectory. A secondary objective was to distinguish reproducible associations from findings that are limited by outcome definition, confounding, or selected referral populations. The clinical purpose was to inform preoperative counseling and selection of children for objective postoperative reassessment.

3 METHODS

3.1 REVIEW DESIGN AND INFORMATION SOURCES

This manuscript is a structured narrative evidence review based on a reproducible PubMed search, targeted supplementary searches, and examination of relevant reference lists. Searches were completed on October 6, 2026, with a publication-date upper limit of October 6, 2026, and no lower publication-date restriction. The review was designed to critically integrate prognostic evidence rather than estimate a pooled incidence or claim an exhaustive, independently screened systematic review.

The principal search combined surgery, disease, pediatric population, and prognostic terms: (adenotonsillectom* OR (tonsillectom* AND adenoidectom*)) AND (obstructive sleep apnea OR obstructive sleep apnoea OR OSA OR OSAS) AND (child* OR pediatric* OR paediatric* OR adolescen*) AND (residual OR persist* OR recur* OR predictor* OR risk factors). Title/abstract fields were used for free-text terms, with additional Medical Subject Headings for obstructive sleep apnea and children. Targeted searches addressed obesity,

allergic rhinitis, Down syndrome, postoperative weight change, rapid eye movement-related indices, and practice guidelines.

3.2 STUDY SELECTION AND EVIDENCE EXTRACTION

Priority was given to studies of participants younger than 18 years that evaluated adenotonsillectomy and reported postoperative OSA, respiratory-event indices, or factors associated with nonresolution. Cohorts, comparative studies, and secondary trial analyses were considered, with mixed-procedure reports flagged separately and guidelines or systematic reviews used for context. Studies limited to adult populations, immediate anesthetic complications without later respiratory outcomes, isolated case reports, and reports without relevant postoperative assessment were not used as core prognostic evidence.

For each core study, population characteristics, operative context, postoperative timing, diagnostic threshold, outcome frequency, and reported associations were extracted from the available record and, when accessible, the full text. Every cited item was confirmed by its PubMed record, and bibliographic details were checked against the indexed metadata. Studies using symptom-based or mixed endpoints were identified explicitly and were not treated as interchangeable with polysomnography-confirmed persistence.

3.3 CRITICAL SYNTHESIS AND METHODOLOGICAL BOUNDARIES

Evidence was organized by risk domain, separating adjusted associations from unadjusted comparisons and distinguishing early residual disease from later recurrence. Critical appraisal considered retrospective selection, incomplete follow-up, availability of postoperative polysomnography, outcome thresholds, confounder adjustment, sample size, and overlap between analyses of the same trial. No protocol registration, duplicate independent screening, formal risk-of-bias score, or certainty grade was assigned, and these procedures are not claimed.

A meta-analysis was not performed because the selected evidence differed substantially in eligibility, respiratory indices, thresholds, postoperative intervals, and covariate models. Study-specific quantitative findings were retained where they clarified magnitude or illustrated differences in definition. Table 1 summarizes the core prognostic studies, while contextual publications inform interpretation, symptom validity, growth, and clinical follow-up.

4 RESULTS AND DISCUSSION

4.1 OUTCOME DEFINITIONS AND THE DISTINCTION BETWEEN IMPROVEMENT AND CURE

A postoperative AHI below 5 events/h is often reported as a favorable outcome, although it may still include mild pediatric OSA. In the multicenter cohort of Bhattacharjee and colleagues, mean AHI fell from 18.2 to 4.1 events/h, yet only 157 of 578 children met the stricter threshold below 1 event/h. The magnitude of improvement and the proportion achieving normalization thus answer different questions and should be reported separately.[5]

The same distinction changes interpretation within a single study. Among 75 children with Down syndrome studied by Ingram and colleagues, cure rates were 12% using an obstructive AHI below 1 event/h and 21% using a threshold below 2 events/h, although respiratory indices improved substantially. Reporting a treatment response without its endpoint can therefore conceal a considerable burden of residual obstruction.[8]

Selection for postoperative polysomnography also affects estimated persistence. Cohorts requiring two sleep studies can preferentially include children with severe disease, ongoing symptoms, or medical complexity, whereas routine clinical follow-up may miss asymptomatic physiological abnormalities. Consequently, neither referral-based polysomnographic prevalence nor symptom-based prevalence should automatically be generalized to all children undergoing surgery.[6,9]

4.2 OBESITY AND ADIPOSITY-RELATED AIRWAY VULNERABILITY

Obesity is the most reproducible anthropometric correlate of incomplete postoperative resolution. In the 169-child cohort of Imanguli and Ulualp, residual OSA occurred in 49% of children with obesity and 27% of those without obesity. The direction of this association agrees with the multicenter finding that body mass index z score contributed importantly to postoperative AHI, although these observational findings do not isolate a single causal pathway.[5,6]

Contemporary evidence reinforces the association after adjustment for other clinical variables. A 2026 retrospective cohort of 642 children reported residual OSA in 26.8%, defined by a postoperative obstructive AHI of at least 2 events/h at six to twelve months. Obesity was associated with higher adjusted odds of persistence, with an odds ratio (OR) of 3.12 and a 95% confidence interval (CI) of 1.85–5.26, alongside baseline AHI and asthma.[10]

The problem is particularly relevant in adolescents with obesity. Kearney and colleagues found clinically meaningful AHI reductions after surgery, but only 48% of the 70 adolescents with obesity achieved an AHI below 5 events/h, and their odds of residual moderate or severe OSA were higher than in 32 nonobese comparators (OR 7.1; 95% CI 2.24–22.48). These findings support realistic counseling and planned reassessment while also showing that a high risk of persistence does not mean that surgery provides no benefit.[11]

Earlier prospective comparative evidence showed the same pattern. Mitchell and Kelly observed persistent OSA in 76% of 33 children with obesity and 28% of 39 normal-weight children, despite marked reductions in respiratory-event frequency in both groups. Variation in the absolute percentages across studies is compatible with differing thresholds and case mix and should not obscure the consistent direction of the obesity association.[12]

Anatomical imaging provides a plausible explanation for incomplete correction. In 27 children with obesity, Nandalike and colleagues observed enlargement of the pharyngeal airway after surgery but also substantial residual adenoid tissue and increases in tongue and soft-palate volume. These observations suggest that removing palatine tonsillar obstruction can leave other structural contributors, although the small imaging cohort cannot establish which anatomical finding independently predicts persistence.[13]

4.3 POSTOPERATIVE WEIGHT TRAJECTORY AND LATE RECURRENCE

Risk is dynamic because adiposity and airway anatomy continue to change after surgery. In the longitudinal study of Huang and colleagues, mean AHI improved at six months but increased during subsequent follow-up, and later recurrence was associated with weight and body mass index changes as well as earlier postoperative severity. Only 88 of the original 135 children completed the three-year assessment, making attrition an important qualification when interpreting the long-term estimates.[14]

A more recent retrospective cohort evaluated perioperative weight change in 250 children aged two to seventeen years. Each additional kilogram was associated with increased odds of residual OSA above 5 events/h (OR 1.06; 95% CI 1.02–1.10) and residual severe OSA above 10 events/h (OR 1.08; 95% CI 1.04–1.12). Because an absolute kilogram has different implications across ages and body sizes, these estimates should be interpreted within the original model rather than converted into a universal individual risk calculator.[15]

The association between weight gain and persistence should be distinguished from the claim that adenotonsillectomy itself causes harmful adiposity. The initial CHAT growth

analysis found greater increases in body mass index z score after early surgery, whereas a later reanalysis using a different adiposity metric and accounting for baseline weight status and OSA resolution did not find an increased risk of excessive weight gain. This disagreement supports monitoring growth trajectories while avoiding a blanket assumption that postoperative weight recovery is pathological, particularly in children initially underweight.[16],[17]

4.4 BASELINE RESPIRATORY SEVERITY AND GAS-EXCHANGE ABNORMALITIES

Higher baseline AHI repeatedly identifies children who are less likely to normalize after surgery. In the 2026 cohort, each unit increase in baseline AHI was associated with higher adjusted odds of residual disease (OR 1.08; 95% CI 1.05–1.11). This is a model-specific estimate and does not establish a universally valid linear relationship across the entire severity spectrum.[10]

Gas-exchange abnormalities can provide additional information beyond event frequency. Among 74 otherwise relatively healthy children with very severe OSA, Isaiah and colleagues reported normalization in 32% using AHI below 1 event/h and in 80% using AHI below 5 events/h, with baseline hypoxemia and hypercapnia related to poorer outcomes. The study supports reviewing oxygenation and carbon dioxide burden alongside AHI, but its selected population and retrospective design limit the precision of individual prediction.[18]

Baseline severity is important even in very young children. Nath and colleagues found residual AHI above 5 events/h in 21% of the 70 children younger than three years who had postoperative testing, with preoperative severity the most consistent predictor. Only a subset of the 283 children with preoperative polysomnography underwent postoperative testing, illustrating how verification and follow-up selection can influence the observed risk.[19]

4.5 AGE AND DEVELOPMENTAL STAGE

Several general pediatric cohorts associate older age with poorer postoperative normalization. The multicenter analysis highlighted children older than seven years, while the Imanguli cohort reported greater residual disease among teenagers than in younger age groups. These findings may reflect changes in adiposity, airway growth, disease duration, and the relative contribution of adenotonsillar tissue, so age should be interpreted together with phenotype rather than as an isolated contraindication to surgery.[5],[6]

Studies restricted to children younger than three years show substantial improvement but variable residual disease. Rayasam and colleagues reported improvement in 94% of 87

children, while 78% still met an AHI threshold of at least 1 event/h after surgery. This does not demonstrate that young age independently raises risk relative to older children, because the study lacked an older comparison group and used a sensitive residual-disease threshold.[20]

Airway abnormalities detected in very young children are not necessarily predictors of surgical failure. In a cohort of 39 children, synchronous airway lesions were not significantly associated with nonresolution, whereas higher baseline obstructive AHI and lower oxygen saturation nadir distinguished those with persistent disease. This negative finding argues against treating every coexisting lesion as an established prognostic factor and reinforces the need to consider physiological relevance.[21]

4.6 ASTHMA, ALLERGIC RHINITIS, AND OTHER RESPIRATORY COMORBIDITIES

Asthma is associated with incomplete resolution in several cohorts, but the strength of the association depends on adjustment and population. Bhattacharjee and colleagues identified a modest contribution among nonobese children, and the 2026 cohort found an adjusted OR of 1.95 (95% CI 1.12–3.40) for concurrent asthma. These observations justify attention to airway disease while leaving uncertainty about the extent to which better asthma control independently modifies postoperative OSA risk.[5,10]

Allergic rhinitis has support from a secondary analysis of randomized-trial data. Wang and colleagues analyzed 372 CHAT participants and found lower adjusted odds of OSA resolution after surgery in children with allergic rhinitis (OR 0.43; 95% CI 0.19–0.96). Because rhinitis was not randomly assigned and the analysis was secondary, the association does not prove that a specific rhinitis intervention prevents persistence.[22]

The Qatar cohort provides additional evidence but used a mixed clinical endpoint. Among 410 children undergoing adenoidectomy and/or tonsillectomy, 52 had persistent symptoms, with the reported 15.4% prevalence based on those followed postoperatively, and allergic rhinitis and syndromic disorders remained associated in the regression analysis. Asthma, young age, and gastroesophageal reflux were significant in univariate analyses, which should not be recast as independently confirmed predictors.[9]

Reflux deserves particular caution because symptoms, airway inflammation, obesity, and syndromic disease may overlap. Its association in selected young or symptom-based cohorts provides a reason to examine relevant clinical history, but the available evidence does not establish reflux as a uniformly independent determinant of polysomnography-

confirmed persistence. A prognostic association also does not establish that empiric reflux treatment will resolve postoperative airway obstruction.[9,20]

4.7 DOWN SYNDROME AND COMPLEX CHRONIC CONDITIONS

Children with Down syndrome frequently retain OSA after adenotonsillectomy despite meaningful improvements in breathing. A meta-analysis of nine studies involving 384 participants found success rates of 16% using postoperative AHI below 1 event/h and 57% using AHI below 5 events/h. The contrast supports interpreting surgery as potentially beneficial within a broader management pathway rather than promising normalization from adenotonsillar removal alone.[23]

A 2024 single-center cohort of 48 children with Down syndrome found that 54.2% retained moderate or severe OSA. Lower preoperative oxygen saturation nadir was associated with that outcome in univariate analysis, but this does not establish an independently validated prediction rule. Alongside the Ingram cohort, the findings support planned postoperative physiological assessment even when symptoms and event frequency improve.[8,24]

Medical complexity beyond Down syndrome also matters. In 133 children studied by Amin and colleagues, persistence occurred in 57% of those with multisystem chronic conditions, 29% with single-system conditions, and 15% without complex chronic conditions. The higher odds in the multisystem group indicate that cumulative comorbidity can help identify a high-risk phenotype, although the category comprises heterogeneous disorders rather than a single mechanism.[25]

4.8 CRANIOFACIAL RESTRICTION AND RESIDUAL SITES OF OBSTRUCTION

Craniofacial morphology can limit the airway benefit achieved by removing lymphoid tissue. Maeda and colleagues reported residual OSA in 11 of 13 children and an inverse relationship between maxillomandibular dimensions and postoperative AHI. The study is mechanistically informative but too small and selected to support a reliable screening cutoff or a generalizable independent risk estimate.[26]

Evidence from children already known to have persistent disease helps locate obstruction but should not be mistaken for prospective prediction. Cine magnetic resonance imaging in 27 children with Down syndrome identified combinations of macroglossia, glossoptosis, recurrent adenoid enlargement, hypopharyngeal collapse, and lingual tonsillar

enlargement. Because all participants had persistent disease, the study characterizes potential causes among affected children rather than estimating the risk associated with these findings before surgery.[27]

For a child with confirmed persistence, identifying the remaining site of obstruction can make subsequent assessment more specific. Expert consensus supports drug-induced sleep endoscopy when additional airway surgery is being considered, and the American Thoracic Society guideline discusses anatomy-directed options in selected patients. These recommendations should guide evaluation of established postoperative disease rather than imply that every child requires advanced airway testing before initial adenotonsillectomy.[2],[3]

4.9 SLEEP-STAGE INDICES AND PREDICTORS THAT REMAIN UNCERTAIN

Rapid eye movement (REM)-related severity may appear intuitively useful, but it has not consistently predicted surgical nonresolution. In 353 children, a retrospective study found persistent OSA in 65.7% using obstructive AHI of at least 1.5 events/h, with no significant difference between REM-predominant and REM-independent disease. Baseline REM AHI should therefore not be presented as a validated standalone predictor on the basis of that study.[28]

A 2026 CHAT secondary analysis adds a useful distinction between spontaneous and postoperative resolution. REM-predominant disease was associated with lower odds of resolution during watchful waiting, but its association with resolution after adenotonsillectomy was not statistically significant (adjusted OR 0.75; 95% CI 0.34–1.66). A marker of persistence without treatment thus cannot automatically be assumed to predict failure of surgical treatment.[29]

Sex and racial categories have been associated with outcomes in individual observational models, including the perioperative-weight cohort. Such variables may capture differences in baseline severity, adiposity, environmental exposures, referral patterns, access to care, or unmeasured social conditions rather than a simple intrinsic biological mechanism. They should not be used as deterministic explanations or independently actionable predictors without replication and careful consideration of confounding.[15]

4.10 IMPLICATIONS FOR SURVEILLANCE AND COUNSELING

Follow-up should be planned before surgery when obesity, severe baseline OSA, syndromic disease, or multiple comorbidities are present. The pediatric tonsillectomy

guideline specifically recommends counseling families that sleep-disordered breathing may persist or recur and may require further management. Immediate postoperative monitoring and later evaluation for residual OSA address different clinical questions, even though some of the same risk characteristics influence both.[30]

Clinical improvement is important but may not accurately classify postoperative physiological status. In 117 children with Down syndrome, parental perception of nighttime breathing did not reliably correspond to postoperative OSA category or its change after surgery. This evidence supports objective reassessment in high-risk children rather than relying on an apparent reduction in snoring to confirm success.[31]

Persistent symptoms can also occur after physiological normalization. A study of 62 children with postoperative AHI below 1 event/h and no adenoid regrowth found residual mouth breathing associated with age, preoperative adenoid size, and dentofacial abnormalities. Consequently, persistent mouth breathing warrants assessment but does not, by itself, establish persistent OSA.[32]

The timing and scope of reassessment should reflect recovery, baseline risk, symptoms, and access to testing. Pediatric guidance supports postoperative reevaluation and objective testing for children at high risk or with continuing symptoms, while expert consensus generally favors allowing recovery before a follow-up sleep study when clinically appropriate. Reappearance of symptoms, increasing adiposity, or deterioration in function should prompt renewed assessment even after an initially favorable postoperative result.[1],[3],[14]

4.11 EVIDENCE LIMITATIONS AND PRIORITIES FOR RESEARCH

The literature is dominated by retrospective cohorts and selected populations with paired sleep studies. Differences in AHI versus obstructive AHI, cure thresholds, follow-up timing, and symptom-based definitions prevent simple comparison of prevalence estimates or direct pooling of prognostic coefficients. Correlated factors such as age, obesity, baseline severity, asthma, and syndromic disease also complicate attribution of independent effects.[6],[7]

Several publications are secondary analyses of CHAT and should not be counted as independent patient cohorts when evaluating the cumulative evidence. This review additionally relies on indexed abstracts when full texts were inaccessible and does not include duplicate screening, formal risk-of-bias scoring, or an exhaustive search of multiple bibliographic databases. Its conclusions are therefore a critical synthesis of verified evidence rather than a new pooled prediction model or a formally graded systematic review.

Future studies should prospectively assess consecutive surgical patients using standardized postoperative respiratory thresholds and prespecified follow-up intervals. Prediction models require external validation, calibration, and evaluation of whether their use improves surveillance and clinically meaningful outcomes rather than discrimination alone. The strongest practical research question is whether addressing modifiable factors and planning objective follow-up can reduce the burden of missed residual disease without delaying effective initial treatment.

Table 1

Core studies addressing postoperative persistence and associated factors

Reference	Population / Intervention / Comparison	Outcomes	Main conclusions
Bhattacharjee et al. (2010) [5]	578 children; multicenter retrospective cohort; preoperative and postoperative polysomnography.	AHI decreased from 18.2 to 4.1 events/h; 27.2% achieved AHI <1.	Age and body mass index z score contributed to residual AHI; asthma and baseline AHI also contributed in nonobese children.
Imanguli and Ulualp (2016) [6]	169 children; retrospective cohort; obesity, comorbidity, age, and severity compared.	Residual AHI >2 in 38%; 49% with obesity versus 27% without obesity.	Obesity, adolescence, severe baseline OSA, and neurological/developmental/craniofacial comorbidity were associated with persistence.
Ingram et al. (2017) [8]	75 children with Down syndrome; tonsillectomy with concurrent or prior adenoidectomy; paired studies.	Cure: 12% at obstructive AHI <1 and 21% at <2; about half retained moderate/severe disease.	Respiratory indices and gas exchange improved, but normalization was uncommon; asleep oxygen saturation related to postoperative severity.
Alhalabi et al. (2024) [9]	410 children; adenoidectomy and/or tonsillectomy; retrospective Qatar cohort with mixed symptom/polysomnography endpoints.	52 had persistent symptoms; reported prevalence 15.4% used postoperative follow-up denominator.	Allergic rhinitis and syndromic disorders remained associated in regression. Mixed endpoints should not be equated with objectively confirmed OSA.
Zhang et al. (2026) [10]	642 children aged 3–14 years; retrospective cohort; polysomnography 6–12 months after surgery.	Residual obstructive AHI ≥2 in 26.8%.	Adjusted associations: obesity OR 3.12; baseline AHI OR 1.08 per unit; asthma OR 1.95. External validation was not established.
Kearney et al. (2022) [11]	70 adolescents with obesity versus 32 nonobese adolescents; paired sleep studies.	48% of the obesity group achieved AHI <5; residual moderate/severe OSA OR 7.1.	Surgery improved OSA, but obesity was associated with markedly greater residual disease and positive airway pressure requirements.
Mitchell and Kelly (2007) [12]	33 children with obesity versus 39 normal-weight children; prospective comparative study.	Persistent OSA in 76% versus 28%, respectively.	Both groups improved; children with obesity retained more disease. The reported prevalence is specific to the study definition.

Reference	Population / Intervention / Comparison	Outcomes	Main conclusions
Nandalike et al. (2013) [13]	27 children with obesity; polysomnography and upper-airway magnetic resonance imaging before and after surgery.	AHI decreased from 23.7 to 5.6 events/h; resolution in 44% overall.	Residual adenoid tissue and changes in tongue/soft-palate volume supported a multifocal anatomical explanation; independent prediction was not established.
Huang et al. (2014) [14]	135 children enrolled; 88 completed three years; repeated clinical and polysomnographic assessments.	AHI >1 in 53.4% at six months and 68% at three years among completers.	Residual disease related to baseline factors; later recurrence related to postoperative severity and weight/body mass index trajectory. Attrition limits interpretation.
Dang et al. (2024) [15]	250 children aged 2–17 years; retrospective perioperative weight and sleep-study analysis.	Per kilogram gained: residual AHI >5 OR 1.06; residual AHI >10 OR 1.08.	Weight change and baseline AHI were associated with persistence. Absolute weight effects are model-specific and may be confounded by growth.
Isaiah et al. (2017) [18]	74 children aged 2–12 years with baseline obstructive AHI >30; major comorbidities excluded.	32% achieved AHI <1; 80% achieved AHI <5.	Hypoxemia and hypercapnia were associated with residual disease; threshold choice substantially changed the apparent success rate.
Nath et al. (2013) [19]	Children younger than three years; 283 had baseline polysomnography, 70 had paired studies.	21% of the paired-study subgroup had residual AHI >5.	Preoperative severity was the most consistent predictor. Selective postoperative testing limits generalizability.
Rayasam et al. (2024) [20]	87 children younger than three years; retrospective paired-polysomnography cohort.	94% improved; 78% retained AHI ≥1.	Improvement was frequent but normalization was uncommon. The age-restricted cohort cannot demonstrate an independent effect of young age.
Michelson et al. (2014) [21]	39 children younger than three years; paired studies; selected children underwent airway evaluation.	Higher baseline obstructive AHI and lower oxygen nadir were associated with nonresolution.	Synchronous airway lesions did not significantly predict failure; anatomical findings require clinical and physiological interpretation.
Wang et al. (2024) [22]	372 CHAT participants; secondary analysis comparing children with and without allergic rhinitis.	Rhinitis associated with lower adjusted odds of resolution after surgery: OR 0.43.	Supports rhinitis as a risk correlate; secondary observational exposure analysis does not establish a preventive treatment effect.
Senthilvel et al. (2024) [24]	48 children with Down syndrome; retrospective study; selected matched non-Down-syndrome comparisons.	54.2% retained moderate/severe OSA; obstructive AHI decreased from 17.9 to 9.1 events/h.	Lower oxygen nadir was associated with moderate/severe persistence in univariate analysis; not an independently validated predictor.
Amin et al. (2018) [25]	133 children with moderate/severe OSA; comparison by burden of complex chronic conditions.	Persistence: 57% multisystem, 29% single-system, 15% without complex chronic conditions.	Multisystem disease identified a higher-risk group, but the category includes heterogeneous mechanisms and disorders.

Reference	Population / Intervention / Comparison	Outcomes	Main conclusions
Maeda et al. (2014) [26]	13 children; preliminary study relating cephalometric dimensions to postoperative AHI.	11 of 13 retained OSA; smaller maxillomandibular dimensions correlated with residual AHI.	Supports an anatomical contribution; sample size and selection preclude a validated cutoff or robust independent risk estimate.
Fields et al. (2024) [28]	353 children; retrospective cohort; craniofacial/neuromuscular disorders excluded.	Persistent obstructive AHI ≥1.5 in 65.7%; no significant difference by REM predominance.	REM AHI did not reliably predict nonresolution; persistence estimates depend on the selected cohort and threshold.
Wang et al. (2026) [29]	382 CHAT participants; 2026 secondary analysis of REM predominance and treatment strategy.	After surgery, adjusted resolution OR 0.75 (95% CI 0.34–1.66) for REM-predominant disease.	REM predominance related to less spontaneous resolution during watchful waiting, but did not significantly distinguish surgical resolution.

AHI, apnea-hypopnea index; CI, confidence interval; CHAT, Childhood Adenotonsillectomy Trial; OR, odds ratio; OSA, obstructive sleep apnea; REM, rapid eye movement. Rates and thresholds retain each study's original definition; adjusted and unadjusted results are distinguished in the text.
Source: Prepared by the authors.

AHI, apnea-hypopnea index; CI, confidence interval; CHAT, Childhood Adenotonsillectomy Trial; OR, odds ratio; OSA, obstructive sleep apnea; REM, rapid eye movement. Rates and thresholds retain each study’s original definition; adjusted and unadjusted results are distinguished in the text.

5 CONCLUSION

Persistent OSA after adenotonsillectomy is best understood as a multifactorial outcome whose apparent frequency depends on both patient characteristics and the definition used. Obesity and greater baseline respiratory severity are the most consistently supported risk factors, while age, asthma, allergic rhinitis, Down syndrome, multisystem chronic disease, craniofacial restriction, and postoperative weight trajectory provide additional context. Associations derived from small cohorts, symptom-based endpoints, or unadjusted analyses require more cautious interpretation than replicated, adjusted findings.

Preoperative counseling should distinguish likely improvement from complete normalization and anticipate postoperative reassessment when several risk factors coexist. Clinical symptoms, respiratory-event indices, gas exchange, growth, and functional outcomes should be interpreted together, with objective testing particularly important in medically

complex children. Continued surveillance remains relevant because early residual disease and later recurrence are different but related challenges.

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