



Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com/en



SFORL Guidelines

Guidelines of the French Society of Otorhinolaryngology. Role of the ENT specialist in the diagnosis of childhood obstructive sleep apnea-hypopnea syndrome (OSAHS). Part 1: Interview and physical examination



J.C. Leclere^{a,*}, R. Marianowski^a, P.J. Monteyrol^b, M. Akkari^c, F. Chalumeau^d, P. Fayoux^e, N. Leboulanger^f, P. Franco^{g,h}, V. Couloigner^f, M. Mondain^c

^a Service d'ORL et de chirurgie cervico-faciale, hôpital Morvan, université de Bretagne Occidentale, CHRU Brest, 29200 Brest, France

^b ORL, polyclinique du Tondu, 33000 Bordeaux, France

^c Service d'ORL, hôpital Gui de Chauliac, université de Montpellier, CHU Montpellier, 34295 Montpellier, France

^d ORL, 67, boulevard Pasteur, 94260 Fresnes, France

^e Service d'ORL, hôpital Jeanne de Flandres, université Lille 2, CHRU Lille, 59120 Loos, France

^f Service d'ORL pédiatrique, hôpital Necker-Enfants-Malades, université Paris Descartes, AP-HP, 75015 Paris, France

^g Inserm U1028, CNRS UMR 5292, université Lyon 1, 69677 Bron, France

^h Unité de sommeil pédiatrique, hôpital Femme-Mère-Enfant, hospices Civils de Lyon, 69003 Lyon, France

ARTICLE INFO

Keywords:

Obstructive sleep apnea-hypopnea syndrome
 Child
 Adolescent
 Obesity
 Spruyt Gozal score
 PSQ (Pediatric Sleep Questionnaire)

ABSTRACT

Objectives: To present the 2017 Clinical Practice Guidelines of the French Society of Otorhinolaryngology concerning the role of the ENT specialist in the diagnosis of pediatric obstructive sleep apnea-hypopnea syndrome. This article focuses specifically on medical history and physical examination.

Methods: A multidisciplinary work-group drew up a first version of the guidelines, graded according to level of evidence following the GRADE grading system. The final version was obtained by including the suggestions and comments from the editorial group.

Results: At the end of the process, guidelines were established and graded regarding the following points: interview and analysis of the various interview scores recommended in the literature; clinical examination with awake upper-airway endoscopy; and indications for referral to non-ENT specialists.

© 2019 Published by Elsevier Masson SAS.

1. Introduction

Clinical examination aims to identify obstruction sites and associated pathologies implicated in obstructive sleep apnea-hypopnea syndrome (OSAHS), risk factors affecting treatment, and individuals at risk of future complications.

2. Material and methods

2.1. Literature search

Relevant articles were retrieved from the PubMed database of the American National Center for Biotechnology Information, hosted by the National Institutes of Health National Library of

Medicine, for the period up to May 2018. Articles were graded by levels of evidence 1 to 4, and the guidelines were graded A, B, C, D or expert opinion by decreasing level of evidence, following the French Health Authority's 2000 guide to literature analysis and recommendations grading (available at <https://www.has-sante.fr>; see Appendix A).

2.2. Writing stages

The organizational committee:

- defined the guidelines objectives and plan;
- chose the work-group members so as to ensure that target specialties were well represented and that the group covered the national territory.

The work-group drew up a first draft of the guidelines, which was submitted to an editorial group for comments and suggestions.

* Corresponding author.

E-mail address: leclere.jean-christophe@hotmail.fr (J.C. Leclere).

The final version was drawn up by the work-group taking account of these comments. It is available on the ORL France website: <https://www.orlfrance.org>. The present article summarizes this final version, keeping the sense while adding certain recent data from the literature: the original search stopped at 2016, whereas the present article extends to 2018.

3. Results

The data most relevant to clinical assessment of suspected childhood OSAHS come from level 1 studies [1–7].

3.1. Interview

Medical and surgical history-taking should screen for:

- personal history of prematurity and family history of OSAHS, both associated with elevated risk of OSAHS;
- comorbidities, often of genetic origin, incurring high risk of severe OSAHS, complex multi-level obstruction and treatment failure:
 - morbid obesity,
 - craniofacial or upper-airway deformity,
 - neuromuscular disease with pharyngeal hypotonia,
 - metabolic disease with upper-airway submucosal conjunctive tissue infiltration (mucopolysaccharidosis),
 - comorbidities incurring risk of complications following OSAHS surgery: cardiopathy, coagulation disorder, poorly controlled asthma, homozygous sickle-cell disease.

The diagnostic, prognostic and therapeutic implications of such elements of history led to a 3-type classification of childhood OSAHS [8]. Type I is young children free of overweight, with marked adenotonsillar hypertrophy; type II is obese children; and type III is children with other elements of history associated with risk of severe OSAHS and treatment problems: craniofacial or upper-airway deformity, neuromuscular disease with pharyngeal hypotonia, metabolic disease with submucosal conjunctive tissue infiltration.

The interview should also screen for the main symptoms suggesting OSAHS, as shown in Table 1.

In adolescents, OSAHS involves certain particular symptoms:

- the classical nocturnal signs seen in younger children (snoring, night sweats, agitation, parasomnia, cervical hyperextension, etc.) are less frequent (level of evidence, 4) [9];
- among daytime signs, somnolence (sometimes in class) is more frequent, and certain misleading alarm signs may be observed: withdrawal, anxiety, depression, aggressiveness, oppositional behavior (level of evidence, 4) [9,10].

3.2. Questionnaires

The ETUDE CHAT randomized clinical trial in childhood adenotonsillectomy confirmed the sensitivity of clinical questionnaires in regard to the potential severity of OSAHS [11] (level of evidence, 1). Various scores are available, such as the Epworth Sleepiness Scale (ESS) and OSAS 18 [12–14]; the Spruyt Gozal questionnaire (Appendix B) [15] has the double advantage of having been validated in its French version [16] and showing good correlation with the apnea-hypopnea index (AHI) (level of evidence, 2) [15,16]. The Sleep-Related Breathing Disorder scale of the Pediatric Sleep Questionnaire (SRBD-PSQ) correlates with improvement

Guideline n° 1. Interviewing children with suspected OSAHS

The interview details:

- medical and surgical history, and notably (GRADE A):
 - elements associated with higher risk of OSAHS: prematurity, family history of OSAHS,
 - comorbidities associated with severe OSAHS in which treatment is complicated: craniofacial or upper-airway deformity, neuromuscular disease with pharyngeal hypotonia, metabolic disease with submucosal conjunctive tissue infiltration,
 - comorbidities with risk of surgical complications: coagulation disorder, cardiopathy, poorly controlled asthma, homozygous sickle-cell disease.
- It screens for the main signs of nocturnal and diurnal childhood OSAHS (GRADE A)
- In adolescents, symptoms often differ from those of childhood (GRADE C)

Guideline n° 2 (GRADE B). It is recommended to use a clinical score based on parent and/or child interview to assess OSAHS severity (Expert opinion). Two questionnaires are recommended: Spruyt Gozal, correlating with apnea-hypopnea index and validated in French, and PSQ, predictive of adenotonsillectomy outcome.

following adenotonsillectomy (level of evidence, 2) [17], but is not yet validated in French.

3.3. Physical examination

Physical examination includes general clinical examination, dentofacial inspection, oropharyngeal examination and waking head and neck endoscopy of the upper airway from nasal cavities to larynx without extending to the glottis. Ideally, a small-diameter (2.2 mm) pediatric endoscope should be used (Expert opinion). Two randomized prospective studies showed no relief of discomfort with use of lidocaine spray (level of evidence, 1) [18,19]. Moreover, 5% lidocaine does not have market authorization for under-16 year-old patients, due to risk of convulsions.

The abnormalities screened for on physical examination comprise:

- open-mouth breathing.
- dentofacial abnormalities, of genetic origin (familial predisposition, syndrome with facial dysmorphism) or related to permanent open-mouth breathing causing defective tongue contact with palate and mandible and oro-linguo-facial muscle hypotonia. These abnormalities may consist in adenoid-type face (long and narrow), narrow ogive palate, micrognathia, retrognathia, or maxillary endognathia [20–22]. They should be more precisely analyzed and treated by an orthopedic dentofacial specialist (Expert opinion);
- nasal obstruction reported by the child if old enough or diagnosed using a mirror or frayed cotton bud placed under the nostrils (little or no movement of the cotton during respiration or little or no fog on the mirror on expiration) and on endoscopy;
- adenoid hypertrophy, assessed endoscopically. Meta-analyses showed that lateral nasopharyngeal radiographs are not to be recommended in this indication [23] (Level of evidence, 1). The degree of adenoid hypertrophy can be semi-quantified on

Table 1
Diurnal and nocturnal signs of OSAHS [1–7].

| Sleeping | Waking | Other |
|--|---|---|
| Sleeping seated or in cervical hyperextension | Headache, fatigue, wrinkles on awakening | Open-mouth breathing |
| Frequent snoring (> 3 nights per week) for at least 3 months | Somnolence (rarer than in adults) | Secondary statural and ponderal growth impairment |
| Cyanosis | Attention disorder, hyperactivity, learning difficulties, memory disorder, difficulties at school | |
| Night-sweats | Slow mastication/swallowing disorder [6,7] | |
| Agitation | | |
| Frequent awakening | | |
| Parasomnia: somniloquy, bruxism, somnambulism, night terror, confusional arousal, nightmares [4,5] | | |
| Apnea with noisy resumption of in-breath ^a | | |
| Enuresis (especially secondary, after ≥ 6 months' continence) | | |
| Napping after 7 years of age | | |

^a Reported or preferably recorded or videoed by parents (e.g., smartphone).

Table 2
Cassano classification [24] of adenoid hypertrophy on awake endoscopy in consultation.

| Degree |
|--|
| Adenoid tissue down to superior quarter of choanal opening |
| Adenoid tissue down to superior half of choanal opening |
| Adenoid tissue down to inferior quarter of choanal opening |
| Adenoid tissue down to choanal floor |

Table 3
Brodsky [30] and Friedman classifications [28] of tonsillar hypertrophy on oropharyngeal examination in consultation.

| Degree | Brodsky score | Friedman score |
|--------|---------------------------------|--|
| | Oropharyngeal obstruction ≤ 25% | Tonsils in tonsillar fossa |
| | Obstruction 26–50% | Tonsils visible beyond anterior pillars |
| | Obstruction 51–75% | Tonsils extending three-quarters of way to midline |
| | Obstruction > 75% | “Kissing tonsils” |

Cassano score (Level of evidence, 3) [24] (Table 2). It seems to correlate with AHI (level of evidence, 2) [25,26]. Certain isolated cases may lead to severe OSAHS in infants (level of evidence, 3) [27];

- high Mallampati score (GRADE C). This score is based on oropharyngeal examination and is widely used by anesthetists to predict intubation problems. Class 1: uvula fully visible; class 2: uvula partially visible; class 3: uvula not visible, but rest of the palate visible; class 4: only hard palate visible. It also correlates with Friedman palatine position score [28]. A retrospective study of 158 children aged 3–18 years suggested that it correlates positively with OSAHS risk, a 1-class rise multiplying risk 6-fold (level of evidence, 3) [29]. It is more predictive when scored supine than sitting.
- tonsillar hypertrophy (Table 3) is more reliably classified on modified Brodsky score [30] than Friedman score in terms of intra- and inter-observer reproducibility [31] (level of evidence, 2). Clinical assessment correlates very poorly with polysomnography (level of evidence, 2) [17,32], notably because nocturnal airway obstruction by the tonsils depends not only on their size but also on lateral pharyngeal wall muscular hypotonia, which varies widely between individual children. Endoscopic assessment may be more reliable than oropharyngeal examination (level of evidence, 4), due (1) as it does not impact local morphology by requiring the mouth to be open or by use of a tongue spatula, and (2) to better visualization of the postero-inferior tonsils, which seem especially implicated in onset of childhood OSAHS (level of evidence, 4) [33].

- any other upper airway obstacle visible on endoscopy, and especially narrow nasopharynx or velopharyngeal isthmus, lateral pharyngeal wall collapse, hypertrophy or retraction of the tongue base, laryngomalacia, or cystic or tumoral obstructive mass. (See also morphologic analysis under induced sleep, in Part 2) (level of evidence, 2).
- overweight, on body-mass index (BMI). Obesity is rare in children with apnea, with prevalence around 10%, but much more frequent in adolescents [34] (level of evidence, 1). It is a comorbidity increasing the risk of severe apnea, functional failure or complications of adenotonsillectomy, and metabolic disorder associated with OSAHS (level of evidence, 1) [35–37].
- delayed ponderal or statural growth is a well-established complication of childhood OSAHS (level of evidence, 1) [38,39], assessed on weight and height charts in the health records. Low weight-gain for age is more frequent in infants than in older children (level of evidence, 3) [40].
- high blood pressure, in adolescents only, and especially in case of obesity (Expert opinion).

3.4. Referral by ENT to other specialists (apart from for sleep recording)

Disclosure of interest

The authors declare that they have no competing interest.

Appendix A. GRADE classification of recommendations.

| Level of evidence provided by the literature | Recommendation grade |
|---|--|
| Level 1 - High-power randomized comparative trial - Randomized comparative meta-analysis - Decision tree based on well-conducted studies | GRADE A Established scientific proof |
| Level 2 - Low-power randomized comparative trial - Well-conducted non-randomized comparative study - Cohort study | GRADE B Scientific presumption |
| Level 3 - Case-control study | GRADE C Low level of evidence |
| Level 4 - Comparative study with serious bias - Retrospective study - Case series - Descriptive (transverse or longitudinal) epidemiological study | GRADE D Expert opinion |

From ANES (Agence Nationale d'Accréditation et d'Évaluation en Santé) Guide to literature analysis and recommendations grading, January 2000 (available at the Health Authority website: <https://www.has-sante.fr>).

Guideline n° 3. Physical examination in apnea should comprise:

- dentofacial inspection (GRADE A);
- oropharyngeal examination (GRADE A);
- assessment of soft-palate visibility on Mallampati score (or, equivalently, Friedman palate positioning score). This score correlates with AHI in children with apnea (GRADE C);
- awake naso-pharyngo-laryngeal endoscopy not extending to the glottis (GRADE A). Lidocaine spray is not helpful (GRADE B);
- screening for adenoid hypertrophy on Cassano score (GRADE C). It correlates with AHI (GRADE B), and may in isolation cause severe infant OSAHS (GRADE C);
- screening for tonsillar hypertrophy, assessed semi-quantitatively on Brodsky score rather than Friedman score (GRADE B). Apparent volume on awake clinical examination correlates poorly with AHI (GRADE B). On oropharyngeal examination, it is preferable to avoid using a tongue spatula, if anatomically possible, so as not to distort local anatomy (Expert opinion). Endoscopy is probably more reliable than oropharyngeal examination (GRADE D). Endoscopy should pay particular attention to the postero-inferior position of the tonsils;
- endoscopic screening for obstacles along the upper airway other than adenotonsillar hypertrophy (GRADE B);
- screening for overweight on BMI (GRADE A);
- screening for delayed ponderal or statural growth (GRADE A);
- blood pressure measurement in adolescents and/or in case of overweight (Expert opinion).

Guideline 4. (Expert opinion). The ENT physician may need to refer the child to other specialists:

- orthopedic dentofacial specialist (orthodontist) in case of doubt concerning dentofacial abnormalities;
- pedopsychiatrist, neuropsychiatrist or pediatrician specializing in children's sleep in case of associated behavioral or cognitive abnormalities;
- other, according to comorbidities: obesity, respiratory failure, neuromuscular disease, coagulation disorder, etc.

Appendix B. Spruyt Gozal score

Please score all the following questions, except question 5, as:

- 0 for "never"
- 1 for "rarely" (1 night a week)
- 2 for "occasionally" (2 nights a week)
- 3 for "frequently" (3 or 4 nights a week)
- 4 for "almost always" (more than 4 nights a week)

(...over the last 6 months)

Q5 is scored as 0: mildly quiet; 1: medium loud; 2: loud; 3: very loud; 4: extremely loud. Q6: snoring during sleep.

Do you ever shake your child to make him/her breathe again when asleep? (Shake child to breath) (Q1)

Does your child stop breathing during sleep? (Apnea during sleep) (Q2)

Does your child struggle to breathe while asleep? (Struggle breathing when asleep) (Q3)

Are you ever concerned about your child's breathing during sleep? (Breathing concerns while asleep) (Q4)

How loud is the snore? (Loudness of snoring) (Q5)

How often does your child snore? (Snoring during sleep) (Q6)

The score is calculated as: $A=(Q1+Q2)/2$; $B=(A+Q3)/2$; $C=(B+Q4)/2$; $D=(C+Q5)/2$; final score= $(D+Q6)/2$. Score > 2.75 has 82% sensitivity, 81% specificity and 92% negative predictive value in detecting moderate OSAHS with AHI ≥ 5 /hour. It does not predict outcome of adenotonsillectomy.

References

- [1] Certal V, Catumbela E, Winck JC, Azevedo I, Teixeira-Pinto A, Costa-Pereira A. Clinical assessment of pediatric obstructive sleep apnea: a systematic review and meta-analysis. *Laryngoscope* 2012;122:2105–14.
- [2] Lumeng JC, Chervin RD. Epidemiology of pediatric obstructive sleep apnea. *Proc Am Thorac Soc* 2008;5:242–52.
- [3] Marcus CL, Brooks LJ, Draper KA, Gozal D, Halbower AC, Jones J, et al. American Academy of Pediatrics. Diagnosis and management of childhood obstructive sleep apnea syndrome. *Pediatrics* 2012;130:576–84.
- [4] Bloomfield ER, Shatkin JP. Parasomnias and movement disorders in children and adolescents. *Child Adolesc Psychiatr Clin N Am* 2009;18(4):947–65.
- [5] Sheldon SH. Parasomnias in children. In: *Encyclopedia of Sleep*; 2013. p. 184–8.
- [6] de Felício CM, da Silva Dias FV, Folha GA, de Almeida LA, de Souza JF, Anselmo-Lima WT, et al. Orofacial motor functions in pediatric obstructive sleep apnea and implications for myofunctional therapy. *Int J Pediatr Otorhinolaryngol* 2016;90:5–11.
- [7] Valera FC, Travitzki LV, Mattar SE, Matsumoto MA, Elias AM, Anselmo-Lima WT. Muscular, functional and orthodontic changes in pre-school children with enlarged adenoids and tonsils. *Int J Pediatr Otorhinolaryngol* 2003;67:761–70.
- [8] Capdevila OS, Kheirandish-Gozal L, Dayyat E, Gozal D. Pediatric obstructive sleep apnea: complications, management, and long-term outcomes. *Proc Am Thorac Soc* 2008;5:274–82.
- [9] Kim JH, Guilleminault C. The nasomaxillary complex, the mandible, and sleep-disordered breathing. *Sleep Breath* 2011;15:185–93.
- [10] Guilleminault C, Lee JH, Chan A. Pediatric obstructive sleep apnea syndrome. *Arch Pediatr Adolesc Med* 2005;159:775–85.
- [11] Marcus CL, Moore RH, Rosen CL, Giordani B, Garetz SL, Taylor HG, et al. Childhood Adenotonsillectomy Trial (CHAT). A randomized trial of adenotonsillectomy for childhood sleep apnea. *N Engl J Med* 2013;368:2366–76.
- [12] Tan HL, Alonso Alvarez ML, Tsaoussoglou M, Weber S, Kaditis AG. When and why to treat the child who snores? *Pediatr Pulmonol* 2017;52:399–412.
- [13] Joosten KF, Larramona H, Miano S, Van Waardenburg D, Kaditis AG, Vandebussche N, et al. How do we recognize the child with OSAS? *Pediatr Pulmonol* 2017;52:260–71.
- [14] Beydon N, Aubertin G. Critères diagnostiques du syndrome d'apnées obstructives du sommeil. *Arch Pediatr* 2016;23:432–6.
- [15] Spruyt K, Gozal D. Screening of pediatric sleep-disordered breathing: a proposed unbiased discriminative set of questions using clinical severity scales. *Chest* 2012;142:1508–15.
- [16] Nguyen X-L, Levy P, Beydon N, Gozal D, Fleury B. Performance characteristics of the French version of the severity hierarchy score for paediatric sleep apnoea screening in clinical settings. *Sleep Med* 2017;30:24–8.
- [17] Rosen CL, Wang R, Taylor HG, Marcus CL, Katz ES, Paruthi S, et al. Utility of symptoms to predict treatment outcomes in obstructive sleep apnea syndrome. *Pediatrics* 2015;135:e662–71.
- [18] Jonas NE, Visser MF, Oomen A, Albertyn R, van Dijk M, Prescott CA. Is topical local anaesthesia necessary when performing paediatric flexible nasendoscopy? *Int J Pediatr Otorhinolaryngol* 2007;71:1687–92.
- [19] Chadha NK, Lam GO, Ludemann JP, Kozak FK. Intranasal topical local anesthetic and decongestant for flexible nasendoscopy in children: a randomized, double-blind, placebo-controlled trial. *JAMA Otolaryngol Head Neck Surg* 2013;139:1301–5.
- [20] Villa MP, Bernkopf E, Pagani J, Broia V, Montesano M, Ronchetti R. Randomized controlled study of an oral jaw-positioning appliance for the treatment of obstructive sleep apnea in children with malocclusion. *Am J Respir Crit Care Med* 2002;165:123–7.
- [21] Villa MP, Malagola C, Pagani J, Montesano M, Rizzoli A, Guilleminault C, et al. Rapid maxillary expansion in children with obstructive sleep apnea syndrome: 12-month follow-up. *Sleep Med* 2007;8:128–34.
- [22] Villa MP, Rizzoli A, Rabasco J, Vitelli O, Pietropaoli N, Cecili M, et al. Rapid maxillary expansion outcomes in treatment of obstructive sleep apnea in children. *Sleep Med* 2015;16:709–16.
- [23] Baldassari CM, Choi S. Assessing adenoid hypertrophy in children: X-ray or nasal endoscopy? *Laryngoscope* 2014;124:1509–10.

- [24] Cassano P, Gelardi M, Cassano M, Fiorella ML, Fiorella R. Adenoid tissue rhinopharyngeal obstruction grading based on fiberoptic findings: a novel approach to therapeutic management. *Int J Pediatr Otorhinolaryngol* 2003;67:1303–9.
- [25] Tagaya M, Nakata S, Yasuma F, Miyazaki S, Sasaki F, Morinaga M, et al. Relationship between adenoid size and severity of obstructive sleep apnea in preschool children. *Int J Pediatr Otorhinolaryngol* 2012;76:1827–30.
- [26] Kang KT, Chou CH, Weng WC, Lee PL, Hsu WC. Associations between adenotonsillar hypertrophy, age, and obesity in children with obstructive sleep apnea. *PLoS One* 2013;8(10):e78666.
- [27] Shatz A. Indications and outcomes of adenoidectomy in infancy. *Ann Otol Rhinol Laryngol* 2004;113:835–8.
- [28] Friedman M, Ibrahim H, Joseph NJ. Staging of obstructive sleep apnea/hypopnea syndrome. *Laryngoscope* 2004;114:454–9.
- [29] Kumar HV, Schroeder JW, Gang Z, Sheldon SH. Mallampati score and pediatric obstructive sleep apnea. *J Clin Sleep Med* 2014;10:985–90.
- [30] Brodsky L. Modern assessment of tonsils and adenoids. *Pediatr Clin North Am* 1989;36:1551–69.
- [31] Kumar DS, Valenzuela D, Kozak FK, Ludemann JP, Moxham JP, Lea J, et al. The reliability of clinical tonsil size grading in children. *JAMA Otolaryngol Head Neck Surg* 2014;140:1034–7.
- [32] Mitchell RB, Garetz S, Moore RH, Rosen CL, Marcus CL, Katz ES, et al. The use of clinical parameters to predict obstructive sleep apnea syndrome severity in children: the Childhood Adenotonsillectomy (CHAT) study randomized clinical trial. *JAMA Otolaryngol Head Neck Surg* 2015;141:130–6.
- [33] Li AM, Wong E, Kew J, Hui S, Fok TF. Use of tonsil size in the evaluation of obstructive sleep apnoea. *Arch Dis Child* 2002;87:156–9.
- [34] Levers-Landis CE, Redline S. Pediatric sleep apnea: implications of the epidemic of childhood overweight. *Am J Respir Crit Care Med* 2007;175:436–41.
- [35] Bhattacharjee R, Kim J, Kheirandish-Gozal L, Gozal D. Obesity and obstructive sleep apnea syndrome in children: a tale of inflammatory cascades. *Pediatr Pulmonol* 2011;46:313–23.
- [36] Vitelli O, Tabarrini A, Miano S, Rabasco J, Pietropaoli N, Forlani M, et al. Impact of obesity on cognitive outcome in children with sleep-disordered breathing. *Sleep Med* 2015;16:625–30.
- [37] Com G, Carroll JL, Tang X, Melguizo MS, Bower C, Jambhekar S. Characteristics and surgical and clinical outcomes of severely obese children with obstructive sleep apnea. *J Clin Sleep Med* 2015;11:467–74.
- [38] Bonuck KA, Freeman K, Henderson J. Growth and growth biomarker changes after adenotonsillectomy: systematic review and meta-analysis. *Arch Dis Child* 2009;94:83–91.
- [39] Esteller E, Villatoro JC, Agüero A, Lopez R, Matión E, Argemi J, et al. Obstructive sleep apnea syndrome and growth failure. *Int J Pediatr Otorhinolaryngol* 2018;108:214–8.
- [40] Freezer NJ, Bucens IK, Robertson CF. Obstructive sleep apnoea presenting as failure to thrive in infancy. *J Paediatr Child Health* 1995;31:17.