

# Sleep-Disordered Breathing: The Dentists' Role – A Systematic Review

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**Objective:** Although dentists have an important role related to sleep disorders, there is a concern about how far dentists can go when screening or treating these patients. The objective of this systematic review is to present guidelines, recommendations, and studies designed with the intention to describe and guide the role of dentists in sleep-disordered breathing (SDB)-related issues.<sup>1</sup>

**Methods:** The eligibility criteria were guidelines, protocols, and recommendations focused on determining the role of dentists in the sleep disorders topic. The search was conducted through the databases Cochrane, EMBASE, Medline, LILACS, PubMed, and Web of Science. This systematic review was reported according to the preferred reporting items for systematic review and meta-analysis protocols (PRISMA).<sup>1</sup>

**Results:** Overall, a total of 1,432 studies were found in the 6 databases searched. After removing duplicates, the studies were evaluated by title and abstract. In the second phase, 231 studies were evaluated by reading their full text. Twenty-two studies matched the inclusion criteria.

**Conclusions:** Through this systematic review it is possible to conclude that the guidelines describe the role of dentists in screening patients for SDB/obstructive sleep apnea (OSA) as follows: refer the patients suspected of SDB/OSA to sleep physicians; apply, manage, and follow up the use of oral appliances.

**Clinical significance:** All dentists should screen for SDB/OSA; however, only well-trained dentists with good knowledge of dental sleep medicine should be part of the multidisciplinary team to treat patients with SDB/OSA.

**Keywords:** dentists' role; guidelines; sleep-disordered breathing; sleep medicine

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## INTRODUCTION

Sleep-disordered breathing (SDB) affects adults and children worldwide.<sup>2</sup> SDB can reach high prevalence as shown by the HypnoLaus study, which found rates of 49.7% for men and 23% for women.<sup>3</sup> It is estimated that approximately 23 million adults in the United States have undiagnosed or untreated moderate to severe obstructive sleep apnea (OSA).<sup>4,5</sup> The main problem in patients with SDB/OSA is the pharyngeal collapse occurring in hypopnea (reduction in ventilation) or apnea (complete respiratory cessation).<sup>6</sup> According to Guillerminault and Huang “the upper airway is a collapsible tube, and its collapsibility increases during sleep”.<sup>7</sup> The increased levels of carbon dioxide (hypercapnia) and the low concentration of oxygen (hypoxemia) in the blood in these patients may lead to hypertension, cardiac diseases, and even premature death.<sup>4,6</sup> SDB is also related to snoring, mood disorder, disruptive behavior, and depletion of quality of life.<sup>2,4,8,9</sup> Some oral anatomic features associated with SDB may include high arched or narrow hard palate and retrognathia.<sup>2,8</sup>

The most common risk factor for sleep apnea in children is the airway constriction associated with enlarged tonsils and/or adenoids.<sup>10</sup> Additionally, the atypical orofacial growing pattern of “adenoid facies” has been associated with SDB, and may lead to a reduced size of the upper airway; causing not just sleep breathing-related problems but also a constricted maxilla, usually causing posterior crossbites and crowded teeth.<sup>11</sup> Impaired growth, cardiovascular problems, and learning and behavioral problems are also linked to SDB.<sup>5,12</sup> Because these problems are critical and are related to craniofacial proportions, the dentist is the first person to recognize these issues.

The approach most often indicated to treat SDB in adults is the oral appliance (OA). The OA can be categorized into two types: mandibular advancement device (MAD),<sup>13</sup> which aims to protrude the mandible and associated soft tissues to open the airway and reduce the apnea-hypopnea index (AHI)<sup>14</sup>; or the less frequently used tongue retaining device where the objective is to maintain the tongue in a forward position, to avoid obstruction of the airway.<sup>15</sup> However, continuous positive airway pressure

(CPAP) therapy is mostly used by sleep physicians and remains the gold standard for OSA treatment.<sup>2</sup> More recently, several studies reported upper airway dimensional changes and AHI decrease in children and adolescents with posterior crossbites/maxillary constriction and retrognathia treated for maxillary expansion and mandibular advancement, respectively.<sup>16–18</sup> In general, those studies, albeit lacking control groups, have encountered positive results in regard to an increase in upper airway dimension and breathing capacity.<sup>16–18</sup>

Although it is evident that dentists can have an important role related to SDB/OSA, the exact position of the dentist in the overall evaluation and treatment paradigm for patients with SDB/OSA continues to be debated. The objective of this systematic review is to summarize existing guidelines, recommendations, and studies designed with the intention to describe and guide the role of dentists in SDB-related issues.

## METHODS

### Protocol and Registration

This systematic review was reported according to the preferred reporting items for systematic review and meta-analysis protocols, or PRISMA.<sup>19</sup>

### Eligibility Criteria

Guidelines, protocols, and recommendations focused on determining the role of dentists in SDB/OSA were included in this study. No limits in year or language were applied.

### Information Sources-Search strategy

The following databases were included in the search strategy: Cochrane, EMBASE, Medline, LILACS, PubMed, and Web of Science. The search strategy used in this review is available in Appendix 1. All searches were conducted in February 2018 and updated in February 2019. The references were managed, and the duplicates were removed using the RefWorks software (ExLibris a ProQuest LCC Company- Jerusalem, Israel).

Two independent reviewers (SG-C and ACG) proceeded with the search on the selected databases.

### Study Selection

The study selection was conducted in two phases. In the first phase, two reviewers (SG-C and ACG) independently checked the titles and abstracts of all studies identified. In the second phase, the same two reviewers evaluated the remaining articles, analyzing the full text to include only those that fulfilled the eligibility criteria.

## Data Collection Process

The data collection was extracted by two authors (SG-C and ACG). Table 1 displays the following information extracted from the studies: authors, country, year, objective, methods, the role of dentists, dental clinical procedures, additional information, results, and conclusions.

## Summary Measures

The main outcome was to determine the role of dentists in patients with SDB.

## Synthesis of Results

A list of the possible role of dentists in view of the SDB problems was made from each article.

## RESULTS

### Selection of Studies

Overall 1,432 studies were found in the six databases searched: Cochrane, Embase, Lilacs, Medline, PubMed, and Web of Science. After removing duplicates, the studies were evaluated by title and abstract. In the second phase, 231 studies were evaluated by reading their full text. Eighteen studies matched the inclusion criteria. Four studies were included by the experts, for a total of 22 included studies. Figure 1 maps the selection process.

### Study Characteristics

The selected studies were published between 1999 and 2019. One was published in Italian,<sup>20</sup> and the others were published in English.<sup>4,11,13,15,20–37</sup> Recommendations made by the studies included in this systematic review were for the dentists' clinical practice in patients with OSA, SDB or snoring. Most of the included studies were based on or were the guideline itself from an accredited dental or medical association as follows: American Association of Orthodontics (AAO)<sup>33</sup>; American Academy of Dental Sleep Medicine (AADSM)<sup>4,21</sup>; American Academy of Sleep Medicine (AASM)<sup>22,23</sup>; AADSM + AASM<sup>24</sup>; AASM + German Sleep Society<sup>25</sup>; American Academy of Craniofacial Pain;<sup>26</sup> Canadian Sleep Society;<sup>27</sup> American College of Prosthodontists;<sup>15</sup> American Dental Association (ADA);<sup>11</sup> German Society of Otorhinolaryngology, Head and Neck Surgery + Association of Scientific Medical Societies in Germany.<sup>28</sup> A group of Italian dental societies also involved with the Italian Association of Sleep Medicine<sup>13</sup>; and British Society of Dental Sleep Medicine.<sup>29</sup> Nonetheless, the statements regarding the role of dentists when treating SDB/OSA made by the studies not linked to a medical or dental association are basically the same.

**Table 1. Studies Design and Detail**

<u>Author &amp; Country</u>	<u>Year</u>	<u>Objective</u>	<u>Methods</u>	<u>Role of dentists and Dental clinical procedures</u>	<u>Additional information Results /Conclusion</u>
American Association of Orthodontics <sup>33</sup>  USA	2019	Guideline for the dentist's role in sleep apnea	Guideline proposed by American Association of Orthodontics	<ul style="list-style-type: none"> <li>• Screening for OSA;</li> <li>• Multidisciplinary management of OSA</li> </ul>	Orthodontists should be familiar with the signs and symptoms of OSA in adult patients. Orthodontists also should include assessment of the patient's height, weight, and neck size to screen adult patients for OSA. Rapid maxillary expansion in patients with constricted maxilla and mandibular advancement correction in patients with class II may change upper airway dimension.
Addy et al. <sup>4</sup>  USA	2018	AADSM guideline for the dentist's role in treating SDB	Guideline supported by the AADSM	<ul style="list-style-type: none"> <li>• Screening for SDB;</li> <li>• Only qualified dentists should screen and treat SDB patients;</li> <li>• Manage OA treatment efficacy and patient follow-up</li> </ul>	Screening for SDB by dentists can collaborate in reducing undiagnosed and untreated patients. AADSM recommends postgraduate training in dental sleep medicine for dentists who intend to work in this field.
Levine et al. <sup>34</sup>  USA	2018	Guidelines for the qualified dentist screen, apply OA and manage patients with OSA	Standardized proposition for patient examination, screening and education, treatment management and follow-up care.	Screening for SDB/OSA signs; Manage OA treatment	The final diagnosis of SDB or OSA should be done by a physician. The physician will prescribe the OA then the dentist will apply, manage, and follow up. Oral and facial anatomic considerations, including pharyngeal crowding, sleep bruxism, and enamel erosion associated with gastroesophageal reflux are also associated with SDB and should be evaluated by the dentist.
Ranieri et al. <sup>20</sup>  Italy	2018	To provide the orthodontist an evidence-based recommendation for the diagnosis and treatment of snoring and OSA in adults.	A literature review of OSA literature in PubMed. Limited to 10 years.	For the orthodontists: <ul style="list-style-type: none"> <li>• Intercept potential OSA patient and approach to the correct process.</li> <li>• Evaluate airway through radiographic exams</li> <li>• Recognize early stages of OSA signs and symptoms.</li> <li>• Refer to the sleep physician.</li> <li>• Apply OA when indicated.</li> <li>• Collaborate with the surgeon in case of maxilla-facial surgery.</li> </ul>	The multidisciplinary approach in which the sleep physician coordinates the team of specialists is indispensable.
A position statement adopted by the ADA <sup>11</sup>  USA	2017	To provide the role of dentistry in the treatment of sleep-related breathing disorders	A position statement adopted by ADA's House of Delegates	Screening for SDB; Apply OA therapy when indicated; Follow up the OA treatment; Update knowledge in dental sleep medicine; The dentist may assess the portable monitoring interim results while following up the OA treatment.	The indication for OA should be made by the physician and the dentist will confirm, apply, and follow up the treatment.

Leibovitz et al. <sup>9</sup>  Israel	2017	The role of dentists in the snoring and OSA treatment in children	A comprehensive literature search of publications from 1973 to 2017 in PubMed.	Dentists play a significant role in the early detection of OSAS and referring to an ear, nose, and throat physician. A multidisciplinary treatment team, which manages and treats OSAS, is the most appropriate approach. Evaluate through sleep questionnaire.	Pediatric SDB may reach 30% of children. Dentists' evaluation should include mouth breathing, nasal speech, recurrent airway infections, lack of concentration, elongated face, crowded teeth, high-arched palate, obesity, adenotonsillar hypertrophy. Dentists have an important role in a multidisciplinary team for the diagnosis and treatment of snoring and OSA in children.
Quan et al. <sup>24</sup>  USA	2017	The role of dentists in patients with OSA	Descriptive analysis based on the guidelines of the American Academy of Sleep Medicine and American Academy Dental Sleep Medicine	Fabrication of an OA device and its implementation are specialized skills that should be done by a qualified dentist, as advocated by the professional societies of both sleep medicine and dental sleep practitioners.	As part of the routine dental examination, dentists can recognize a small upper airway and other anatomic risk factors for OSA and use the opportunity to identify potential patients through use of simple screening questions and/or questionnaires. This can help reduce the problem of underdiagnosis of OSA. The diagnosis of OSA, however, should be reserved for physicians, especially sleep specialists, whose training prepares them to explore the interaction of OSA with other medical diagnoses. To accomplish these tasks, it is essential that dentists work collaboratively with the referring sleep medicine physician. Both sleep physicians and qualified dentists have essential roles in the treatment of OSA with OA. The sleep physician must confirm the diagnosis and may recommend OA. The dentist will confirm that OA is appropriate and initiate therapy. Follow-up should be performed by a dentist and physician, each contributing their special expertise.
Masoud et al. <sup>30</sup>  Saudi Arabia USA	2017	To review the key literature relevant to sleep-disordered breathing (SDB) characteristics and diagnosis, including history, examination, and investigation with an emphasis on radiographic airway analyses.	Review of literature	Dentists can be the first professionals to recognize a patient's potential sleep problem since they typically have more frequent contact with their patients than do physicians. Besides first screening, Mandibular advancement devices are within the role of dentists.	Before the treatment plan, the dentist should perform an anamnestic and clinical examination and refer to a sleep study if necessary. The radiographic airway analyses may be inconclusive in this diagnosis. More research in pediatric dentistry is utmost.

Wu and Dubois <sup>15</sup>  USA	2016	American College of Prosthodontists position statement elaborated in 2005, revised and approved in 2015 and 2016	Association guideline	The prosthodontists may screen for SDB/OSA, refer the patient to a sleep physician for a diagnosis. To monitor and manage any occlusal changes that can occur with OAs. Prosthodontists may provide OAs only if they have had training in dental sleep medicine.	Prosthodontists should include a mandatory questionnaire screening for OSA. The final diagnosis should be made by the physician.
Stuck et al. <sup>28</sup>  Germany	2015	Diagnosis and treatment of snoring in adults. Developed by the German Society of Otorhinolaryngology, Head and Neck surgeons revised and designed according to the specifications of the Association of the Scientific Medical Societies in Germany	A systematic review of the literature with the latest research published. The review of the literature was performed in June 2012 using Medline.	Intra-oral appliance for snoring. Examination of the oral cavity evaluating the size of the tongue, mucosal status, and dentition as well as facial skeleton especially retrognathia and narrow maxilla.	Snoring can be successfully treated with intraoral devices. Mandibular advancement devices are used to enlarge the pharynx in the anterior-posterior dimension by protruding the mandible. These intraoral devices are also used in patients with OSA.
Ramar et al. <sup>21</sup>  USA	2015	Clinical practice guideline for the treatment of OSA and snoring with the OA by the AADSM	3 sleep medicine physicians, 2 dentists with expertise in OA and 2 research staff members with expertise in guidelines developed questions to be discussed through RCTs published.	Recommendations for the efficacy for the use of OA based on the quality of evidence and counterbalanced by an assessment of the benefits versus the risks. 'Qualified dentists' should provide OA therapy	The recommendation should also be made by patients' preference and cost evaluation. OAs can significantly reduce the AHI; respiratory disturbance index; respiratory event index across all levels of OSA severity in adult patients. There was no difference in the mean reduction AHI before and after OA treatment versus CPAP across all levels of OSA severity.
Levrini <sup>13</sup>  Italy	2015	To present a set of proposed clinical recommendations aimed at Italian dentists involved in the management of patients with OSA or snoring	Delegates of Italian scientific societies operating in fields relevant to the issue of sleep medicine in dentistry, proposed questions regarding the clinical management of OSAS and snoring patients. Società Italiana Medicina del Sonno Odontoiatrica; Associazione Italiana Medicina del Sonno; Surgical commission, Associazione Italiana Medicina del Sonno (ENT representative) and Associazione	Screening patients with snoring or OSAS. In interdisciplinary management, dentists can decide with the sleep specialist to treat or not patients with snoring or OSAS if he or she has characteristics defined by clinical recommendations. OA treatment. Evaluation of clinical and radiographic characteristics commonly associated with SDB. If a diagnosis of snoring or OSAS moderate or mild, is confirmed, the dental analysis and the decision regarding the application of an OA, as well as its characteristics, are exclusively within the competence of	OAs can be used to treat simple snoring; mild to moderate OSA, in patients who prefer OAs to CPAP or who are not suitable candidates for CPAP, because of its failure or failure of behavioral approaches such as weight loss or positional therapy; patients with severe OSAS who do not respond to or do not tolerate CPAP and in whom no indication for either maxillofacial or ear, nose, and throat surgery appears applicable. The application of OAs is highly desirable in cases of simple snoring or mild to moderate OSA, whereas

			Otorinolaringologi Ospedalieri Italiani; Collegio dei Docenti di Odontoiatria; Associazione Nazionale Dentisti Italiani; • Associazione Italiana Odontoiatri; Associazione Italiana Pazienti con Apnee del Sonno.	the dentist, irrespective of his or her academic training.	considerable caution is warranted when treating severe OSAS. It is fundamental to ensure that the patient understands his problem and, at the same time, to present all the various treatment options.
Almeida et al. <sup>32</sup>	2014	College of Dental Surgeons of British Columbia Standards and Guidelines for Obstructive Sleep Apnea -	Guideline for the Role of Dentists in the Treatment of Snoring and Obstructive Sleep Apnea with Oral Appliances prepared by the College of Dental Surgeons of British Columbia	Screen for potential OSA; Refer these patients to the sleep physician; Provide OA therapy	It is important to be aware of the multidisciplinary teamwork between dentists and sleep physicians that is required for the OA when treating patients with a diagnosis of snoring and/or OSA; as well as clarify the role and responsibilities of each professional.
Canada					
Ngiam et al. <sup>31</sup>	2013	Guidelines for the use of OA for the treatment of OSA and snoring	Review of the literature by a multidisciplinary team	Recognize the signs of SDB; to refer to a physician; prescribe, manage and follow up OA treatment; manage possible side effects on tooth and TMJ.	Important to evaluate long-term effects of OA treatments. OA may or may not have positive results in OSA and snoring
Australia					
Spencer et al. <sup>26</sup>	2013	Guidelines for the use of OA for snoring and OSA treatment by the American Academy of Craniofacial Pain	Consensus-based on their review of the current evidence published guidelines and clinical experience of the authors.	Dentists should have the proper training to provide OA and TMD treatment and craniofacial pain.	OA may result in exacerbation of previous asymptomatic TMDs and craniofacial pain. Specialized training is essential to deliver therapy for snoring, OSA, and TMD.
USA					

Canada	Gauthier et al. <sup>27</sup> 2012	The current Canadian position paper contains recommendations for the management by dentists of SDB in adults with the use of OAs as a treatment option for snoring and OSA.	The recommendations are based on literature reviews and expert panel consensus. Many of the dentists and sleep physicians who contributed to the preparation of the present article are members of the Canadian Sleep Society and the authors reached a consensus based on the current literature.	Recognize SDB symptoms; refer the patient to a sleep medicine physician; evaluate other issues such as bruxism, orofacial pain, headache, gastroesophageal reflux; manage SDB, bruxism, dental consequences of reflux, orofacial pain, weight control, exercise program, behavior approaches in collaboration with the psychologist and physician; manage and apply OA. Assess the results of portable polysomnography but without diagnosing.	The diagnosis of OSA should always be made by a sleep physician, and OAs should be fitted by a qualified dentist who is trained and experienced in dental sleep medicine. Follow-up assessment by the referring physician and polysomnography or sleep studies are required to verify treatment efficacy. The physician should interpret level III and IV portable polysomnography devices. The dentist should only use portable monitoring to monitor the titration, not to do follow up the diagnosis of efficacy. That's the role of the sleep physician.
USA	Epstein et al. <sup>22</sup> 2009	Guideline designed to assist primary care providers as well as sleep medicine specialists, surgeons, and dentists who care for patients with OSA by providing a comprehensive strategy for the evaluation, management and long-term care of adult patients	AASM parameters to the evaluation and management of OSA in adults added to the literature review and evidence grading. Plus, consensus-based recommendations.	OA initiation, management and follow-up. However, before the OA therapy, the patient should undergo a complete intraoral examination, TMJ and anamnestic. Request a cephalometry when necessary. The dentist should be qualified to apply OA therapy.	Questions regarding OSA should be incorporated into routine health evaluations. Suspicion of OSA should trigger a comprehensive sleep evaluation. The diagnostic strategy includes a sleep-oriented history and physical examination, objective testing, and education of the patient.
UK	Stradling and Dookun <sup>29</sup> 2009	Screening protocol and recommendation for snoring and OSA's treatment	British Society of Dental Sleep Medicine -	Identify patients with OSA; Refer these patients to the physician; Provide OA treatment;	The regular contact of patients and dentists gives the dentist an important role for screening for OSA and snoring since snoring can be linked to OSA. A multidisciplinary approach is necessary.
Germany	Schwarting et al. <sup>25</sup> 2007	Guide multidisciplinary team (sleep physician and sleep disorder dentist) when to prescribe OA	Summarize the indications MAD in adults with SBD through the guidelines developed by the AASM and the German Sleep Society	MAD is indicated for primary snoring, upper airway resistance syndrome, mild to moderate OSA with AHI up to 25/h and BMI of up to 30 kg/m <sup>2</sup> . MAD also can be used as an alternative to CPAP. This therapy must be done by specialized dentists in sleep disorders.	The final diagnose of OSA must be made by the sleep physician. Inter and intradisciplinary treatment must be taken into account, especially the preliminary medical diagnoses and the medical follow-up.

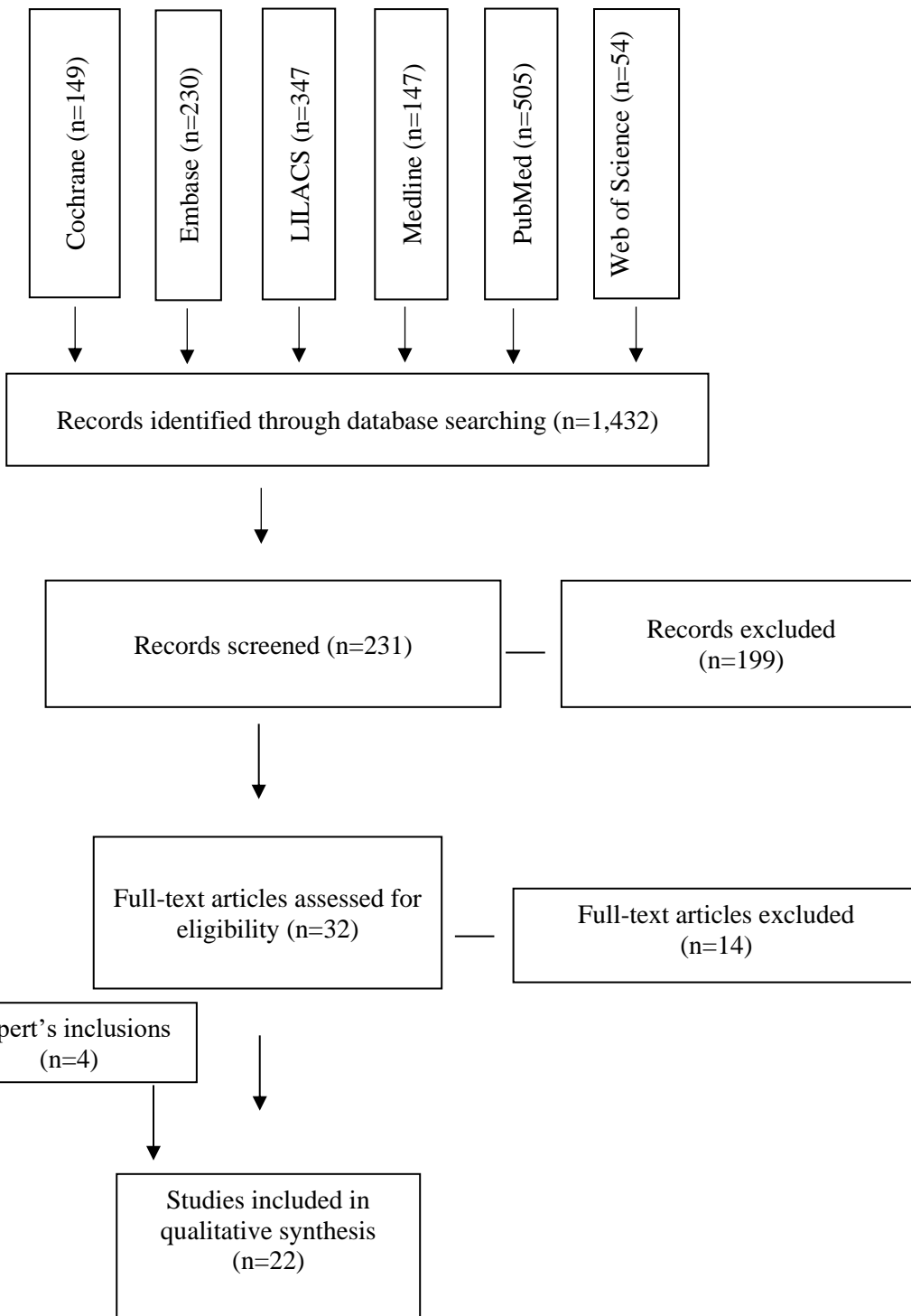
Kushida et al. <sup>23</sup>  USA Canada	2006	Practice parameters for the treatment of snoring and OSA in adults	Standards of Practice Committee of the AASM develop the practice parameters based on review paper and strength of evidence.	In a patient with OSA, the oral appliance should be fitted by a qualified dentist with training in the TMJ, occlusion and oral structures. The dentist should have taken special training in SDB. Require a cephalometric evaluation when necessary. OA patients should return for follow up after the optimal fit is obtained, the patient should return after 6 months in the first year and then at least once a year.	Follow up sleep testing is not recommended for patients with primary snoring. Patients with OSA should undergo polysomnography or attend cardiorespiratory sleep study with OA in place after the final adjustments. The last judgment regarding any specific treatment is the physician's responsibility.
Schmidt-Nowara <sup>36</sup>  USA	2001	The history and diagnosis of sleep disorders related to the dentist.	Review.	Therapy and management offered by a dentist have become recognized as an important aspect of care for patients with SDB.	Dentists who offer this service need to become acquainted with the multifactorial nature of sleep medicine to better serve their patients and to facilitate their interaction with other sleep medicine clinicians.
Lavigne et al. <sup>37</sup>  Canada Italy The Netherlands	1999	Guideline for dental sleep clinician in the management of SDB	Review of the literature	Manage TMD problems and chronic orofacial pain. Indicate and manage the use of OA	Prior to OA treatment, a diagnosis of OSA must be made by a physician. OA should only be used in primary snoring and mild to moderate OSA, or in cases in which the CPAP is not indicated in patients with severe OSA.

AADSM, American Academy of Dental Sleep Medicine; AASM, American Academy of Sleep Medicine; AHI, apnea-hypopnea index; BMI, body mass index; CPAP, continuous positive airway pressure; MAD, mandibular advancement device; OA, oral appliance; OSA, obstructive sleep apnea; OSAS, obstructive sleep apnea syndrome; RCT, randomized controlled trial; SDB, sleep-disordered breathing; TMD, temporomandibular disorder; TMJ, temporomandibular joint.



Figure 1. Flow Chart PRISMA<sup>19</sup>

Identification  
Screening  
Eligibility  
Included



## Results of Individual Studies

### **Studies' recommendations for ALL dentists:**

- Dentists/orthodontists/prosthodontists should screen for potential patients with SDB/OSA.<sup>4,9,29–33,11,13,15,20,22,24,27,28</sup>
- Screening could include questionnaires, such as the validated tool for OSA risk assessment STOP-Bang questionnaire, the Epworth Sleepiness Scale, Friedman Tongue Classification System, Kushida Index, or Berlin Questionnaire for Sleep Apnea; evaluation of neck size and body mass index; modified Mallampati classification to describe the patency of oral airway.<sup>33</sup>
- Refer to the sleep physician or otolaryngologist when SDB/OSA is suspected.<sup>9,11,15,20,24,27,29,31,32,33</sup>

### **Studies' recommendations for OA:**

- OA is an effective therapy for OSA.<sup>15,21,33</sup>
- OA is indicated for patients with mild to moderate OSA who prefer OAs to CPAP therapy or who do not respond to CPAP therapy or have contraindications for the use of CPAP therapy, although the sleep physicians are responsible for prescribing the most appropriate or acceptable treatment option.<sup>11,13,30,31,34,35,15,20,22–25,27,29</sup>
- OA can significantly decrease the AHI, respiratory disturbance index, and respiratory event index, independently of OSA severity.<sup>15,21</sup>
- Reduction in AHI before and after treatment with OAs versus CPAP has no statistically significant differences ( $P = 0.44$ ).<sup>21</sup>
- The sleep physician should prescribe OA rather than no treatment for adult patients who request treatment of primary snoring and also for patients with OSA who do not tolerate CPAP therapy.<sup>21,23</sup>
- The evaluation of OA treatment efficacy should be done by the sleep physician with sleep testing.<sup>4,11,32,33</sup>

### **Studies' recommendations for the management/treatment of SDB by qualified dentists:**

- Only qualified dentists should manage SDB/OSA and snoring screening and therapy.<sup>4,9,15,21–23,25–28,32,33,34,35</sup>
- When an OA is prescribed, the qualified dentist should use a custom, titratable appliance over noncustom oral devices.<sup>4,11,21,24,33,32</sup>
- The dentist should instruct patients with OA to return for follow-up, and evaluate possible dental-related side effects such as occlusal changes and long-term effects.<sup>4,15,34,21–24,26,31–33</sup>
- The dentist can acquire objective information with a portable monitor for purposes of titration only; the diagnosis and follow-up assessment are the sleep physician's role.<sup>32,33</sup>

### **Studies' recommendations for multidisciplinary approach:**

- The final diagnosis of SDB or OSA should be

made by a physician or sleep physician.<sup>4,11,15,22,24,25,27,32,33,35</sup>

- The evaluation of OA treatment efficacy should be done by the sleep physician with sleep testing.<sup>4,11,32,33</sup>
- The dentist must collaborate with the surgeon in case of maxillofacial surgery.<sup>20</sup>
- Two orthodontic treatments in children may change airway dimension: rapid maxillary expansion in patients with a constricted maxilla and mandibular advancement for class II malocclusion correction; however, the orthodontic treatment in children in whom OSA is diagnosed should be planned based on the same principles for correction of dental and skeletal malocclusion.<sup>33</sup>
- The management of OSA in children is different from that in adults, with tonsillectomy and adenoidectomy usually considered the first-line treatment.<sup>33</sup>
- Multidisciplinary teamwork is indispensable.<sup>4,20,24,25,33</sup>

### **Additional findings within studies about SDB:**

- The grade of severity of OSA is classified as mild (5-14 AHI); moderate (15-30 AHI), and severe (+30 AHI).<sup>20</sup> However, for children the threshold is lower: mild (1-5 AHI), moderate (5-10 AHI), and severe (+10 AHI).<sup>9,23,33,34</sup>
- Usually, the reduction in the AHI, respiratory disturbance index, and respiratory event index must be less than 5 and greater than 50% reduction in these indexes to be classified as successful.<sup>21</sup>
- Snoring patients without features of OSA should undergo treatment to reduce snoring to a subjective reasonable level.<sup>23</sup>
- Age 12 years is the cutoff point for childhood SDB.<sup>9</sup>

## DISCUSSION

A definition given by the AADSM in 2008 states that the dentists' role in dental sleep medicine "focuses on the management of sleep-related breathing disorders (SDB), which includes snoring and obstructive sleep apnea (OSA), with oral appliance therapy (OAT) and upper airway surgery."<sup>37</sup> With a broader definition, Lobbezoo et al.<sup>38</sup> proposed that "Dental Sleep Medicine is the discipline concerned with the study of the oral and maxillofacial causes and consequences of sleep-related problems." From this perspective, the role of dentists would go farther, including the management of orofacial pain, oral moistening disorders (including oral dryness and hypersalivation), gastroesophageal reflux disorder, SDB (including snoring and OSA), and mandibular movement disorders (including dyskinesia, dystonia, and sleep bruxism). According to the studies included in this systematic review, screening SDB, OA treatment, and follow-up are the major roles for dentists working in dental sleep medicine.

## Screening for SDB

Dentists have an important role in the early screening of patients with SDB/OSA because the dentist usually has regular contact with patients.<sup>29,30,33</sup> The anatomic determinant factors attributed to the development of SDB/OSA are micrognathia, retrognathia, macroglossia, adenotonsillar hypertrophy, and nasal septum deviation.<sup>20</sup> Additionally, some genetic confounders can also be related to SDB/OSA such as jaw position, tonsillar tissue, and tongue size that may affect the size of the pharyngeal airway.<sup>6</sup> Therefore, indications of the presence of SDB/OSA might be evident in the oral cavity such as high-arched or narrow hard palate and retrognathia.<sup>2,8</sup> With that being said, the dentist has a responsibility for the evaluation of the determinant factors attributed to the development of SDB/OSA previously described. Moreover, dentists have radiographic examinations that might help to evaluate the upper airway, such as cephalometric tomography and cone-beam computed tomography.<sup>20</sup> According to the Guide for Radiation Health and Safety Program of the Alberta Dental Association and College, dentists should review and provide a report about the entire data volume generated by cone-beam computed tomography.<sup>39</sup> However, the cephalometric images do not define mediolateral information in the oropharyngeal airway and may lead to inaccurate information regarding volume and minimal cross-sectional area.<sup>33</sup> According to the AAO, orthodontists also should assess the patient's height, weight, and neck size to screen for SDB/OSA.<sup>33</sup> An important screening tool is the questionnaire; AAO recommends the use of the STOP-Bang questionnaire, which is a validated tool for OSA risk assessment in adults, and the Pediatric Sleep Questionnaire or the Epworth Sleepiness Scale in children.<sup>33</sup> The STOP-Bang questionnaire includes questions on snoring, tiredness, observed pauses in breathing, high blood pressure, and body mass index (BMI). A BMI higher than 35 kg/m<sup>2</sup>, age older than 50 years, neck circumference of 17 inches or larger in males and 16 inches or larger in females, and male sex are confounders for the development of SDB/OSA.<sup>33</sup> The scores in this questionnaire gives the predisposition for OSA: for 2 or fewer "yes" answers, indicative of low risk for OSA; for 3 to 4 "yes" answers, indicative of moderate risk for OSA; for more than 5 "yes" answers, suggestive high risk for OSA.<sup>33</sup> The Modified Mallampati Classification for patency of oral airway can be done by the orthodontists and would be helpful to evaluate patients at risk for upper airway obstruction during sleep.<sup>33</sup> The Brodsky tonsil classification grades the tonsil hypertrophy when analyzing the oropharyngeal airway space taken up by the two tonsils; the Friedman Tonsil Grading System gives information on the size of the tonsil.<sup>33</sup> Caution should be taken when using the tonsils' size evaluation because they do not give a correlation to OSA severity; an otolaryngologist will best evaluate and correlate the size of the tonsils to clinical symptoms.<sup>33</sup> In addition, according to the International Classification of Sleep

Disorders, there are some sleep breathing-related symptoms classified as borderline abnormal/normal sleep such as snoring.<sup>40</sup> Yet snoring can also be related to OSA,<sup>28</sup> and dentists have a duty to manage OSA.<sup>21,26,31</sup> Developing a model where the dentist, the family physician, and the sleep physician are in the loop to take care of patients, each one playing a particular role involved in the care of SDB/OSA: screening for the dentist, diagnosis for the sleep physician, and global health (hypertension, obesity, following up) for the family physician, would improve the quality of care for the patient.<sup>14</sup>

## Diagnosis

There is consensus among the studies that the final diagnosis of OSA should be done by a physician or a sleep physician.<sup>4,11,14</sup> Masse pointed out an important concern that the comorbidities associated with OSA such as hypertension are not within the scope of a dentist's care.<sup>14</sup>

## Treatment

The main role of dentists when treating SDB/OSA patients is to evaluate, apply, and follow up OA use with the intention to increase respiratory capacity and decrease AHI episodes.<sup>21,23</sup> The OA is used in patients with SDB/OSA and snoring with the aim to protrude the mandible, enlarging the pharynx.<sup>8</sup> The mandibular protrusion allows greater breathing capacity, reducing the frequency and intensity of snoring, leading to an improvement in the quality of sleep and, consequently, in the quality of life.<sup>21</sup> There are several types of OA available on the market; however, a study on the diagnosis and treatment of SDB/OSA in adults discouraged the use of premolded OA in which the use of warm water is required in order to fit the appliance in the patient's mouth.<sup>41</sup> A similar statement is suggested by several guidelines in which it is claimed that the customized OA is more effective than the premanufactured one.<sup>20, 21</sup> Therefore, only custom-made, titratable OAs should be applied.<sup>4,11,21,24,32</sup> Furthermore, there are some contraindications for the use of OA that only the dentist has the knowledge to manage: insufficient teeth to support the device, periodontal problems inducing tooth mobility, active temporomandibular joint disorder, and limited maximum protrusive distance (6 mm).<sup>42,43</sup> Cephalometric, tomographic, and videoendoscopic studies have revealed an increase in the velopharyngeal, nasopharyngeal, and anteroposterior dimension of the upper airway when using OA.<sup>44-46</sup> With that in mind, the oral appliances for maxillary expansion and mandibular advancement treatments in cases of constricted maxilla or class II malocclusion might be beneficial for children and adolescents in whom SDB has been diagnosed; however, the primary goal in those cases remains correction of malocclusion.<sup>33</sup> Upper airway dimensional changes and breathing capacity have been analyzed and several studies reported that those appliances effectively

increase the upper airway and decrease AHI; however, randomized controlled trials are needed to ascertain in which children these forms of treatment will be of benefit for SDB.<sup>47</sup> OAs have to be managed by a qualified dentist because technical skills and knowledge are required to reach a favorable outcome.<sup>4,15,21–23,25–28,32,33,34</sup> According to the AADSM, the dentist working with sleep apnea should have received specialized training with a duration of at least 25 hours.<sup>4</sup> Despite the fact that the dentist is the only healthcare professional able to perform OA management, in cases of SDB/OSA, the sleep physician should indicate the therapy with OA and then the dentist will evaluate and confirm the indication to apply the therapy.

### Follow-up

Nonetheless, it is of utmost importance that the dentist controls the management of the OA to minimize side effects such as occlusal interferences, pain in the masticatory muscles, temporomandibular joint pain, and discomfort with hypersalivation.<sup>21</sup> The patients should be referred back to the sleep physician for the confirmation of OA therapy efficacy.<sup>4</sup> The multidisciplinary teamwork is the key to success in the treatment for patients with SDB/OSA where the dentist following up on the OA, the family physician following up on global health, and the sleep physician following up on OSA/SDB treatment would lead to a favorable outcome.

### Position Statements of Dental and Medical Associations

Overall, the position statements or guidelines of the various dental or medical associations agree that the dentist's role in SDB is related to the screening for potential SDB/OSA<sup>9,13,20,22,24,27–31</sup> and to refer to the sleep physicians when SDB or OSA is suspected<sup>11,15,24,27,29,31,32</sup>; only qualified dentists should manage SDB/OSA and snoring therapies<sup>4,15,21–23,25–28,32</sup>; OAs are indicated for patients with mild to moderate OSA who prefer OA to CPAP therapy or who do not respond to CPAP or have contraindications for the use of CPAP<sup>11,13,15,22–26,27,29</sup>; when OA is prescribed, the qualified dentist should preferably use custom, titratable appliances over noncustom oral devices<sup>4,11,21,24,32</sup>; the dentists should provide follow-up of OA therapy to evaluate possible dental-related side effects such as occlusal changes<sup>11,15,22,24,26,32</sup>; and the final diagnosis of SDB/OSA should be done by the sleep physician<sup>4,11,15,22,24,25,27,32</sup>; however, a multidisciplinary teamwork is essential for a better outcome.<sup>4,24,25</sup>

### LIMITATIONS

Only AADSM has defined the skills necessary for a qualified dentist; other groups should develop their own definitions of the competencies for a qualified dentist.

A well-defined and established model of teamwork involving patient, dentist, family physician, and sleep physician should be developed and challenged by studies.

### FUTURE CONSIDERATIONS

Better and further studies are needed on the role of dentists and effectiveness of maxillary expansion and mandibular advancement appliances in patients with OSA.<sup>41</sup> The multidisciplinary approach for treating OSA is of great importance for better results, a model should be developed where dentist (screening and treatment), family physician (medical history and follow-up), and sleep physician (diagnosis of OSA) should be in a loop to give to the patients the best treatment against OSA. Dental and medical students should learn about dental sleep medicine.<sup>41</sup> It is particularly relevant to improve and to align the curriculum guidelines for dental sleep medicine.

### CONCLUSION

Through this systematic review, it is possible to conclude that in general, the guidelines describe the role of the dentist in SDB/OSA as:

- All dentists can prescreen patients through a clinical examination, patient history, and questionnaires to reduce undiagnosed SDB/OSA;
- Refer patients to the physician or sleep physician;
- A qualified dentist can apply, manage and follow up OA.

Additionally, OA therapy is an effective first-line treatment for patients suffering from primary snoring and in whom mild to moderate OSA has been diagnosed. OA therapy is a treatment option for patients with severe OSA who are, for whatever reason, unable to adhere to CPAP therapy. Dentists should screen for SDB/OSA; however, only dentists with good knowledge of dental sleep medicine or dentists who regularly update their knowledge and training in dental sleep medicine should be part of the multidisciplinary team to treat patients with SDB/OSA. It is important to know that there are more causes that affect sleep other than SDB that the dentist should be aware of.

### ABBREVIATIONS

**SDB:** sleep-disordered breathing

**OSA:** obstructive sleep apnea

**OA:** oral appliance

**MAD:** mandibular advancement device

**AHI:** apnea-hypopnea index

**CPAP:** continuous positive airway pressure

**AAO:** American Association of Orthodontics

**AADSM:** American Academy of Dental Sleep Medicine

**AASM:** American Academy of Sleep Medicine (AASM)

**RDI:** respiratory disturbance index

**REI:** respiratory event index

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## APPENDIX

## Appendix 1. Databases and individualized truncations of words.

Database (Up to Feb, 2019)	Key words & search truncation
Cochrane <a href="https://www.cochranelibrary.com/">https://www.cochranelibrary.com/</a>	Sleep* OR apnea* OR apnoea* AND dent* OR denta* OR denti* AND guideline
MedLine and EMBASE (Ovid)  <a href="http://ovidsp.tx.ovid.com">http://ovidsp.tx.ovid.com</a>	Sleep*.mp OR apnea*.mp OR apnoea*.mp AND dent*.mp OR denta*.mp OR denti*.mp AND guideline.mp
PubMed  <a href="http://www.ncbi.nlm.nih.gov/pubmed">http://www.ncbi.nlm.nih.gov/pubmed</a>	((guideline) AND ((sleep) OR (apnea) OR (sleep apnea) OR (apnoea)) AND ((dent*) OR (denta*) OR (denti*)))
LILACS <a href="http://lilacs.bvsalud.org">lilacs.bvsalud.org</a>	guideline [Words] and obstructive sleep apnea [Words] or sleep apnea [Words]
Web of Science <a href="http://apps.webofknowledge.com">http://apps.webofknowledge.com</a>	("guideline") AND ("dent*") OR ("denta*") OR ("denti*") AND ("sleep*") OR ("sleep apnea") OR ("apnea*") OR ("sleep apnoea*") OR ("apnoea")