Research

Acceptance of Dental Office Obstructive Sleep Apnea Screening among Minnesota State Fair Attendees

Yvette Reibel, MSDH, RDH; David N. Flynn, MD, MBA; Ashley Petersen, PhD; Priscilla M. Flynn, MPH, DrPH, RDH

Abstract

Purpose: Obstructive sleep apnea (OSA) is a common breathing disorder; however, many individuals remain undiagnosed. The purpose of this study was to assess the comfort level of community-dwelling adults to participate in OSA screening in a dental office setting and survey the OSA risk levels of an adult population.

Methods: This cross-sectional study was conducted among adults presenting at the University of Minnesota Driven to Discover Research Facility during the 2018 Minnesota State Fair. Participants completed a brief survey including the eight-item STOP-Bang questionnaire for OSA screening. Electronic tablets were used for data capture. Data analyses included descriptive statistics, t-tests, and Chi-square tests.

Results: A total of 639 adults met the survey inclusion criteria (n=639). The majority of participants (88%) reported no prior OSA diagnosis. Based on STOP-Bang criteria, 61% (n=344) of the participants were at low, 29% (n=161) intermediate, and 10% (n= 56) high risk of OSA. A majority (64%) of participants reported being either "comfortable" or "very comfortable'"with OSA screening performed in a dental office setting.

Conclusion: Over one third of participants with no prior OSA diagnosis were at moderate to high risk for OSA, and the majority stated that they would be comfortable undergoing OSA screening in a dental office setting. Dental hygienists screening patients for OSA with the STOP-BANG questionnaire are likely to have a high level of patient acceptance. Referring patients to the appropriate health care provider for further testing may increase timely diagnoses and treatment of OSA.

Keywords: obstructive sleep apnea, sleep disordered breathing, STOP-Bang questionnaire, health screenings, dental hygienists

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Introduction

Sleep disordered breathing (SDB) has risen along with obesity in the United States (US). A recent estimate of the prevalence of mild to severe SDB is projected to be 26% for persons 30–70 years of age.[1] Although obstructive sleep apnea (OSA) is one of the most common sleep disorders among US adults, an estimated 80% of cases remain undiagnosed.[2,3] Obstructive sleep apnea is characterized by repetitive collapse of the airway during sleep,[4,5] followed by arousal, which reverses airway collapse and restores normal oxygenation and ventilation. These episodes are associated with dysfunction of the autonomic nervous system and increases in oxidative stress.[6] These episodic processes may explain the association between OSA and cardiovascular diseases including hypertension, heart failure, arrhythmias, and stroke.[7, 8, 9] Of specific relevance to

oral health care providers, OSA has also been identified as a contributing factor to inflammation, as measured by elevated levels of inflammatory cytokines,[10] with several studies reporting an association with periodontal disease.[11-14]

Key risk factors for OSA include obesity, hypertension, large neck circumference, advanced age, and male gender.[4,15] Symptoms of OSA include general fatigue and excessive daytime sleepiness; loud snoring; and witnessed apneic events.[4] A useful clinical screening tool that is rapidly becoming the standard for a quick OSA assessment is the 8-item STOP-Bang questionnaire (see Figure 1).[16] The instrument consists of four subjective items (STOP: Snoring, Tiredness, Observed apnea, and high blood Pressure) and four demographic items (Bang: BMI, age, neck circumference, and gender).[17] Total STOP-

Figure 1. STOP-Bang Questionnaire[20]

Snoring: Do you snore loudly (loud enough to be heard through closed doors)?	Yes	No
Tired: Do you often feel tired, fatigued, or sleepy during daytime?	Yes	No
Observed: Has anyone observed you stop breathing during your sleep?	Yes	No
Blood Pressure: Do you have or are you being treated for high blood pressure?	Yes	No
BMI: BMI more than 35 kg/m²?	Yes	No
Age: Age over 50 years old?	Yes	No
Neck circumference: neck circumference greater than 40 cm?	Yes	No
Gender: Male?	Yes	No

Legend: Yes=1, No=0

Scoring: High risk of OSA: Answered 'yes' to 3 or more questions

Low risk of OSA: Answered 'yes' to less than 3 questions

Bang scores range from 0 to 8, with scores of 0-2 indicating low risk for OSA, whereas scores of 3 or more, demonstrate a significantly increased risk of OSA.[5] The questionnaire can be completed in 1-2 minutes and requires minimal training to administer.

Patients assessed at increased risk for OSA should be referred to the appropriate health care specialist for further testing and diagnosis. A definitive OSA diagnosis is obtained by conducting a polysomnograph (i.e., sleep study), in consultation with a sleep medicine physician.[10,18] Based on this essential information, the etiology and severity of the OSA is determined, followed by an appropriate treatment plan. Continuous positive airway pressure (CPAP) is the gold standard treatment for most patients diagnosed with OSA. The CPAP uses high pressure to force air through the airway to prevent collapse during periods of sleep.[4]

For individuals who are intolerant of CPAP treatment (25-58%), other treatment options are prescribed.[19] Mandibular advancement devices (MAD) are oral devices that advance the mandible and tongue to prevent the collapse of the upper airway during sleep.[20-22] These devices are fitted and maintained in dental settings, in collaboration with medical professionals. Several visits are often required to adjust these devices to the ideal position for patients. Similar to the CPAP, patient compliance is a concern, with only 32% of patients using an oral appliance regularly.[23] Long-term compliance is also a concern, with many as 55% of patients stopping use of the oral appliance within the first year. Of those who

discontinued treatment, 62% reported an inability to adapt to the device and 38% reported temporomandibular pain associated with device use.[23] Additional treatment options include airway surgery and hypoglossal nerve stimulation during sleep.[24] Successful treatment has been shown to improve both quality of life and cardiovascular outcomes.[24,25]

Dental hygienists are well-positioned to screen and refer patients for further diagnostic testing, due to their knowledge of head and neck anatomy and because routine dental visits often occur at a higher frequency than primary care visits.[26] While the STOP-Bang questionnaire can easily be used in dental offices to identify patients at risk for OSA, it is not clear whether patients would be comfortable undergoing OSA screening during dental visits. The purpose of this study was to determine individuals' comfort level in completing the STOP-Bang questionnaire in the dental office setting. Secondary goals were to determine the proportion of patients at risk for OSA in an adult population and assess their most recent dental and medical visits.

Methods

This descriptive study was conducted among a convenience sample of adult attendees at the Minnesota State Fair in August 2018. A short survey was administered during two five-hour data gathering sessions at the University of Minnesota Driven to Discover Research Facility. The study was described to potential participants who approached the study booth, and written consent was obtained. Subjects were asked to complete the survey using an electronic device with a touchscreen. Research staff were available to assist participants who needed technical assistance. No personal identifying information was obtained from the participants. Inclusion criteria were age 18 and older and English literacy.

A brief original survey was designed for specific use in this study. Demographic and health history questions were included to assess participants' most recent medical and dental care visits, age and sex assigned at birth, and prior medical diagnoses. Prior medical diagnoses questions (yes/no) included OSA, hypertension, cardiovascular diseases, stroke, periodontal disease, and diabetes. The risk of OSA was determined using the STOP-Bang questionnaire. The final item asked the participant's level of comfort completing a similar survey in the dental office setting: response choices used a 5-item Likert scale, ranging from 5=very comfortable, to 1=very uncomfortable.

While the overall survey instrument was not validated, the psychometric properties of the STOP-Bang questionnaire have been tested extensively.[27] Development of the instrument was

based on initial factor analysis of the STOP questionnaire components, selected from 14 initial questions designed to reflect snoring, daytime tiredness, observed breathing cessation, and high blood pressure. The "Bang" items were chosen based in univariate analysis of items predictive performance. Subsequent analysis have focused on the predictive validity of the screening instrument compared to definitive sleep study results. In a recent meta-analysis, the instrument sensitivity was shown to be high (90 to 96%) although specificity was somewhat low (25-49%).[17] This combination of high sensitivity and lower specificity allows the questionnaire to capture almost all participants who truly have OSA for further diagnostic screenings, which uses the definitive sleep study to rule out OSA diagnosis for those not having it.

The study was submitted to the University of Minnesota Institutional Review Board and deemed exempt from further review. The study staff communicated to participants that study participation was not a substitute for a medical assessment. Resources and educational materials were available for participants who were concerned regarding their OSA risk. A paper copy of the STOP-Bang was available for attendees to take home and complete, that included scoring and follow-up recommendations. Referral to a medical provider was also available for interested participants.

Analysis included calculating participants' risk of OSA using the standard scoring of the STOP-Bang questionnaire. Scores of 5-8 were deemed high risk, scores of 3-4 moderate risk, and scores of 0-2 low risk.[28] Descriptive statistics (means and standard deviations for continuous measures; counts and proportions for categorical measures) were used to describe the sample. Characteristics were compared between those with and without an OSA diagnosis and between OSA risk categories (low, moderate, high) for those with no prior OSA diagnosis using two-sample t-tests or one-way ANOVAs for continuous variables and Chi-square tests for categorical variables.

Results

A total of 646 adults completed the survey. Responses from seven participants were excluded from the analysis due to participants not providing written consent, despite completing the survey, for a sample size of 639. Table I displays the characteristics of the study participants. The majority of participants were female (59%) with a mean age (standard deviation [SD]) of 51.1 years (17.0). A majority reported having a medical (83%) or dental visit (84%) within the past year. The most frequently reported OSA comorbidity was high blood pressure (22%) followed by periodontal disease (15%). Nearly two-thirds (64%) indicated that they would be "very comfortable" or "comfortable" completing an OSA screening questionnaire in a dental office setting.

The characteristics of participants with and without an OSA diagnosis are displayed in Table II. As expected, those diagnosed with OSA were older ($p<0.001$), more likely to be male ($p<0.001$), had more recent medical visits ($p=0.014$), and a higher prevalence of diabetes ($p<0.001$) and hypertension ($p<0.001$). No statistically significant differences were found for the most recent dental visit or level of comfort with

Table I. Demographic characteristics (n=639)

Characteristic	n (%)
Sex assigned at birth	
Male	261 (40.8)
Female	378 (59.2)
Last medical visit	
Less than 6 months ago	343 (53.7)
6-12 months ago	185 (29.0)
13-24 months ago	63 (9.9)
2-5 years ago	35 (5.5)
More than 5 years ago	13 (2.0)
Last dental visit	
Less than 6 months ago	388 (60.7)
6-12 months ago	148 (23.2)
13-24 months ago	49 (7.7)
2-5 years ago	35 (5.5)
More than 5 years ago	19 (3.0)
Comfort with OSA screening in a dental office	
Very comfortable	229 (35.8)
Comfortable	178 (27.9)
Neutral	175 (27.4)
Uncomfortable	40 (6.3)
Very uncomfortable	17 (2.7)

OSA screening in a dental office. Characteristics of participants that had not previously been diagnosed with OSA by STOP-Bang risk category are shown in Table III. Participants in higher risk categories were more likely to be older ($p<0.001$) and male ($p<0.001$). A majority of participants with a high-risk score reported visiting a medical (50%) or dental provider (55%) in the last 6 months. The majority of all risk groups were "very comfortable" or "comfortable" with OSA screening in a dental setting. No statistically significant differences were found by risk category for most recent medical or dental visit, or comfort with OSA screening in a dental office.

Discussion

Obstructive sleep apnea is a common but often undiag-nosed medical disorder that is associated with numerous medical comorbidities including

Table II. Characteristics of the study population by prior OSA diagnosis (n=639)

Characteristic	No prior OSA diagnosis n (%)	Prior OSA diagnosis n (%)	p-value
Age, mean (SD)*	49.6 (17.2)	61.6 (11.4)	<0.001
Male	215 (38.3)	46 (59.0)	<0.001
	n = 561	n = 78	
Last medical visit			**0.014**
Less than 6 months ago	289 (51.5)	54 (69.2)	
6-12 months ago	165 (29.4)	20 (25.6)	
13-24 months ago	61 (10.9)	2 (2.6)	
2-5 years ago	33 (5.9)	2 (2.6)	
More than 5 years ago	13 (2.3)	0 (0)	
Last dental visit			**0.26**
Less than 6 months ago	334 (59.5)	54 (69.2)	
6-12 months ago	132 (23.5)	16 (20.5)	
13-24 months ago	45 (8.0)	4 (5.1)	
2-5 years ago	34 (6.1)	1 (1.3)	
More than 5 years ago	16 (2.9)	3 (3.8)	
Diagnosed dental and medical conditions			
Periodontal disease	81 (14.4)	14 (17.9)	0.52
Diabetes	32 (5.7)	14 (17.9)	<0.001
High blood pressure	109 (19.4)	32 (41.0)	<0.001
Stroke	5 (0.9)	2 (2.6)	0.21
Heart disease	27 (4.8)	8 (10.3)	0.06
Comfort with OSA screening in a dental office			**0.33**
Very comfortable	196 (34.9)	33 (42.3)	
Comfortable	158 (28.2)	20 (25.6)	
Neutral	157 (28.0)	18 (23.1)	
Uncomfortable	37 (6.6)	3 (3.8)	
Very uncomfortable	13 (2.3)	4 (5.1)	

*Standard deviation (SD)

heart disease, stroke, and periodontal disease. Risk factors for OSA, such as advanced age, male gender, obesity and large neck circumference are easily identifiable and can be rapidly assessed using the STOP-Bang questionnaire. Screening for OSA facilitates identification of high-risk patients who could benefit from further diagnostic testing and treatment.

Results from this study identified that, over half of participants who were not previously diagnosed with OSA indicated that they would be either "very comfortable" or "comfortable" completing OSA screening in a dental setting. Only 9.0% indicated that they would be "uncomfortable" or "very uncomfortable" completing OSA screening in the dental setting. These results suggest that the vast majority of adults in the general public may be willing to undergo OSA screening during dental visits. While no other studies of the general public are available, one previous study among dental patients found that approximately 50% expressed acceptance of OSA screenings in a dental office setting.[29] However, it should be noted that a variety of OSA screenings exist.

Currently there are few studies regarding OSA screening practices in dental offices and follow-up treatment after OSA diagnosis. One study conducted among practicing Minnesota dental hygienists reported that about 10% had an established OSA screening protocol in their practice settings and no single screening instrument was used more frequently than another.[30] In a separate study, dentists were surveyed to establish the frequency of OSA screening in the dental office.[31] While 76% of the dentists reported screening for OSA, only 14% screen every patient.[31] Unfortunately the low response rate (7%) of that study make the results difficult to generalize the population as a whole.[31]

In this study, most participants (76.4%) who were categorized as at moderate or high risk of OSA, based on the STOP-Bang scoring, did not report being previously diagnosed with OSA. This is consistent with the estimated 80% of moderate to serve cases of OSA in the US that are undiagnosed.[16] This high percentage of undiagnosed individuals may benefit from a screening intervention to help identify, diagnose, and provide treatment before serious medical conditions arise or worsen.

Daytime sleepiness due to OSA has been linked to multiple workplace and public health risks. Individuals with untreated OSA have a two-fold increases in workplace accidents.[32] Commercial drivers have been studied with concern over road fatigue and OSA effects, resulting in about 7% of motor vehicle accidents (MVAs).[32] Policies for commercial drivers have been developed related to their abilities to perform driving tasks safely, and discussion of the impact OSA on non-commercial drivers has begun.[33]

Table III. Participant characteristics with no prior OSA diagnosis by STOP-BANG OSA risk (n=561)

Characteristic	Low OSA Risk n (%)	Moderate OSA Risk n (%)	High OSA Risk n (%)	*p*-value
Age, mean (SD)*	45.7 (17.5)	55.6 (15.2)	56.7 (12.8)	<0.001
Male	75 (21.8)	94 (58.4)	46 (82.1)	<0.001
	n = 344	n = 161	n = 56	
Last medical visit				**0.23**
Less than 6 months ago	168 (48.8)	93 (57.8)	28 (50.0)	
6-12 months ago	104 (30.2)	43 (26.7)	18 (32.1)	
13-24 months ago	44 (12.8)	11 (6.8)	6 (10.7)	
2-5 years ago	22 (6.4)	10 (6.2)	1 (1.8)	
More than 5 years ago	6 (1.7)	4 (2.5)	3 (5.4)	
Last dental visit				**0.48**
Less than 6 months ago	210 (61.0)	93 (57.8)	31 (55.4)	
6-12 months ago	79 (23.0)	34 (21.1)	19 (33.9)	
13-24 months ago	28 (8.1)	14 (8.7)	3 (5.4)	
2-5 years ago	18 (5.2)	14 (8.7)	2 (3.6)	
More than 5 years ago	9 (2.6)	6 (3.7)	1 (1.8)	
Comfort with OSA screening in a dental office				**0.21**
Very comfortable	130 (37.8)	53 (32.9)	13 (23.2)	
Comfortable	83 (24.1)	54 (33.5)	21 (37.5)	
Neutral	102 (29.7)	39 (24.2)	16 (28.6)	
Uncomfortable	22 (6.4)	10 (6.2)	5 (8.9)	
Very uncomfortable	7 (2.0)	5 (3.1)	1 (1.8)	

*Standard deviation (SD)

In addition to performance issues, OSA is associated with safety concerns for patients undergoing surgery requiring anesthesia. Individuals with OSA are at a higher risk for cardiovascular and cardiopulmonary complications post-operatively.[34] Preoperative screenings for OSA, using the STOP-Bang, is recommended to identify patients with moderate to severe OSA risk.[17]

A percentage of participants in this study indicated that they had seen a dental provider within the last 12 months. Among moderate-risk patients, 79% of patients indicated that they had visited a dentist within 12 months. Among high-risk patients, 89% had visited a dentist within 12 months. Corresponding numbers for physician visits were 84% for intermediate-risk participants and 82% for high-risk participants. This suggests that there is opportunity for OSA screening at either the dental office or medical office for most at-risk patients. However, opportunistic screening medical offices is generally poor, as patients' primary complaints take diagnostic precedence,

thus creating a need which could be filled by dental hygienists.[23]

The dental office may be an ideal setting for OSA screening, as dental hygienists have the necessary knowledge base to identify anatomical risk factors for OSA and preventative care dental visits occur on a regular basis. A recent study among practicing Minnesota dental hygienists found that participants viewed OSA as either an important, very important, or extremely important clinical disorder (92.9%) with similar responses regarding the importance of identifying patients with possible OSA (92.3%).[30] Recognizing the importance of OSA may indicate that dental hygienists would willingly incorporate OSA screening into routine dental hygiene care.

This study had limitations. First, this survey was completed at a research booth by participants who willingly approached the researchers and consented to the study and may not be representative of the general population. Participants in this study, due to selection bias, may be more comfortable completing questionnaires (e.g., the STOP-Bang) than members of the general population or the population that seeks regular dental care. Moreover, it is possible that participants who approached the research booth were more likely than members of the general population to seek either dental or medical care, thus the data for date of most recent dental and physician visits may be biased.

Based on these findings, further research is needed in several areas. The first is to determine the attitudes of dental hygienists regarding OSA screenings in clinical practice and appointment time management. Attitude measures will help project how these screenings can be incorporated into routine dental hygiene care appointments. Additional assessment of current screening protocols will establish further recommendations for development of an OSA screening,

referral, and OSA treatment protocol. It is also essential to determine how OSA screenings can be effectively implemented and how to collaborate with medical professionals to obtain a formal OSA diagnosis and assist in treatment implementation.

Conclusion

Results from this study demonstrate that a large proportion of community adults in Minnesota are at moderate to high risk for obstructive sleep apnea. These individuals would be comfortable undergoing screening for OSA in a dental office and had visited the dentist over the previous 12 months. Dental hygienists are well positioned to implement OSA screening and initiate referral protocols in Minnesota dental offices.

Disclosure

Acknowledgements

Yvette Reibel, MSDH, RDH is an assistant clinical professor, Division of Dental Hygiene, Department of Primary Dental Care, University of Minnesota School of Dentistry, Minneapolis, MN, USA; *David N. Flynn, MD, MBA* is an assistant clinical professor, Department of Anesthesiology, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA; *Ashley Petersen, PhD* is an assistant professor, Division of Biostatistics, University of Minnesota School of Public Health, Minneapolis, MN, USA; *Priscilla M. Flynn, MPH, DrPH, RDH* is an associate professor, Division of Dental Hygiene, Department of Primary Dental Care, University of Minnesota School of Dentistry, Minneapolis, MN, USA

Corresponding author: Yvette G. Reibel, MSDH; wlod0003@umn.edu

References

1. Peppard PE, Young T, Barnet JH, et al. Increased prevalence of sleep-disordered breathing in adults. Am J Epidemiol. 2013 May1;177(9):1006-14.

2. Garvey J, Pengo M, Drakatos p, Kent B. Epidemiological aspects of obstructive sleep apnea. J Thorac Dis. 2015 May; 7(5):920-9.

3. Frost & Sullivan. Hidden health crisis costing America billions underdiagnosing and undertreating obstructive sleep apnea draining healthcare system. [Internet]. Darien (IL): American Academy of Sleep Medicine; 2016. [cited 2019 Sept 1] Available from: https://aasm.org/resources/pdf/sleep-apnea-economic-crisis.pdf

4. An S, Ranson C. Obstructive sleep apnea for the dental hygienist: overview and parameters for interprofessional practice. Can J Dent Hyg. 2011;45(4):238-53.

5. Chung F, Abdullah HR, Liao, P. STOP-Bang Questionnaire: a practical approach to screen for obstructive sleep apnea. Chest. 2016 Mar;149(3):631-8.

6. Floras JS. Sleep apnea and cardiovascular disease: an enigmatic risk factor. Circ Res. 2018 Jun 8;122(12):1741-64.

7. Zulucky AA, Nicholl DD, Hanly PJ, et al. Nocturnal hypoxemia severity and renin-angiotensin system activity in obstructive sleep apnea. Am J Respir Crit Care Med. 2015 Oct;192(7):873-80.

8. Minichbauer BC, Sheats RD, Wilder RS, et al. Sleep medicine content in dental hygiene education. J Dent Educ. 2015 May;79(5):484-92.

9. Redline S, Yenokyan G, Gottlieb D, et al. Obstructive sleep apnea-hypopnea and incident stroke: the sleep heart health study. Am J Respir Crit Care Med. 2010 Jul;182(2): 269-77.

10. Shamsuzzaman ASM, Winnicki M, Lanfranchi P, et al. Elevated C-reactive protein in patients with obstructive sleep apnea. Circulation. 2002 May;105(21):2462-4.

11. Loke W, Girvan T, Ingmundson P, et al. Investigating the association between obstructive sleep apnea and periodontitis. J Periodontol. 2015 Feb; 86(2): 232-43.

12. Gamsiz-Isik H, Kiyan E, Bingol Z, et al. Does obstructive sleep apnea increase risk for periodontal disease? A case-control study. J Periodontol. 2017 May;88(5): 443-9.

13. Ahmad NE, Sauders AE, Sheats R, et al. Obstructive sleep apnea in association with periodontitis: a case control study. J Dent Hyg. 2013 Aug;87(4):188-99.

14. Gunaratnam K, Taylor B, Curtis B, et al. Obstructive sleep apnoea and periodontitis: a novel association. Sleep Breath. 2009 Aug;13: 233-39.

15. Young T, Skatrud J, Peppard PE. Risk factors for obstructive sleep apnea in adults. JAMA. 2004 Apr 28; 291(16): 2013-6.

16. American Sleep Apnea Association. Sleep apnea Information for clinicians [Internet].Washington (DC): American Sleep Apnea Association; 2019 [cited 2019 Sept 1]; [about 2 screens] Available from: https://www.sleepapnea.org/learn/sleep-apnea-information-clinicians/

17. Nagappa M, Liao P, Wong J, et al. (2015) Validation of the STOP-Bang questionnaire as a screening tool for obstructive sleep apnea among different populations: a systematic review and meta-analysis. PLoS ONE 2015 Dec 14;10(12): e0143697.

18. Abrishami A, Khajehdehi A, Chung F. A systematic review of screening questionnaires for obstructive sleep apnea. Can J Anaesth. 2010 May; 57(5):423-38.

19. Ramar K, Dort LC, Katz SG, et al. Clinical practice guideline for the treatment of obstructive sleep apnea and snoring with oral appliance therapy: an update for 2015. J Clin Sleep Med. 2015 Jul 15;11(7):773-827

20. Sasao Y, Nohara K, Okuno K, et al. Videoendoscopic diagnosis for predicting the response to oral appliance therapy in severe obstructive sleep apnea. Sleep Breath. 2014 Dec; 18(4):809–15.

21. Sutherland K, Chan AS, Cistulli PA. Three-dimensional assessment of anatomical balance and oral appliance treatment outcome in obstructive sleep apnoea. Sleep Breath. 2016 Sep; 20(3):903–10.

22. Gakwaya S, Melo-Silva CA, Borel JC, et al. Impact of stepwise mandibular advancement on upper airway mechanics in obstructive sleep apnea using phrenic nerve magnetic stimulation. Respir Physiol Neurobiol. 2014 Jan1;190:131–6.

23. Saglam-Aydinatay B, Taner T. Oral appliance therapy in obstructive sleep apnea: Long-term adherence and patient's experiences. Med Oral Patol Cir Bucal. 2018 Jan; 23(1): e72-e77.

24. Veasey SC, Rosen IM. Obstructive sleep apnea in adults. N Engl J Med. 2019 Apr 11;380(15):1442-9.

25. Jonas DE, Amick HR, Feltner C, et al. screening for obstructive sleep apnea in adults: evidence report and systematic review for the US Preventive Services Task Force. JAMA. 2017 Jan 24;317(4):415-33.

26. Kornegay EC, Brame JL. Obstructive sleep apnea and the role of dental hygienists. J Dent Hyg. 2015 Oct;89(5):286-92.

27. Boynton G, Vahabzadeh A, Hammoud S, et al. Validation of the STOP-BANG questionnaire among patients referred for suspected obstructive sleep apnea. J Sleep Disord Treat Care. 2013 Sep 23;2(4): 10.4172/2325-9639.

28. Chung F, Yegneswaran B, Liao P, et al. STOP questionnaire: a tool to screen patients for obstructive sleep apnea. Anesthesiology. 2008 May;108(5): 812-21.

29. Dillow K, Essick G, Sanders A, et al. Patient response to sleep apnea screening in a dental practice. J Public Health Dent. 2017 Dec;77(1):13-20.

30. Reibel YG, Pusalavidyasagar S, Flynn PM. Obstructive sleep apnea knowledge: Attitudes and screening practices of Minnesota dental hygienist. J Dent Hyg. 2019 Jun;93(3):29-36.

31. Chiung HK, Long A, Carrico CK, et al. The prevalence of general dentists who screen for onstructive sleep apnea. J Dent Sleep Med. 2018; 5(3): 55-60.

32. Garbarino S. Obstructive sleep apnea (OSA) and driving safety. La Medicina del Lavoro. 2017 Aug;108(4):297-303.

33. Rizzo D, Libman E, Creti L, et al. Determinants of policy decisions for non-commercial drivers with OSA: An integrative review. Sleep Medicine Reviews. 2018 Feb;37:130-7.

34. Mutter TC, Chateau D, Moffatt M, et al. A matched cohort study of postoperative outcomes in obstructive sleep apnea: could preoperative diagnosis and treatment prevent complications? Anesthesiology. 2014 Oct;121:707–18.