Prevalence and risks of habitual snoring and obstructive sleep apnea symptoms in adult dental patients

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ABSTRACT

الأهداف: تهدف هذه الدراسة الى تحديد مدى إنتشار وخطورة الشخير الإعتيادي وانْقِطاعُ النَفَسِ النّومِيّ الإنسدادي وأعراضهم لدى البالغين من مرضى الأسنان.

الطريقة: لقد شملت الدراسة ما مجموعه 200 مريض ومريضة من مراجعي عيادات الأسنان لدى إحدى الجامعات. تم استخدام أساليب تقييم موضوعية وشخصية حيث أتم مراجعي العيادات استبيانات ذاتية. تم تقييم الشخير الاعتيادي وخطر انْقطاعُ النَفَسِ النّومِيّ الإنسدادي بإستخدام النسخة العربية من استبيان برلين. تمَ إستخدام مقياس إيبورث لقياس معدل النعاس في أثناء أوقات النهار. باشر باحثين متدربين عملية أخذ القياسات الصادرة من أجسام الأفراد الخاضعين للدراسة: من قياس ضغط الدم لكل فرد ونسب تشبع الأكسجين ومعدل نبضات القلب، بالإضافة إلى الفحص السريري لمجرى الهواء العلوي ومدى تأثير إنسداد الأسنان عليه.

النتائج: تواجد الشخير الاعتيادي لدى 18.2% من الإناث و81.8% من الرجال. تبين أن توقف التنفس أثناء النوم عند الرجال كان يحدث لأكثر من مرة في الأسبوع لدى ما نسبته 9% من بين الذين شملتهم الدراسة. من بين الرجال، تبين أن ما نسبته 78.3% كانوا معرضين بشكل خطير لمرض انْقطاعُ النَفَسِ النّومِيّ الإنسدادي، مقارنةً بما نسبته 21.7% من الإناث. النعاس النهاري أكثر شيوعاً بين الذكور منه بين النساء. بحسب التحليل متعدد المتغيرات الذي تم إجراءه لدراسة مخاطر مرض انْقطاعُ النَفَسِ النّومِيّ الإنسدادي فقد أكتشف بأن المرضى المصابين بالبدانة معرضين للإصابة بهذا المرض بمعدل 10 أضعاف مقارنةً مع أقرانهم من أصحاب الأوزان الطبيعية. التّفَرُّض في اللسان وحجم اللوز وقراءات مرتفعة على مقياس إيبورث، كلها تعتبر مسببات مستقلة وخطرة لانْقطاعُ النَفَسِ النّومِيّ الإنسدادي بالإضافة الى البدانة.

الخاتمة: كشفت لنا النتائج بأن التّفَرُّض في اللسان و اللوز بالدرجتين الثالثة والرابعة كانا مرتبطتين بشكل واضح بمخاطر مرض انْقطاعُ النَفَسِ النّومِيّ الإنسدادي مما يؤكد علّى الدور الهام الذي يؤديه أطباء الأسنان في تشخيص وكشف علامات وأعراض مرض انْقطاعُ النَفَسِ النّومِيّ الإنسدادي.

Objectives: To determine the prevalence of habitual snoring and risk of obstructive sleep apnea (OSA) among dental patients and investigate factors associated with high-risk OSA.

Methods: This cross-sectional study was performed at the Department of Preventive Dental Sciences, College of Dentistry, University of Dammam, Kingdom of Saudi Arabia, between October and December 2014. A total of 200 consecutive female and male dental patients were included in this study. Subjective and objective assessments were carried out. Habitual snoring and risk of OSA were assessed using the Arabic version of the Berlin questionnaire. Two trained investigators carried out the objective measurements of anthropometric data, blood pressure, oxygen saturation, pulse rate, and clinical examination of upper-airway, and dental occlusion.

Results: Habitual snoring was present in 18.2% of the females and 81.8% of the males (p<0.05). Breathing pauses during sleep of more than once a week occurred in 9% (n=17) of the sample. Of the males, 78.3% were at high risk of OSA compared with 21.7% of the females. Multivariate analysis for risk of OSA revealed that obese patients were almost 10 times more likely to report OSA symptoms than their non-obese counterparts (odds ratio: 9.9, 95% confidence intervals: 4.4-22.1). Tongue indentations, tonsil size, and a high Epworth Sleepiness Scale score were also independent risks of OSA.

Conclusion: Tongue indentations and tonsil grades III and IV were significantly associated with risk of OSA. This validates the important role of dentists in the recognition of the signs and symptoms of OSA.

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Obstructive sleep apnea (OSA) is a repetitive complete or partial obstruction of the upper airway during sleep.[1] It is characterized by snoring, hypoxia, hypercapnia, and arousals from sleep.[2] Obstructive sleep apnea is found in 24% of male and 9% of female adults.[3] Data from the Canadian Community Health Survey[4] showed that approximately 26% of adult Canadians were at high risk of developing OSA. Two studies[5,6] in Saudi Arabian population reported a 39% prevalence of OSA in females and 33.3% in males. Obstructive sleep apnea can cause tiredness, anxiety, depression, and is associated with diminished motor and cognitive functions, and reduced quality of life.[7] The individuals with OSA have 2-10 times increased risk of motor vehicle accidents than those without OSA.[8] Untreated OSA has been linked to systemic complications such as coronary artery disease,[9] heart failure,[2] impaired glucose tolerance, insulin resistance, and dyslipidemia[10] among other conditions. Unfortunately, most of the OSA cases (85%) remain undiagnosed,[11] partly due to lack of information to patients and health professionals as well as the high costs of diagnostic tests. Several factors contribute to the development of OSA, which includes obesity, older age,[12] male gender, menopause, hereditary, smoking, alcohol, craniofacial abnormalities,[13] and periodontal disease.[14] Orofacial anatomical abnormalities such as mandibular micrognathia or retrognathia, large tongue, hypertrophy of palatine tonsils, enlarged uvula, and deep palatal arch are craniofacial risks for developing OSA.[15] Habitual snoring is one of the symptoms of sleep disordered breathing. A population based longitudinal study found that 13% of adults developed habitual snoring over 14 years. The factors associated with habitual snoring include male gender, obesity, smoking, and asthma.[16] In addition, snoring is strongly associated with increased all-cause mortality.[17] Dentists play a major role in the recognition of the signs and symptoms and the overall management of OSA.[18] No data exist on the epidemiology or risks of OSA symptoms among dental patients in Saudi Arabia. This study aims to determine the prevalence of habitual snoring and OSA risk in adult dental patients and investigate the factors associated with high risk of OSA.

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Methods. This cross-sectional study was conducted on consecutive adult dental patients attending the dental clinics at the College of Dentistry, University of Dammam, Dammam, Kingdom of Saudi Arabia between October and December 2014. The study was approved by the Committee for Biological and Medical Ethics of the Deanship of Scientific Research, University of Dammam. The study was conducted in accordance with the Helsinki Declaration. A sample of 135 was estimated to determine the prevalence of OSA risk based on the study of BaHammam et al[6] and using STATA version 13. To identify the factors associated with high risk OSA, we estimated 122 subjects to detect a 20% difference between high and low risk OSA patients and allow isolating 3-4 variables in a multiple logistic regression analysis with 80% power at the 5% level of significance.

The inclusion criteria were adult female and male patients between the age of 18 and 65 years, who presented at the predoctoral and internship dental clinics for examination, or treatment. Patients younger than 18 years, had craniofacial anomalies such as cleft lip and palate, expectant women, and those unable to read were all excluded. Eligible patients were invited to participate, and signed informed consents were obtained. Subjective and objective assessments were carried out.

Measures of snoring and risk of OSA. Subjective assessments. Patients were asked to complete a structured questionnaire that asked about demographic information (age, gender, educational level, marital status, housing condition, socioeconomic status), medical history and current medications, dental history and behaviors (brushing, flossing, and dental care utilization), and habitual smoking (defined as ≥20 cigarettes per day). Habitual snoring and risk of OSA were assessed using the Arabic version of the Berlin questionnaire,[19] which was previously tested and validated. The Berlin questionnaire[20] is a 10-item survey in which questions are divided into 3 categories (category 1 [snoring], category 2 [fatigue and sleepiness], and category 3 [hypertension with ≥140/90 mm Hg], and body mass index). An individual was considered at high risk for OSA if he/she scored positive (≥2 points) on 2 of the 3 categories. Habitual snoring was defined as a snoring frequency of 3-4 times per week or more.[21] The Epworth Sleepiness Scale (ESS)[22] was used to measure daytime sleepiness. The ESS is an 8-item questionnaire that asks about the frequency of dozing during different activities and can range from zero (no dozing possibility) to 3 (high dozing possibility). The total ESS score ranges from 0-24 and a score of

≥10 indicates excessive sleepiness.[22] The questionnaires were self-administered and filled anonymously by patients in the waiting area. Prior to data collection, the questionnaire was pilot tested on 10 dental patients who were not part of the main study and the questions were modified accordingly.

Objective assessments. Two trained investigators collected anthropometric measurements from the subjects, and then conducted upper-airway, temporomandibular (TMJ) joint, and dental occlusion examinations. Anthropometric measurements included height (cm) and weight (kg) using a digital scale (Detecto 6129, MO, USA), and neck circumference (NC, cm) measured at the level of the cricothyroid membrane. The NC was also corrected for height using the following formula: NC"/(5.5*height in meters+31)%.[23] The BMI (kg/m^2) was calculated and obesity was defined as ≥30 kg/mm^2. Systolic and diastolic blood pressure (mm Hg) was measured with a digital sphygmomanometer. Oxygen saturation (SpO_2) and pulse rate in beats per minute were assessed using a pulse oximeter (OxyTrue® S, Selmsdorf, Germany). Upper-airway examination included: tonsil size based on Friedman's classification (tonsillar hypertrophy was defined as grades 4 and 5),[24] modified Mallampati classification (moderate or severe if Class III or IV,[25] tongue size (categorized into: normal, tongue indentations, and tongue-tie), size and shape of uvula and soft palate, and depth of palatal vault. The TMJ evaluation included the maximum opening (mm), and the presence of sounds and pain. The dental occlusion examination included the presences of enamel wear using the Basic Erosive Wear Examination (BEWE) Index[26] in all sextants. Total scores were added and the risk of enamel wear was categorized into (no risk: ≤2, low risk: 3-8, medium risk: 9-13, and high risk: ≥14).[26] The occlusion variables also included facial profile, crossbite, open bite, angle classification, overbite (mm), overjet (mm), oral habits (namely, mouth breathing), and presence of mandibular Tori. The 2 examiners underwent a period of training and calibration with an experienced faculty member prior to data collection. The intra- and inter-examiner reliability were assessed and calculated using the kappa statistic for categorical variables[27] and intra-class correlation coefficient for continuous variables and showed substantial agreement (between 0.70 and 0.98).

A total of 234 patients were eligible. Thirty-four patients were excluded for different reasons.

Table 1 - Demographic profile of the 200 patients attending the dental clinics.

Variable	Value
Male/female ratio, n (%)	154 (77)/46 (23)
Age (years) (mean±SD)	34.7 ± 11.2 (Median=33, IQR=20-60)
Education, n (%)	
College of higher	107 (53.5)
High school of less	93 (46.5)
Marital status	
Married	112 (56.0)
Not married or widowed	88 (44.0)
Monthly income (SR), n (%)	
High (≥15,000)	22 (11.0)
Middle (5,000-14,999)	89 (44.5)
Low (<5,000)	89 (44.5)
BMI, kg/m^2	27.5 ± 6.5
BMI categories, n (%)	
Normal weight (18.5-24.9)	73 (36.5)
Underweight (<18.5)	8 (4.0)
Overweight (25-29.9)	56 (28.0)
Obese (≥30)	63 (31.5)
Height, cm	168 ± 0.9
Weight, kg	78.2 ± 19.3
Height corrected NC, cm	38.3 ± 3.8
Hypertension, n (%)	26 (13.0)
Diabetes, n (%)	19 (9.5)
Habitual smoking, n (%)	58 (29.0)
SPO_2%	98.4 ± 2.1
Heart rate, bpm	72.8 ± 9.9
Brushing frequency, n (%)	
More than once a day	112 (56.0)
Once a day	57 (28.5)
Few times a week or less	31 (15.5)
Use of dental floss	78 (39.0)
History of last dental visit, n (%)	
Within the last year	146 (73.0)
More than a year ago	54 (27.0)

SPO_2 - percutaneous oxygen saturation, NC - neck circumference, BMI - body mass index, bpm - beats per minute, IQR - interquartile range

Table 2 - Distribution of snoring and risk of obstructive sleep apnea (OSA) in 200 females and males patients attending the dental clinics.

Outcomes	Female (n=46)		Male (n=154)		*P*-value
Snoring					0.049*
Non-snoring	35	(28.5)	88	(71.5)	
Simple snoring	5	(11.4)	39	(88.6)	
Habitual snoring	6	(18.2)	27	(81.8)	
Risk of OSA					0.817
Low	36	(23.1)	118	(75.6)	
High	10	(21.7)	36	(78.3)	
Daytime sleepiness					0.256
Low	34	(25.4)	100	(74.6)	
High	12	(18.2)	54	(81.8)	

* Significant at $p<0.05$ using Fisher's exact test

Statistical analysis. Data were entered on an Excel spreadsheet, then transferred to STATA version 13 for analysis (Stata Statistical Software: Release 13. College Station, TX: StataCorp LP.) Descriptive statistics were initially conducted. Independent sample t-test was used for continuous variables and Pearson Chi-square test and Fisher's exact test (when appropriate) for categorical data. The risk of OSA was dichotomized into high or low based on the Berlin questionnaire cut off. Univariate analysis and multivariate backward stepwise regression were used to assess factors associated with the risk of OSA. The level of significance was set at 5% using 2-tailed tests. Hosmer-Lemeshow goodness-of-fit test and the area under the receiver operator characteristic (ROC) curve were used to assess the validity of the multivariate regression model.

Results. Two hundred dental patients were included, (n=154, 77%) of them were males (**Table 1**). Most of the patients were highly educated and in the low to middle income groups. Almost one third of the patients were obese (n=63). The neck circumference (NC)

Table 3 - Clinical differences between low and high risk of obstructive sleep apnea (OSA) in 200 dental patients.

Variables	Risk of OSA		
	Low (n=154)	High (n=46)	*P*-value
Age, years	34.1 ± 11.7	36.7 ± 8.9	0.177
Male, n (%)	118 (76.6)	36 (23.4)	0.817
BMI kg/m^2	26.1 ± 5.6	32.4 ± 7.1	<0.001*
Obese (≥30 Kg/m^2), n (%)	31 (49.2)	32 (50.8)	<0.001*
Neck circumference, cm	38.3 ± 3.6	41.8 ± 4.3	<0.001*
Height corrected neck circumference, cm	38.1 ± 3.8	38.8 ± 3.9	0.321
Hypertension, n (%)	12 (46.2)	14 (53.9)	<0.001*
Diabetes, n (%)	16 (84.2)	3 (15.8)	0.573
Habitual smoker, n (%)	44 (75.9)	14 (24.1)	0.807
Systolic BP, mm Hg	126.5 ± 15.1	126.3 ± 14.2	0.969
Diastolic BP, mm Hg	76.0 ± 11.4	78.5 ± 8.9	0.183
SPO_2, n (%)	97.8 ± 1.3	98.3 ± 0.9	0.698
Heart rate, bpm	71.5 ± 8.6	75 ± 8.8	0.055
Habitual Snoring, n (%)	6 (18.2)	27 (81.8)	<0.001†
Epworth Sleepiness Scale score	6.9 ± 4.6	8.9 ± 4.7	0.011*
Convex facial profile, n (%)	27 (75.0)	9 (25.0)	0.796
Mallampati, class III or IV, n (%)	23 (24.5)	71 (75.5)	0.642
Tonsil size (Grades III or IV), n (%)	9 (42.9)	12 (57.1)	0.022*
Tongue indentations, n (%)	11 (47.8)	12 (52.2)	0.003*
High vaulted palate, n (%)	9 (28.1)	23 (71.9)	0.452
Elongated uvula or down sloping soft palate, n (%)	36 (73.5)	13 (26.5)	0.499
Molar angle classification, n (%)			0.917
Class I	79 (78.2)	22 (21.8)	
Class II	41 (75.9)	13 (24.1)	
Class III	34 (75.6)	11 (24.4)	
Mean overjet, mm	2.5 ± 2.1	2.6 ± 1.9	0.736
Overbite, n (%)			0.614
<0 mm	6 (75.0)	2 (25.0)	
0-2 mm	133 (76.0)	42 (24.0)	
>2 mm	15 (88.2)	2 (11.8)	
Mandibular tori, n (%)	15 (78.9)	4 (21.1)	0.832
BEWE, medium or high risk, n (%)	5 (71.4)	2 (28.6)	0.662
Brushing frequency, n (%)			0.672
More than once a day	88 (78.9)	24 (21.4)	
Once a day	44 (77.2)	13 (22.8)	
Few times a week or less	22 (71.0)	9 (29.0)	
Does not use dental floss, n (%)	62 (79.5)	16 (20.5)	0.504
Last dental visit more than a year ago	40 (74.1)	14 (25.9)	0.550

BEWE - basic erosive wear examination index, *Significance level $p<0.05$ using Chi-square test, †Significance level $p<0.05$ using Fisher's exact test, SPO_2 - percutaneous oxygen saturation, BMI - body mass index, bpm - beats per minute

measurements were significantly higher in males (40 cm ±3.9) than in females (36.4 cm ±0.4) (p<0.001). Twenty percent of patients were taking medications for diabetes, hypertension, ulcerative colitis, hyperthyroidism, and vitamin D deficiency.

Table 2 presents the distribution of habitual snoring and risk of OSA by gender. Habitual snoring was present in 17% of the sample and was significantly more prevalent in males than in females, (p=0.049). Breathing pauses during sleep with a frequency of more than once per week occurred in 9% (n=17) of the sample, of those 88.2% were males. Approximately 42.5% (n=85) reported falling a sleep while driving or waiting. Twenty-three percent of the sample was at high risk of OSA (78.3% in males and 21.7% in females, p=0.817).

The clinical differences between high and low OSA patients are shown in **Table 3**. High risk of OSA was significantly associated with obesity, increased mean NC, presence of hypertension, habitual snoring, large tonsil size, and the presence of tongue indentations. Clinical differences were also compared between

Table 4 - Clinical differences in habitual snoring of 200 dental patients.

Variable	Snoring		P-value
	Non-snorer (n=167)	Habitual (n=33)	
Age (years) (mean±SD)	34.2 ± 11.5	37.2 ± 9.4	0.167
Male, n (%)	127 (82.5)	27 (17.5)	0.472
Height (mean±SD)	168 ± 0.1	171 ± 0.1	0.096
Weight (mean±SD)	76.3 ± 18.5	87.3 ± 21.1	0.003*
BMI, kg/m^2 (mean±SD)	27.1 ± 6.2	30 ± 7.3	0.018*
Obese (≥30 Kg/m^2), n (%)	46 (73.0)	17 (27.0)	0.007*
Neck circumference, cm (mean±SD)	38.8 ± 3.9	40.8 ± 4.2	0.009*
Height corrected neck circumference, cm (mean±SD)	38.1 ± 3.8	39.3 ± 3.9	0.118
Hypertension, n (%)	18 (69.2)	8 (30.8)	0.042*
Diabetes, n (%)	17 (89.5)	2 (10.5)	0.745
Habitual smoker, n (%)	49 (84.5)	9 (15.5)	0.811
Systolic blood pressure, mm Hg (mean±SD)	127.1 ± 15.1	122.9 ± 13.2	0.136
Diastolic blood pressure mm Hg (mean±SD)	76.8 ± 11.4	75.7 ± 8.2	0.564
SPO_2, (mean±SD)	97.8 ± 7.9	98.3 ± 0.7	0.745
Heart rate, bpm (mean±SD)	72 ± 11.5	73.8 ± 9.3	0.410
Epworth Sleepiness Scale score (mean±SD)	6.9 ± 4.6	9.8 ± 4.1	<0.001*
Convex facial profile, n (%)	29 (80.6)	7 (19.4)	0.730
Mallampati, class III or IV, n (%)	18 (19.2)	76 (80.9)	0.342
Tonsil size (Grades III or IV), n (%)	9 (42.9)	12 (57.1)	0.001*
Tongue indentations, n (%)	7 (30.4)	16 (69.6)	0.056
High vaulted palate, n (%)	9 (28.1)	23 (71.9)	0.053
Elongated uvula or down sloping soft palate, n (%)	41 (83.7)	8 (16.3)	0.970
Molar angle classification, n (%)			0.557
Class I	82 (81.2)	19 (18.8)	
Class II	45 (83.3)	9 (16.7)	
Class III	40 (88.9)	5 (11.1)	
Mean overjet, mm (mean±SD)	2.4 ± 2.1	2.9 ± 1.9	0.240
Overbite, n (%)*			0.546
<0 mm	7 (87.5)	1 (12.5)	
0-2 mm	144 (82.3)	31 (17.7)	
>2 mm	16 (94.1)	1 (5.9)	
Mandibular tori, n (%)	16 (84.2)	3 (15.3)	1.00
BEWE, medium or high risk, n (%)	5 (71.4)	2 (28.6)	0.325
Brushing frequency, n (%)			0.577
More than once a day	94 (83.9)	18 (16.1)	
Once a day	49 (86.0)	8 (14.0)	
Few times a week or less	24 (77.4)	7 (22.6)	
Does not use dental floss, n (%)	65 (83.3)	13 (16.7)	0.960
Last dental visit more than a year ago	45 (83.3)	9 (16.7)	0.969

*significance level p<0.05 using Chi-square test, †significance level p<0.05 using Fisher's exact test, bpm - beats per minute, BEWE - basic erosive wear examination index

Table 5 - Multivariate logistic regression of the risks of obstructive sleep apnea (OSA) symptoms in 200 dental patients.*

Variable	Univariate analysis OR (95% CI)	*P*-value	Multivariate analysis OR (95% CI)	*P*-value
Obese (≥30 Kg/m^2)	9.1 (4.3 - 19.0)	<0.001	9.9 (4.4-22.1)	<0.001
Habitual snoring	6.7 (3.9 - 11.4)	<0.001		
Hypertension	5.2 (2.2 - 12.2)	<0.001		
Tongue indentations	3.7 (1.5 - 9.1)	0.004	3.1 (1.1-9.2)	0.046
Tonsil size (Grades III or IV)	2.9 (1.1 - 7.3)	0.027	3.4 (1.1-10.3)	0.034
Neck circumference, cm	1.2 (1.1 - 1.4)	<0.001		
High ESS score	1.1 (1.0 - 1.2)	0.013	1.1 (1.0-1.1)	0.024

OR - odds ratio, CI - confidence interval, ESS - Epworth Sleepiness Scale, *Significance level $p<0.05$

habitual and non-habitual snorers (**Table 4**). The analysis revealed that weight in kg, obesity, hypertension, NC, ESS score, and tonsil size were significantly related to habitual snoring.

The multivariate regression model for risk of OSA isolated 4 variables (**Table 5**). Obese patients were almost 10 times more likely to report OSA symptoms than their non-obese counterparts (odds ratio: 9.9, 95% confidence interval [CI]: 4.4-22.1). Tongue indentations and tonsil sizes III or IV were the only dental variables that maintained significance on the multivariate level. The Hosmer-lemeshow test was not statistically significant (p=0.4250), and the area under the receiver operating characteristic (ROC) curve was 0.823, both confirming adequacy of the fitted model.

Discussion. This study assessed the prevalence of habitual snoring and risks of OSA among adult dental patients. Habitual snoring is an important characteristic of sleep-disordered breathing. Approximately 82% of males and 18.2% of females in our study were habitual snorers. These proportions are different from the findings of BaHammam et al[5,6] who reported that 40.8% of the Saudi females and 52.3% of the males who attended outpatient hospital clinics were snorers. The differences between our study and the earlier studies can be explained by the diverse definitions of snoring used. Our study measured habitual snoring, defined as a snoring frequency of ≥3-4 times per week, while the previous studies[5,6] measured the presence of snoring inclusive of both simple and habitual snoring.

Twenty-three percent of the dental patients in the present study were at high risk of OSA (one in 4 adult dental patients is at increased risk of OSA). This percentage is similar (26%) to the findings in a previous survey of 1506 adults conducted by the National sleep Foundation in America.[28] The results however, were different from 2 studies on Saudis[5,6] that reported 39% prevalence of OSA in females and 33.3% in males. Another study reported the prevalence of sleep apnea and snoring among dental patients in America and approximately 33% of male and 6% of female populations had moderate to severe sleep apnea, while snoring was observed in 46% of males and 16% of females.[29]

A greater percentage of high-risk OSA subjects in the present study were male. Bixler et al[30] had shown that OSA is 3 times more common in male than premenopausal female, and 2 times higher than postmenopausal female. Gender differences have been attributed to several factors including differences in fat distribution, gender hormones, neurochemical mechanisms, and sleep arousals[31] putting male at a greater risk of OSA.

Consistent with many previous studies,[32-34] this study found that obesity is the strongest independent risk factor for OSA with a 10-fold increase in risk. Peppard et al[35] indicated that approximately 10% gain in body weight is associated with 32% increase in the symptoms of OSA, whereas 10% body weight loss can result in 26% reduction in the severity of the disease. Obesity is a serious public health problem among all age groups in Saudi Arabia. The prevalence of obesity in adults has increased significantly from 22% to 36% between 1990 and 2005.[36] Al-Quwaidhi et al[36] projected that obesity will reach 41% in males and 78% in females by 2022.

Of the intra-oral variables evaluated, only tongue indentations and tonsil size were statistically significantly associated with the risk of OSA. Lee et al[37] reported a significant predictive effect of tonsil size on OSA in 20-23 year old male Korean soldiers. These findings confirm the effects of upper airway anatomy on the occurrence of OSA. Although the tonsils decrease in size by adulthood, other factors such as obesity can modify the effect of pharyngeal soft tissues on OSA risk. Pharyngeal tissue size was found to be correlated with

body size among snorers and OSA subjects in a previous study.[38] High ESS score was associated with a 10% increase in risk of OSA in this study. Daytime sleepiness is an important finding in OSA. It has to be stated that the ESS has a low predictive ability compared with other tests such as the multiple sleep latency and maintenance of wakefulness tests. These tests were not used in this study. Thus, this result needs to be interpreted with caution. Latest evidence from a large epidemiological study reported that the severity of OSA increases with age.[12] This is contrary to the findings of our study that showed no significant effect of age on the risk of OSA. Similarly, hypertension failed to maintain significance at the multivariate level. Neck circumference was statistically significantly associated with high-risk OSA at the univariate level. However, this association failed to reach significance at the multivariate analysis. This is contrary to the findings of Davies et al[39] that showed that NC corrected for height is more predictive of OSA than obesity.

Study limitations. The risk of OSA was subjectively determined using the Berlin Questionnaire. Objective diagnosis of OSA with attended or unattended overnight polysomnography is important to confirm the prevalence and the severity of OSA. The sample in this study was over represented by males. It has been suggested that Saudi females have greater OSA occurrence than reported, as a result of the markedly increasing rates of obesity.[6] More balanced samples are warranted in future studies. There is need for bigger samples with different age groups to confirm the occurrence of OSA and its severity in adults and pediatrics.

In conclusion, the prevalence of OSA symptoms was 21.7% in female and 78.3% in male adult dental patients. Obesity, increased tonsil size, presence of tongue indentations, and high ESS score were independent risks for OSA. Tongue indentations and tonsil size are significantly associated with risk of OSA; thus, this will take on the important role of dentists in the recognition of the signs and symptoms of OSA.

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