ACTA
STOMATOLOGICA
CROATICA
www.ascro.hr

Acta stomatol Croat. 2025;59(2):155-164.
DOI: 10.15644/asc59/2/5

ORIGINAL SCIENTIFIC PAPER
IZVORNI ZNANSTVENI RAD

Marieta Bujak[1], Nikolina Bošnjak[2], Renata Pecotić[3]

Snoring Symptoms and Obstructive Sleep Apnea Risk Factors Identified by Doctors of Dental Medicine

Simptomi hrkanja i faktori rizika opstrukcijske apneje tijekom spavanja koje su identificirali doktori dentalne medicine

[1] University of Split School of Medicine
Medicinski fakultet Sveučilišta u Splitu
[2] Health Center of Zagreb County
Zdravstveni centar Zagrebačke županije
[3] Department of Neuroscience, University of Split School of Medicine
Zavod za neuroznanost, Medicinski fakultet Sveučilišta u Splitu

Abstract

Objective: To examine the association between snoring, a primary symptom of obstructive sleeps apnea (OSA) and patients' age, sex, and anthropometric characteristics. The goal is to support dental medicine doctors in identifying individuals at increased risk of OSA. **Materials and methods:** This retrospective cross-sectional clinical study included 795 participants. Data were collected on age, sex, and anthropometric measurements. Participants also completed the STOP questionnaire and the Epworth Sleepiness Scale. Overnight polysomnography was performed at the Split Sleep Medicine Center of the University Hospital of Splitand the University of Split School of Medicine between 2018 and 2023. **Results:** Participants who reported snoring were significantly heavier (96.5 ± 20.5 kg vs. 84.6 ± 19.3 kg) and had a higher BMI (31.3 ± 10.9 kg/m² vs. 27.2 ± 5.1 kg/m²) than those without snoring. They also had larger neck (41.5 ± 6.0 cm vs. 38.8 ± 4.5 cm), waist (107.8 ± 15.4 cm vs. 96.9 ± 15.4 cm), and hip (110.7 ± 12.3 cm vs. 106.0 ± 11.0 cm) circumferences ($P < 0.001$ for all). These participants also reported greater day- time sleepiness (Epworth Sleepiness Scale: 7.8 ± 4.9 vs. 5.9 ± 4.2; $P < 0.001$) and had significantly higher AHI values (32.8 ± 26.1 vs. 15.1 ± 17.5; $P < 0.001$), indicating more severe OSA. **Conclusion:** Snoring is significantly associated with higher body mass, increased BMI, larger body circumferences, greater daytime sleepiness, and more severe OSA. It may serve as a useful clinical marker for dentists when identifying patients at elevated risk for OSA. Among the examined variables, BMI, AHI, and age were significant predictors of snoring, while sex did not show a statistically significant influence.

Received: March 30, 2025
Accepted: May 26, 2025

Address for correspondence
Marieta Bujak
University of Split School of Medicine
Šoltanska 2A, 21 000 Split, Croatia
marietab9@gmail.com

MeSH Terms: Obstructive Sleep Apnea; Risk Factors; Polysomnography; Snoring
Author Keywords: AHI; Anthropometric characteristics; Dentist; High risk patients; OSA; Stop questionnaire; Epworth Sleepiness Scale

Marieta Bujak ORCID 0000-0001-9926-3203 | Renata Pecotić ORCID 0000-0003-3519-2201

Introduction

Snoring is tipically defined as a respiratory sound that occurs during inhalation or exhalation while sleeping, caused by vibrations of the oropharyngeal walls due to reduced upper airway patency (1). It can be described both quantitatively,—measured in decibels (dB)—and qualitatively, as one of the hallmark symptoms of obstructive sleep apnea (OSA) (2).

Obstructive sleep apnea (OSA) is the most prevalent sleep-related breathing disorder, affecting approximately 1 in 20 adults. It is characterized by recurrent episodes of partial or complete upper airway collapse, resulting in disrupted sleep architecture and decreased arterial oxygen saturation (3). The etiology of OSA is multifactorial and includes a range of interrelated pathologies and risk factors such as obesity (neck circumference >41 cm, BMI >30 kg/m²), advanced age, male sex, anatomical variations of hard and soft

Uvod

Hrkanje se tipično definira kao respiratorni zvuk koji se pojavljuje pri udisaju ili izdisaju tijekom spavanja, a uzrokovan je vibracijama stijenki orofarinksa zbog smanjene prohodnosti gornjih dišnih putova (1). Može se opisivati kvantitativno – mjerenjem u decibelima (dB) i kvalitativno kao jedan od glavnih simptoma opstrukcijske apneje tijekom spavanja (OSA) (2).

Opstrukcijska apneja tijekom spavanja (OSA) najčešći je poremećaj disanja povezan sa spavanjem koji pogađa približno jednu od 20 odraslih osoba. Karakteriziraju je ponavljajuće epizode djelomičnog ili potpunog kolapsa gornjih dišnih putova, što rezultira poremećajem arhitekture spavanja i smanjenjem arterijske zasićenosti kisikom (3). Etiologija OSA-e je multifaktorijalna i obuhvaća niz uzajamno povezanih patoloških stanja i čimbenika rizika poput pretilosti (op-

tissues, postmenopausal status, smoking, and genetic predisposition (4). The severity of OSA is assessed using the apnea-hypopnea index (AHI), which reflects the average number of apnea and hypopnea events per hour of sleep (5). Clinically, OSA presents with symptoms such as snoring, daytime sleepiness, night sweats, restless sleep, heartburn, morning headaches, and insomnia. These symptoms often evolve gradually, which may lead to delayed diagnosis after significant health deterioration. Despite its high prevalence, OSA frequently remains undiagnosed.

Dental clinics can play a pivotal role in the early detection of patients at risk for OSA. Numerous studies have highlighted the potential of dentists to recognize symptoms and risk factors associated with OSA, using tools such as the STOP questionnaire in routine clinical practice. This allows for early identification of high-risk individuals and timely referral to specialized centers (6, 7). Alongside detailed patient history, and screening tools like the STOP questionnaire and the Epworth Sleepiness Scale, overnight polysomnography remains the "gold standard" for diagnosing OSA (6, 8).

Before selecting a treatment approach—whether conservative or surgical—it is essential to determine the cause and severity of the airway obstruction through a multidisciplinary evaluation involving various medical specialties, including dental professionals. For patients diagnosed with mild to moderate OSA, or those intolerant to continuous positive airway pressure (CPAP) therapy, intraoral appliances such as mandibular advancement devices (MAD) or tongue retaining devices (TRD) are preferred conservative treatment options (9, 10). A MAD (Figure 1) is a custom-made device that maintains the lower jaw in a protruded position during sleep, keeping the airway open. TRDs, on the other hand, hold the tongue forward to prevent airway obstruction (11). According to the American Academy of Sleep Medicine (AASM), oral appliances are the standard treatment for primary snoring in adults, reducing the frequency and intensity of snoring and improving sleep quality for patients and their partners (12,13).

seg vrata >41 cm, indeks tjelesne mase >30 kg/m^2), starije dobi, muškog spola, anatomskih varijacija tvrdih i mekih tkiva, postmenopauzalnog statusa, pušenja i genetske predispozicije (4). Težina OSA-e procjenjuje se s pomoću indeksa apneja-hipopneja (AHI) koji odražava prosječan broj epizoda apneje i hipopneje po satu spavanja (5). Klinički se OSA manifestira simptomima poput hrkanja, dnevne pospanosti, noćnog znojenja, nemirnoga spavanja, žgaravice, jutarnjih glavobolja i nesanice. Simptomi često napreduju postupno, što može rezultirati kašnjenjem u dijagnozi nakon značajnog pogoršanja zdravstvenog stanja. Unatoč visokoj prevalenciji, OSA često ostaje nedijagnosticirana.

Stomatološke ordinacije mogu biti ključne u ranom otkrivanju pacijenata s rizikom od OSA-e. U mnogobrojnim istraživanjima autori su upozorili na potencijal stomatologa da prepoznaju simptome i čimbenike rizika povezane s OSA-om korištenjem alata kao što je upitnik STOP u svakodnevnoj kliničkoj praksi. To omogućuje rano prepoznavanje visokorizičnih osoba i pravodobno upućivanje u specijalizirane centre (6, 7). Uz detaljnu anamnezu i probirne alate poput upitnika STOP i Epworthove ljestvice pospanosti, noćna polisomnografija ostaje „zlatni standard" za dijagnosticiranje OSA-e (6, 8).

Prije odabira terapijskog pristupa – bilo konzervativnoga, bilo kirurškoga – potrebno je ustanoviti uzrok i težinu opstrukcije dišnih putova na temelju multidisciplinarne evaluacije koja obuhvaća različite medicinske struke, uključujući i stomatologe. Za pacijente s blagim do umjerenim oblikom OSA-e ili one koji ne podnose terapiju pozitivnim tlakom u dišnim putovima (CPAP), preferirani konzervativni tretmani uključuju intraoralne naprave poput udlaga za pomicanje donje čeljusti prema naprijed (MAD) ili stabilizatore jezika (TRD) (9, 10). MAD (slika 1.) individualno je izrađena naprava koja tijekom spavanja održava donju čeljust u protruziji, čime se održava otvorenost dišnoga puta. TRD pak drži jezik pomaknutim prema naprijed da bi se spriječila opstrukcija dišnih putova (11). Prema stajalištu Američke akademije za medicinu spavanja (AASM), oralne naprave, smanjujući učestalost i intenzitet hrkanja te poboljšavajući kvalitetu spa-

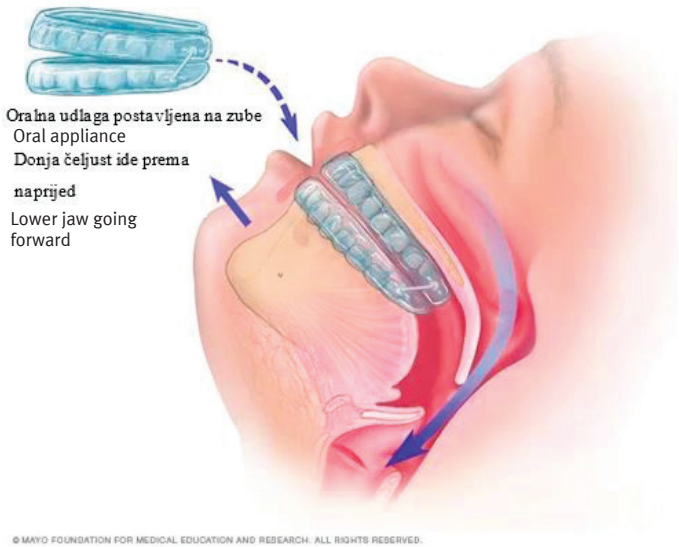

Figure 1 Illustration of the use of an oral appliance that keeps the airway open (45)
Slika 1. Prikaz uporabe intraoralne udlage koji dišni put održava otvorenim (45.)

In addition to their therapeutic role, dental professionals are well-positioned to identify patients at high risk of sleep-disordered breathing. Dentists routinely evaluate patient age, sex, and anthropometric features, and have direct access to assess the oropharyngeal region, which may present anatomical or pathological changes contributing to airway obstruction. Moreover, OSA, which is often associated with snoring, leads to mouth breathing, dry mouth, and altered salivary pH, thus negatively impacting oral health and contribute to conditions such as gingivitis, periodontitis, dental erosion and overall tooth loss (14-22). Research has shown that patients with untreated OSA often present with increased dental wear and a higher incidence of cavities, which can result in more frequent tooth fractures compared to individuals without sleep-disordered breathing (21, 23). This underscores the importance of early detection and management of OSA to prevent or mitigate its detrimental effects on oral health (23-25). Al-Maweri et al. reported that oral appliances not only improve sleep quality, but also reduce the incidence of dry mouth and improve salivary flow supporting the link between OSA treatment and oral health. These findings reinforce the important role of dental professionals in OSA care (26).

Despite their strategic role in identifying at-risk individuals, dental professionals in Croatia often lack formal education on this topic. This gap may explain the growing emphasis in international guidelines, issued by national dental associations, on the importance of dentist involvement in the diagnosis and management of OSA patients (27–29). Such education is essential to ensure that dentists are equipped to identify potential OSA cases early, provide appropriate referrals, and even offer interventions such as oral appliances for patients with mild to moderate cases.

The aim of this study was to examine the relationship between snoring—as one of the key symptoms of OSA—and age, gender, and anthropometric characteristics, with the goal of enhancing dentist awareness and improving identification of high-risk patients.

We hypothesize that:

1 Snoring is associated with higher body weight, BMI, increased neck, waist, and hip circumferences.
2 Snoring is more frequent among older individuals and males.

Materials and methods

Procedures

This retrospective cross-sectional clinical study included a total of 795 participants. Data on age, gender, and anthropometric characteristics were collected, followed by an analysis of previously completed STOP questionnaires and the Epworth Sleepiness Scale. Additionally, results from overnight polysomnographies performed at the Clinical Hospital Center Split and the University of Split School of Medicine between 2018 and 2023 were analyzed (Class 003-08/22-03/003, Reg. No. 2181-198-03-04-22-0029).

vanja za pacijenta i partnera (12, 13), standardni su tretman za primarno hrkanje u odraslih.

Uz terapijsku ulogu, doktori dentalne medicine imaju mogućnost prepoznavanja pacijenata s visokim rizikom od poremećaja disanja tijekom spavanja. Stomatolozi rutinski procjenjuju dob, spol i antropometrijske karakteristike pacijenata, te imaju izravan uvid u orofaringealnu regiju koja može pokazivati anatomske ili patološke promjene koje pridonose opstrukciji dišnog puta. Nadalje, OSA je često povezana s hrkanjem, što vodi do disanja na usta, suhoće usne šupljine i promjene pH sline, što negativno utječe na oralno zdravlje i potiče stanja poput gingivitisa, parodontitisa, dentalne erozije i gubitka zuba (14 – 22). Istraživanja pokazuju da neliječeni pacijenti s OSA-om imaju izraženije istrošene zube i veću učestalost karijesa, što rezultira češćim frakturama zuba u odnosu prema osobama bez poremećaja u disanju tijekom spavanja (21, 23). To dodatno ističe važnost rane detekcije i liječenja OSA-e radi sprječavanja ili ublažavanja negativnih učinaka na oralno zdravlje (23 – 25). Potvrđujući vezu između liječenja OSA-e i oralnog zdravlja, Al-Maweri i suradnici izvijestili su da oralne naprave ne samo da poboljšavaju kvalitetu spavanja, nego i smanjuju učestalost suhoće usta i poboljšavaju protok sline. Ti nalazi dodatno ističu koliko je važan doktor dentalne medicine u skrbi za pacijente s OSA-om (26).

Unatoč strateškoj ulozi u prepoznavanju rizičnih osoba, doktori dentalne medicine u Hrvatskoj često nisu odgovarajuće educirani o toj problematici. Taj nedostatak može objasniti sve veći naglasak u međunarodnim smjernicama nacionalnih dentalnih udruga na važnost uključivanja stomatologa u dijagnostiku i liječenje pacijenata s OSA-om (27 – 29). Takva edukacija ključna je da bi stomatolozi bili osposobljeni za rano prepoznavanje potencijalnih slučajeva OSA-e i odgovarajuće usmjeravanje takvih pacijenata, a u nekim slučajevima i pružanje terapijskih intervencija poput oralnih naprava za pacijente s blagim do umjerenim oblicima bolesti.

Cilj ovog istraživanja bio je ispitati povezanost između hrkanja, kao jednoga od ključnih simptoma OSA-e, i dobi, spola te antropometrijskih karakteristika sa svrhom da se poveća svijest doktora dentalne medicine i poboljša prepoznavanje pacijenata s visokim rizikom.

Hipoteze su:

Hrkanje je povezano s većom tjelesnom masom, većim indeksom tjelesne mase (ITM) te povećanim opsegom vrata, struka i bokova te je češće među starijim osobama i muškarcima.

Materijali i metode

Postupci

Ovo retrospektivno presječno kliničko istraživanje obuhvatilo je ukupno 795 ispitanika. Prikupljeni su podatci o dobi, spolu i antropometrijskim karakteristikama, nakon čega je obavljena analiza ispunjenih upitnika STOP i Epworthove ljestvice pospanosti. Analizirani su i rezultati noćnih polisomnografija provedenih u Centru za medicine spavanja u Splitu Kliničkog bolničkog centra Split i Medicinskog fakulteta Sveučilišta u Splitu od 2018. do 2023. godine (Klasa: 003-08/22-03/003, Urbroj: 2181-198-03-04-22-0029).

Sample

The study included 795 participants, comprising 515 men (65%) and 280 women (35%), with a mean age of 54.74 ± 12.93 years. Upon arrival at the Clinical Hospital Center Split, and after providing informed consent, each participant's age, gender, and anthropometric measurements (height, weight, BMI, neck, waist, and hip circumference), as well as relevant medical conditions, were recorded by a certified technician.

All participants then completed the STOP questionnaire (Snoring, Tiredness, Observed apnea, high Blood Pressure) and the Epworth Sleepiness Scale, both translated and validated in Croatian (30). Inclusion criteria encompassed patients aged 18 to 75 who had been referred for polysomnography and did not have comorbid conditions that could affect the study results. Exclusion criteria included central sleep apnea, central hypoventilation syndromes, obesity hypoventilation syndrome, known CPAP users, and incomplete medical records.

The STOP questionnaire includes questions on snoring, fatigue, breathing cessation during sleep, and high blood pressure, with "YES" or "NO" answers (31). Two or more positive responses indicate an increased risk for OSA. The extended STOP-BANG version incorporates additional items on BMI, age, neck circumference, and gender (32).

The Epworth Sleepiness Scale allows participants to self-assess their level of daytime sleepiness during routine activities (0 = no need to sleep, 1 = slight, 2 = moderate, 3 = high likelihood of falling asleep). A total score above 9 indicates excessive daytime sleepiness. Croatian version of the scale, developed by the team at the University of Split School of Medicine and the Clinical Hospital Center Split, includes linguistic and cultural adaptations to ensure clarity and relevance for the Croatian population. It meets statistical criteria for reliability and validity, providing consistent and comparable assessments with international standards (30).

After completing the questionnaires, participants underwent overnight polysomnography (PSG), considered the "gold standard" for diagnosing OSA, at the Sleep Medicine Center of the Clinical Hospital Center Split. The Alice 5LE device (Philips Respironics, Eindhoven, Netherlands) was used. Data were analyzed by a trained technician, and diagnoses and further instructions were provided by a somnologist. The study recorded electroencephalography (EEG), electrooculography (EOG), electrocardiography (ECG), electromyography (EMG) of the chin and lower limbs, airflow, chest and abdominal movements, snoring, and pulse oximetry, all under video surveillance (33, 34).

Statistical Analysis

Continuous variables were presented as mean ± standard deviation, and categorical variables as counts and percentages. Statistical analysis was performed using MedCalc software (MedCalc Software, Mariakerke, Belgium, version 11.5.1.0). All relevant assumptions were verified, including data normality, sample independence, and absence of significant outliers.

Chi-square tests were used for categorical variables, and the independent samples t-test was used for continuous vari-

Uzorak

U istraživanju je sudjelovalo 795 ispitanika – 515 muškaraca (65 %) i 280 žena (35 %), s prosječnom dobi od 54,74 ± 12,93 godine. Poslije dolaska u Centar za medicine spavanja Split, nakon potpisivanja informiranog pristanka, za svakog sudionika zabilježeni su dob i spol, a obavljena su i antropometrijska mjerenja (visina, masa, ITM, opseg vrata, struka i bokova) te zabilježeni relevantni medicinski podatci.

Zatim su svi ispunili upitnik STOP (hrkanje, umor, zapaženi zastoji disanja tijekom spavanja, visoki krvni tlak) i Epworthovu ljestvicu pospanosti, koji su validirani i prevedeni na hrvatski jezik (30). Kriteriji za uključivanje bili su pacijenti u dobi od 18 do 75 godina koji su upućeni na polisomnografiju i nisu imali komorbiditete koji bi mogli utjecati na rezultate istraživanja. Kriteriji za isključivanje obuhvaćali su sindrome centralne hipoventilacije, sindrom hipoventilacije uslijed pretilosti, poznate korisnike uređaja CPAP te nepotpune medicinske podatke.

Upitnik STOP sadržava pitanja o hrkanju, umoru, prestanku disanja tijekom spavanja i visokome krvnom tlaku, na koje su pacijenti mogli odgovoriti s „DA" ili „NE" (31). Dva ili više pozitivnih odgovora upućuju na povećani rizik od OSA-e. Proširena verzija STOP-BANG uključuje dodatne stavke o ITM, dobi, opsegu vrata i spolu (32).

Epworthova ljestvica pospanosti omogućuje samoprocjenu razine dnevne pospanosti tijekom uobičajenih aktivnosti (0 = nema potrebe za spavanjem, 1 = blaga, 2 = umjerena, 3 = velika vjerojatnost da zaspe). Ukupni rezultat veći od 9 upozorava na pretjeranu dnevnu pospanost. Prevedena i validirana ljestvica uključuje jezične i kulturne prilagodbe kojima bi se osigurala jasnoća i relevantnost za hrvatsku populaciju. Pružajući dosljedne i usporedive rezultate s međunarodnim standardima, zadovoljava statističke kriterije pouzdanosti i valjanosti (30).

Nakon ispunjavanja upitnika ispitanici su podvrgnuti cjelonoćnoj polisomnografiji (PSG) koja se smatra „zlatnim standardom" za dijagnostiku OSA-e. Za izvođenje cjelonoćne polisomnografije korišten je uređaj Alice 5LE (Philips Respironics, Eindhoven, Nizozemska). Podatke je analizirao educirani tehničar, a dijagnozu i daljnje upute davao je somnolog. Snimanjem su obuhvaćeni elektroencefalografija (EEG), elektrookulografija (EOG), elektrokardiografija (EKG), elektromiografija (EMG) brade i donjih ekstremiteta, protok zraka, pokreti prsnog koša i abdomena, hrkanje i pulsna oksimetrija, sve uz videonadzor (33, 34).

Statistička analiza

Kontinuirane varijable prikazane su kao srednja vrijednost ± standardna devijacija, a kategorizirane varijable kao apsolutni i relativni broj (broj i postotak). Statistička analiza obavljena je u softveru MedCalc (MedCalc Software, Mariakerke, Belgija, verzija 11.5.1.0). Provjerene su sve relevantne pretpostavke, uključujući normalnost distribucije podataka, neovisnost uzoraka i odsutnost značajnih odstupanja (outliera).

Table 1 Demographic and Anthropometric Characteristics of the Participants
Tablica 1. Demografske i antropometrijske značajke ispitanika

Variable • Varijable	Total • Ukupno N=795	Men • Muškarci N=515	Women • Žene N=280	P*
Age (years) • Dob (godine)	54.74±12.93	54.10±13.17	55.19±13,44	0.271
Height (cm) • Visina (cm)	176.96±22.43	182.35±25.27	166.9±9.74	<0.001
Weight (kg) • Masa (kg)	93.22±20.76	100.03±18.17	80.44±19.84	<0.001
BMI (kg/m²) • ITM (kg/m²)	30.10±9.79	30.63±10.13	29.06±9.06	0.033
Neck circumference (cm) • Opseg vrata (cm)	40.79±5.73	42.99±5.42	36.70±3.67	<0.001
Waist circumference (cm) • Opseg struka (cm)	106.62±44.48	112.10±53.62	97.49±17.05	<0.001
Hip circumference (cm) • Opseg bokova (cm)	109.27±12.18	109.04±10.69	109.82±14.58	0.497
ESS score • ESS zbroj	7.17±4.88	7.21±4.80	7.16±5.02	0.876
STOP, N (%)				
Has risk • ima rizik	603 (76)	402 (78)	204 (73)	
No risk • nema rizik	187 (24)	113 (22)	76 (27)	
0,119†				

All values are presented as mean ± standard deviation, STOP questionnaire risk is presented as percentages
Student's t-test; †Chi-square test; BMI – Body Mass Index; ESS – Epworth Sleepiness Scale; STOP – Questionnaire for assessing the risk of obstructive sleep apnea (Snoring, Tiredness, Observed apnea, high blood Pressure)
Vrijednosti su prikazane kao srednja vrijednost ± standardna devijacija ili kao brojevi (postotci)
*Studentov t-test; †hi-kvadrat test; ITM – indeks tjelesne mase; ESS – Epworthova ljestvica pospanosti (engl. *Epworth Sleepiness Scale*); Upitnik STOP za procjenu rizika od opstrukcijske apneje tijekom spavanja (engl. *Snoring, Tiredness, Observed apnea, high blood Pressure*)

Table 2 Demographic and Anthropometric Characteristics of Participants Based on Snoring Symptom
Tablica 2. Demografske i antropometrijske značajke u ispitanika s obzirom na simptom hrkanja

Variable • Varijable		Snoring YES • Hrkanje DA N=556	Snoring NO • Hrkanje NE N=202	P*
Age (years) • Dob (godine)		55.9±11.6	51.2±15,4	<0.001
Gender N (%) • Spol N (%)	M	377 (67)	119 (59)	
	F • Ž	179 (33)	83 (41)	
Height (cm) • Visina (cm)		177.4±25.9	175.9±9.6	0.448
Weight (kg) • Masa (kg)		96.5±20.5	84.6±19.3	<0.001
BMI (kg/m²) • ITM (kg/m²)		31.3±10.9	27.2±5.1	<0.001
Neck circumference (cm) • Opseg vrata (cm)		41.5±6.0	38.8±4.5	<0.001
Waist circumference (cm) • Opseg struka (cm)		107.8±15.4	96.9±15.4	<0.001
Hip circumference (cm) • Opseg bokova (cm)		110.7±12.3	106.0±11.0	<0.001
ESS score • ESS zbroj		7.8±4,9	5.9±4.2	<0.001
Hypertension • Hipertenzija		265 (48)	64 (32)	15.156†
Diabetes • Dijabetes		73 (13)	18 (9)	2.097†
Depression • Depresija		73 (13)	24 (12)	0.074†
Asthma • Astma		58 (10)	10 (5)	4.738†
GERD • GERB		177 (32)	53 (26)	2.220†

Values are presented as mean ± standard deviation, gender affiliation is presented as percentage
Student's t-test; Chi-square test; BMI – Body Mass Index; ESS – Epworth Sleepiness Scale; STOP – Questionnaire for assessing the risk of obstructive sleep apnea (Snoring, Tiredness, Observed apnea, high blood Pressure)
Vrijednosti su prikazane kao srednja vrijednost ± standardna devijacija ili kao brojevi (postotci)
*Studentov t-test; †hi-kvadrat test; ITM – indeks tjelesne mase; ESS – Epworthova ljestvica pospanosti (engl. *Epworth Sleepiness Scale*); Upitnik STOP za procjenu rizika od opstrukcijske apneje tijekom spavanja (engl. *Snoring, Tiredness, Observed apnea, high blood Pressure*

ables. Multivariate logistic regression was applied to develop a model linking snoring symptoms with anthropometric and polysomnographic variables, including age, gender, BMI, and AHI. The significance level was set at $P < 0.05$.

Za kategorizirane varijable korišten je hi-kvadrat test, a za kontinuirane varijable t-test za nezavisne uzorke. Multivarijatna logistička regresija primijenjena je za izradu modela koji povezuje simptome hrkanja s antropometrijskim i polisomnografskim varijablama, uključujući dob, spol, ITM i AHI. Razina značajnosti postavljena je na $P < 0,05$.

Table 3 Polysomnographic Findings in Participants Based on Snoring Symptom
Tablica 3. Polisomnografski nalaz u ispitanika s obzirom na simptom hrkanja

Variable • Varijable	Snoring YES • Hrkanje DA N=556	Snoring NO • Hrkanje NE N=202	P*
AHI	32.8±26.1	15.1±17.5	<0.001
AHI REM	35.2±24.8	20.1±19.3	<0.001
AHI nonREM	31.8±26.8	14.1±18.0	<0.001
Sleep stage distribution • Udio stadija spavanja			
Stage N1 • Stadij N1 non REM	4.0±4.7	4.3±4.9	0.517
Stage N2 • Stadij N2 non REM	74.3±10.7	71.1±9.9	<0.001
Stage N3 • Stadij N3 non REM	7.4±7.0	9.4±7.8	<0.001
REM stage • Stadij REM non REM	14.3±7.0	15.3±6.6	0.088
Types of apnea • Vrste apneja			
Central apnea (N) • Centralna apneja (N)	9.1±17.3	5.1±11.6	0.002
Obstructive apnea (N) • Opstrukcijska apneja (N)	93.5±119.9	31.1±66.1	<0.001
Mixed apnea (N) • Mješovita apneja (N)	20.5±46.5	6.8±27.4	<0.001
Hypopnea (N) • Hipopneja (N)	90.3±73.4	51.2±52.6	<0.001
Blood oxygen saturation • Zasićenost krvi kisikom			
Lowest blood oxygen saturation **(%)** • Najniža zasićenost krvi kisikom (%)	77.9±14.8	86.2±10.10	<0.001
Sleep position • Položaj spavanja			
Left side • Lijevi bok	107.4±96.9	86.4±84.4	0.006
Right side • Desni bok	52.6±70.2	59.3±72.3	0.245
Back • Leđa	200.6±115.7	194.3±111.1	0.522
Chest/Prone • Prsa	13.2±34.6	19.7±45.1	0.036

Values are presented as mean ± standard deviation; blood oxygen saturation is presented as percentage.
Student'st-test; AHI-Apnea-HypopneaIndex; REMsleepstage–RapidEyeMovementsleepstage; non-REM sleep stage – Non-Rapid Eye Movement sleep stage
Vrijednosti su prikazane kao srednja vrijednost ± standardna devijacija ili kao brojevi (postotci)
*Studentov t-test; AHI – indeks apneja-hipopneja; REM – stadij spavanja; non-REM – stadij spavanja

Table 4 Logistic Regression of the Subjective Snoring Symptom and AHI, Age, Gender, and Body Mass Index (BMI) as Predictors
Tablica 4. Logistička regresija subjektivnog simptoma hrkanja i AHI dobi, spola te indeksa tjelesne mase (ITM) kao prediktora

		OR	CI 95%	P
R^2	14.2%			
P	<0.001			
Variables • Varijable				
AHI		1.03	1.02 do 1,04	<0.001
Age • Dob		1.02	1.01 do 1.03	0.006
Gender (men) • Spol (muškarci)		1.01	0.70 do 1,47	0.944
BMI • ITM		1.06	1.02 do 1,10	0.003

AHI–Apnea-HypopneaIndex • indeks apneja-hipopneja; ITM – Body Mass Index (BMI) • indeks tjelesne mase

Results

Of the 795 participants, 515 (65%) were men and 280 (35%) were women. There was no statistically significant age difference between sexes (54.10 ± 13.17 vs. 55.19 ± 13.44 years, $P = 0.271$). As shown in Table 1, men were significantly taller (182.35 ± 25.27 cm vs. 166.9 ± 9.74 cm, $P < 0.001$), heavier (100.03 ± 18.17 kg vs. 80.44 ± 19.84 kg, $P < 0.001$), had a higher BMI (30.63 ± 10.13 kg/m² vs. 29.06 ± 9.06 kg/m², $P = 0.033$), and larger neck (42.99 ± 5.42 cm vs. 36.70 ± 3.67 cm, $P < 0.001$) and waist circumferences (112.10 ± 53.62 cm vs. 97.49 ± 17.05 cm, $P < 0.001$) than women.

Among all participants, 556 (73%) reported subjective snoring symptoms, while 202 (27%) did not report snoring

Rezultati

Od ukupno 795 ispitanika, 515 bili su muškarci (65 %), a 280 žene (35 %). Nije pronađena statistički značajna razlika u dobi između spolova (54,10 ± 13,17 godina prema 55,19 ± 13,44 godina, $P = 0,271$). Kao što je prikazano u tablici 1., muškarci su bili statistički značajno viši (182,35 ± 25,27 cm prema 166,9 ± 9,74 cm, $P < 0,001$), teži (100,03 ± 18,17 kg prema 80,44 ± 19,84 kg, $P < 0,001$) i imali su veći ITM (30,63 ± 10,13 kg/m² prema 29,06 ± 9,06 kg/m², $P = 0,033$) te veći opseg vrata (42,99 ± 5,42 cm prema 36,70 ± 3,67 cm, $P < 0,001$) i struka (112,10 ± 53,62 cm prema 97,49 ± 17,05 cm, $P < 0,001$) u usporedbi sa ženama.

Među svim ispitanicima, 556 (73 %) prijavilo je subjek-

symptoms. Compared to non-snorers, individuals with snoring were significantly heavier (96.5 ± 20.5 kg vs. 84.6 ± 19.3 kg, $P < 0.001$), had higher BMI (31.3 ± 10.9 kg/m² vs. 27.2 ± 5.1 kg/m², $P < 0.001$), and exhibited greater neck (41.5 ± 6.0 cm vs. 38.8 ± 4.5 cm, $P < 0.001$), waist (107.8 ± 15.4 cm vs. 96.9 ± 15.4 cm, $P < 0.001$), and hip circumferences (110.7 ± 12.3 cm vs. 106.0 ± 11.0 cm, $P < 0.001$) (Table 2). They also scored significantly higher on the Epworth Sleepiness Scale (7.8 ± 4.9 vs. 5.9 ± 4.2, $P < 0.001$), indicating greater daytime sleepiness. No significant differences were found in the prevalence of chronic diseases between the groups (Table 2).

Polysomnography revealed that individuals with prominent snoring symptoms had more severe forms of OSA, as indicated by significantly higher AHI scores (32.8 ± 26.1 vs. 15.1 ± 17.5, $P < 0.001$). These participants also had elevated AHI values in both REM and non-REM sleep (35.2 ± 24.8 vs. 20.1 ± 19.3, $P < 0.001$) and experienced more frequent episodes of central, mixed, and obstructive apneas, as well as hypopneas (Table 3).

Snoring participants spent more time in the N2 sleep stage (74.3 ± 10.7 vs. 71.1 ± 9.9 min, $P < 0.001$) and less time in N3 sleep (7.4 ± 7.0 vs. 9.4 ± 7.8 min, $P < 0.001$). They also slept longer on their left side (107.4 ± 96.9 vs. 86.4 ± 84.4 min, $P = 0.006$) and less on their stomach (13.2 ± 34.6 vs. 19.7 ± 45.1 min, $P = 0.036$). Furthermore, they had significantly lower minimum oxygen saturation levels (77.9 ± 14.8% vs. 86.2 ± 10.1%, $P < 0.001$).

In the logistic regression model, snoring was set as the dependent variable. The analysis showed that snoring symptoms were most strongly predicted by increased BMI, higher AHI values, and older age, whereas gender was not a significant predictor (Table 4).

Discussion

The results of this study support previous findings suggesting a relationship between the subjective symptom of snoring and obstructive sleep apnea (OSA), particularly in association with increased body mass index (BMI), neck circumference, and higher apnea-hypopnea index (AHI) values. While our data demonstrated a strong correlation between snoring and AHI values, similar studies—such as Bernstein et al.—have shown that not all individuals who snore are necessarily diagnosed with clinically significant OSA. This highlights the complexity of using snoring as a standalone diagnostic indicator and underscores the need for comprehensive diagnostic assessments to identify individuals at increased risk for OSA (35). Differences in study design, sample characteristics, and the inherently subjective nature of self-reported symptoms likely contribute to the variability in findings across studies.

Our findings align with those of Wickramasinghe et al., who also reported associations between obesity, elevated BMI, and male sex with a higher risk of OSA (36). However, although our study observed a higher frequency of snoring among men diagnosed with OSA, sex was not identified

tivne simptome hrkanja, a 202 (27 %) to nisu učinili. U usporedbi s osobama koje ne hrču, ispitanici koji su prijavili hrkanje bili su znatno teži (96,5 ± 20,5 kg prema 84,6 ± 19,3 kg, $P < 0,001$), imali su viši BMI (31,3 ± 10,9 kg/m² prema 27,2 ± 5,1 kg/m², $P < 0,001$), te veće vrijednosti opsega vrata (41,5 ± 6,0 cm prema 38,8 ± 4,5 cm, $P < 0,001$), struka (107,8 ± 15,4 cm prema 96,9 ± 15,4 cm, $P < 0,001$) i bokova (110,7 ± 12,3 cm prema 106,0 ± 11,0 cm, $P < 0,001$) (tablica 2.). Također su postizali više rezultate na Epworthovoj ljestvici pospanosti (7,8 ± 4,9 prema 5,9 ± 4,2, $P < 0,001$), što upućuje na izraženiju dnevnu pospanost. Nisu pronađene značajne razlike u prevalenciji kroničnih bolesti između skupina (tablica 2.).

Polisomnografija je pokazala da su ispitanici s izraženim simptomima hrkanja imali teže oblike OSA-e, što je potvrđeno značajno većim AHI vrijednostima (32,8 ± 26,1 prema 15,1 ± 17,5, $P < 0,001$). Ti su ispitanici također imali povišene AHI vrijednosti u REM i non-REM fazama spavanja (35,2 ± 24,8 prema 20,1 ± 19,3, $P < 0,001$), te su iskusili češće epizode centralne, miješane i opstrukcijske apneje i hipopneje (tablica 3.).

Ispitanici koji su hrkali provodili su više vremena u N2 fazi spavanja (74,3 ± 10,7 prema 71,1 ± 9,9 minuta, $P < 0,001$), a manje u N3 fazi (7,4 ± 7,0 prema 9,4 ± 7,8 minuta, $P < 0,001$). Također su češće spavali na lijevom boku (107,4 ± 96,9 prema 86,4 ± 84,4 minuta, $P = 0,006$), a rjeđe na trbuhu (13,2 ± 34,6 prema 19,7 ± 45,1 minuta, $P = 0,036$). Nadalje, imali su značajno niže vrijednosti minimalne zasićenosti kisikom (77,9 ± 14,8 % prema 86,2 ± 10,1 %, $P < 0,001$).

U modelu logističke regresije hrkanje je postavljeno kao zavisna varijabla. Analiza je pokazala da su simptomi hrkanja najsnažnije predviđeni povećanim ITM-om, većim AHI vrijednostima i starijom dobi, a spol se nije pokazao kao statistički značajan prediktor (tablica 4.).

Rasprava

Rezultati ovog istraživanja podupiru dosadašnje spoznaje koje upozoravaju na povezanost subjektivnog simptoma hrkanja s opstrukcijskom apnejom tijekom spavanja (OSA), osobito u kontekstu povećanog indeksa tjelesne mase (BMI), opsega vrata te većih vrijednosti indeksa apneja-hipopneja (AHI). Iako su naši podatci pokazali snažnu korelaciju između hrkanja i AHI vrijednosti, slične studije – poput one Bernsteina i suradnika – pokazale su da nemaju svi pojedinci koji hrču nužno dijagnosticiranu klinički značajnu OSA-u. To ističe složenost korištenja hrkanja kao samostalnoga dijagnostičkog pokazatelja i potrebu za sveobuhvatnim dijagnostičkim procjenama kako bi se identificirali pojedinci s povećanim rizikom od nastanka OSA -e(35). Razlike u dizajnu studija, karakteristikama uzorka te subjektivna priroda samoprijavljenih simptoma vjerojatno pridonose varijabilnosti rezultata među istraživanjima.

Naši nalazi u skladu su s rezultatima Wickramasinghea i suradnika koji su također izvijestili o povezanosti pretilosti, povećanog ITM-a i muškog spola s većim rizikom od nastanka OSA-e (36). No iako smo u našem istraživanju utvrdili veću učestalost hrkanja među muškarcima s dija-

as a statistically significant factor influencing the frequency of snoring symptoms. This contrasts with the findings of Al-Jewair et al., who reported a significantly higher prevalence of snoring among men (37). These discrepancies may stem from methodological differences, particularly in the measurement of snoring—subjective self-report versus objective polysomnography. Al-Jewair et al. also noted significantly larger neck circumferences among men, supporting the role of anatomical differences in OSA pathogenesis. Consistent with this, our study found that participants who snored not only had higher BMI but also larger neck, waist, and hip circumferences, reinforcing the importance of physical examination and comprehensive history-taking in identifying high-risk patients.

Our data further corroborate findings by Yildirim et al., who emphasized the association between neck circumference and elevated AHI values, suggesting that neck circumference may be an independent risk factor for OSA, beyond general obesity (38). Similarly, Quintana-Gallego et al. found a higher frequency of snoring among men, while women were more likely to report a negative impact of snoring on quality of life and daily functioning (39). These gender-based perceptual differences may reflect sociocultural influences, where women may view snoring as more disruptive, whereas men may underreport or be less affected by such symptoms. This raises broader questions about the influence of social attitudes on symptom reporting and health-seeking behavior.

Our findings also confirmed a statistically significant association between snoring and increased daytime sleepiness, which is consistent with previous literature. However, some studies have shown that daytime sleepiness is more prevalent among men and not clearly linked to age or BMI (40–40). This inconsistency may be due to variability in measurement approaches (subjective questionnaires vs. objective sleep studies) or the confounding effects of other factors such as sleep quality or unrecognized comorbidities.

Research by Cruz et al. and Hofauer et al. further supports the association between snoring and increased cardiovascular risk, as well as the higher prevalence of primary snoring in men (43, 44). Despite these findings, our data did not support sex as a significant predictor of snoring frequency. Instead, BMI, AHI values, and older age emerged as the strongest predictors of both snoring and OSA risk. The noted methodological differences in snoring assessment and the relatively homogenous composition of our study sample may help explain the divergence from prior studies.

This study underscores the need for further research to deepen our understanding of the interplay between snoring, OSA, and other risk factors, including psychological, physiological, and sociocultural variables. A standardized approach to assessing snoring symptoms is essential for improving diagnostic consistency and accuracy. Moreover, early identification and monitoring of snoring are crucial for preventing OSA-related complications. Further research is needed to focus on longitudinal tracking of snoring symptoms and their progression into OSA, paying particular attention to lifestyle factors, genetic predispositions, and the effectiveness of early interventions (46, 47).

gnosticiranom OSA-om, spol nije identificiran kao statistički značajan čimbenik koji utječe na učestalost simptoma hrkanja. To je u suprotnosti s nalazima Al-Jewaira i suradnika koji su istaknuli značajno veću prevalenciju hrkanja u muškaraca (37). Ta neslaganja mogu nastati zbog metodoloških razlika, osobito u načinu mjerenja hrkanja – subjektivna samoprocjena u odnosu prema objektivnoj polisomnografiji. Al-Jewair i suradnici također su zabilježili znatno veći opseg vrata u muškaraca, što dodatno podupire ulogu anatomskih razlika u patogenezi OSA-e. U skladu s tim, naše istraživanje pokazalo je da su ispitanici koji hrču imali ne samo veći ITM, nego i veći opseg vrata, struka i bokova, što dodatno ističe važnost kliničkog pregleda i detaljnog uzimanja anamneze u identifikaciji bolesnika s visokim rizikom.

Naši rezultati dodatno potvrđuju nalaze Yildirima i suradnika koji su istaknuli povezanost između opsega vrata i povećanih AHI vrijednosti, te sugerirali da opseg vrata može biti neovisni čimbenik rizika od OSA-e, neovisno o općoj pretilosti (38). Slično tomu, Quintana-Gallego i suradnici utvrdili su veću učestalost hrkanja u muškaraca, a žene su češće izvještavale o negativnom utjecaju hrkanja na kvalitetu života i svakodnevno funkcioniranje (39). Te spolno uvjetovane perceptivne razlike mogu odražavati sociokulturne utjecaje, pri čemu žene češće doživljavaju hrkanje kao disruptivno, a muškarci ga mogu rjeđe prijavljivati ili percipirati kao manje problematično. To otvara šira pitanja o utjecaju društvenih stajališta na prijavljivanje simptoma i traženje medicinske pomoći.

Naši nalazi također potvrđuju statistički značajnu povezanost između hrkanja i povećane dnevne pospanosti, što je u skladu s ranijom literaturom. No autori nekih istraživanja pokazali su da je dnevna pospanost češća u muškaraca i da nije jasno povezana s dobi ili s vrijednostima ITM-a (40 – 41). Ta nedosljednost može biti posljedica različitih metoda mjerenja (subjektivni upitnici u odnosu prema objektivnim studijama spavanja) ili zbunjujućeg učinka drugih čimbenika kao što su kvaliteta spavanja ili neprepoznati komorbiditeti.

Istraživanja Cruza i suradnika te Hofauera i suradnika dodatno potvrđuju povezanost hrkanja s povećanim kardiovaskularnim rizikom te veću prevalenciju primarnog hrkanja u muškaraca (43, 44). Unatoč tim nalazima, naši podatci nisu potvrdili spol kao značajan prediktor učestalosti hrkanja. Umjesto toga, ITM, AHI vrijednosti i starija dob pokazali su se kao najsnažniji prediktori i hrkanja i rizika od OSA-e. Metodološke razlike u procjeni hrkanja i razmjerno homogeni sastav našeg uzorka mogli bi djelomično objasniti razlike u odnosu na prethodna istraživanja.

U ovoj studiji ističe se potreba za daljnjim istraživanjima kako bi se produbilo razumijevanje povezanosti između hrkanja, OSA-e i drugih čimbenika rizika, uključujući psihološke, fiziološke i sociokulturne varijable. Standardizirani pristup u procjeni simptoma hrkanja ključan je za poboljšanje dijagnostičke dosljednosti i točnosti. Nadalje, rana identifikacija i praćenje hrkanja presudno su važni za prevenciju komplikacija povezanih s OSA-om. Buduća istraživanja trebala bi se usmjeriti na longitudinalno praćenje simptoma hrkanja i njihov prijelaz u OSA-u, uz poseban fokus na čimbenike načina života, genetsku predispoziciju te učinkovitost ranih intervencija (46, 47).

The strengths of this study include a large sample size, the use of validated and standardized screening tools (STOP and Epworth questionnaires), and objective diagnosis via polysomnography, supported by robust multivariate statistical analyses.

However, several limitations must be acknowledged. These include: inability to establish causation, reliance on self-reported snoring symptoms; potential selection bias, given that participants were already referred for polysomnography; insufficient data on other relevant risk factors; and data collected from a single institution, which may limit the generalizability of findings to the wider population.

Conclusions

Owing to regular check-ups and direct access to the oropharyngeal region, dental medicine doctors play a key role in the early identification of patients at risk for OSA. Participants who reported snoring had significantly higher body mass, BMI, and larger neck, waist, and hip circumferences than those who did not. Snoring participants exhibited greater daytime sleepiness, as indicated by higher scores on the Epworth Sleepiness Scale. AHI values were significantly higher among snoring participants in both REM and non-REM sleep stages. Men diagnosed with OSA had larger neck and waist circumferences and higher BMI compared to women. No significant association was found between the presence of chronic diseases and snoring symptoms. BMI, AHI values, and age were the most significant predictors of snoring and OSA risk, whereas sex did not show a statistically significant impact.

Conflict of interest: None declared

Acknowelegmen: None declared

Funding: None declared

Author's contribution: M. B. – writing of article, data processing, comparison with similar scientific research on this topic; **N. B. –** collecting data, statistical analysis of data; **R. P. -** mentor of this scientific paper

Snaga ove studije uključuje velik uzorak ispitanika, korištenje validiranih i standardiziranih probirnih alata (upitnik STOP i Epworthova ljestvica pospanosti) te objektivnu dijagnozu cjelonoćnom polisomnografijom, potkrijepljenu snažnim multivarijantnim statističkim analizama.

Potrebno je istaknuti nekoliko ograničenja, a to su nemogućnost utvrđivanja uzročno-posljedične povezanosti, oslanjanje na subjektivne podatke o hrkanju, potencijalnu pristranost uzorka s obzirom na to da su ispitanici već bili upućeni na polisomnografiju, nedostatak podataka o drugim relevantnim čimbenicima rizika, te činjenicu da su podatci prikupljeni iz jedne ustanove, što može ograničiti mogućnost generalizacije rezultata na širu populaciju.

Zaključci

Zahvaljujući redovitim pregledima i uvidu u orofaringealnu regiju, doktori dentalne medicine imaju ključnu ulogu u ranom prepoznavanju pacijenata s rizikom za OSA-u. Ispitanici s prijavljenim simptomom hrkanja imali su znatno veću tjelesnu masu, indeks tjelesne mase (ITM) te veći opseg vrata, struka i bokova u usporedbi s onima koji ne hrču. Ispitanici koji hrču pokazivali su izraženiju dnevnu pospanost, što je potvrđeno većim rezultatima na Epworthovoj ljestvici pospanosti. Vrijednosti indeksa apneja-hipopneja (AHI) bile su znatno veće kod ispitanika koji su hrkali, kako u REM fazi tako i u non-REM fazama spavanja. Muškarci s dijagnosticiranom OSA-om imali su veći opseg vrata i struka te veći ITM u odnosu prema ženama. Nije utvrđena značajna povezanost između kroničnih bolesti i simptoma hrkanja. ITM, AHI vrijednost i dob pokazali su se kao najsnažniji prediktori hrkanja i rizika od OSA-e, a spol nije pokazao statistički značajan utjecaj.

Sukob interesa: Nije bilo sukoba interesa

Zahvale: Nije prijavljen

Financiranje: Nije prijavljeno

Doprinos autora: M. B. – pisanje članka, obrada podataka, usporedba sa sličnim znanstvenim istraživanjima na ovu temu; **N. B.** – prikupljanje podataka, statistička analiza podataka; **R. P.** - mentor ovog znanstvenog rada.

Sažetak

Cilj: Ispitati povezanost između hrkanja, primarnog simptoma opstrukcijske apneje tijekom spavanja (OSA) te dobi, spola i antropometrijskih karakteristika ispitanika. Cilj je poduprijeti doktore dentalne medicine u prepoznavanju osoba s povećanim rizikom od OSA-e. **Materijali i metode:** Ovo retrospektivno presječno kliničko istraživanje obuhvatilo je 795 sudionika. Prikupljeni su podatci o dobi, spolu i antropometrijskim mjerenjima. Sudionici su ispunili upitnik STOP i Epworthovu ljestvicu pospanosti. Noćna polisomnografija provedena je od 2018. do 2023. godine u Centru za medicine spavanja Kliničkog bolničkog centra Split i Medicinskog fakulteta Sveučilišta u Splitu. **Rezultati:** Sudionici sa simptomom hrkanja bili su znatno teži (96,5 ± 20,5 kg prema 84,6 ± 19,3 kg) i imali su viši indeks tjelesne mase (ITM) (31,3 ± 10,9 kg/m² prema 27,2 ± 5,1 kg/m²) u usporedbi s onima koji nisu hrkali. Također su imali veći opseg vrata (41,5 ± 6,0 cm prema 38,8 ± 4,5 cm), struka (107,8 ± 15,4 cm prema 96,9 ± 15,4 cm) i bokova (110,7 ± 12,3 cm prema 106,0 ± 11,0 cm) ($P < 0,001$ za sve). Ti sudionici također su prijavili veću dnevnu pospanost (Epworthova ljestvica pospanosti: 7,8 ± 4,9 prema 5,9 ± 4,2; $P < 0,001$) te su imali znatno više vrijednosti indeksa apneja-hipopneja (AHI) (32,8 ± 26,1 prema 15,1 ± 17,5; $P < 0,001$), što ukazuje na teži oblik OSA-e. **Zaključak:** Hrkanje je značajno povezano s većom tjelesnom masom, većim vrijednostima ITM-a, većim tjelesnim opsezima, izraženijom dnevnom pospanošću i težim stupnjem OSA-e. Hrkanje može poslužiti kao koristan klinički marker doktorima dentalne medicine pri prepoznavanju pacijenata s povećanim rizikom od OSA-e. Među ispitivanim varijablama istaknuti prediktori hrkanja bili su ITM, AHI i dob, a spol nije pokazao statistički značajan utjecaj.

Zaprimljen: 30. ožujka 2025.
Prihvaćen: 26. svibnja 2025.

Adresa za dopisivanje
Marijeta Bujak
Sveučilište u Splitu Medicinski fakultet
Šoltanska 2A, 21 000 Split, Hrvatska
marietab9@gmail.com

MeSH pojmovi: opstruktivna apneja pri spavanju; čimbenici rizika; polisomnografija; hrkanje
Autorske ključne riječi: AHI; Antropometrijske karakteristike; Stomatolog; Pacijenti visokog rizika; OSA; Stop upitnik; Epworthova ljestvica pospanosti

References

1. Sankar V. Physiological Approach in Snoring and Obstructive Sleep Apnea [Internet]. 2021 [cited 2025 Jun 1]. Available from: https://emedicine.medscape.com/article/869941-overview
2. Dalmasso F, Prota R. Snoring: analysis, measurement, clinical implications and applications. Eur Respir J. 1996;9:146–59.
3. Friedman M. Sleep apnea and snoring. Amsterdam: Elsevier; 2017.
4. Shaw P, Tafti M, Thorpy MJ. The Genetic Basis of Sleep and Sleep Disorders. New York: Cambridge University Press; 2013.
5. Chokroverty S. Sleep Disorders Medicine: Basic Science, Technical Considerations and Clinical Aspects. 4th ed. New York: Springer; 2017.
6. Lobbezoo F, De Vries N, De Lange J, Aarab G. A Further Introduction to Dental Sleep Medicine. Nat Sci Sleep. 2020;12:1173–9.
7. Quan SF, Schmidt-Nowara W. The Role of Dentists in the Diagnosis and Treatment of Obstructive Sleep Apnea: Consensus and Controversy. J Clin Sleep Med. 2017;13(9):1117–9.
8. Stansbury RC, Strollo PJ. Clinical manifestations of sleep apnea. J Thorac Dis. 2015;7(9):E298–310.
9. Conley RS. Management of sleep apnea: a critical look at intraoral appliances. Orthod Craniofac Res. 2015;18 Suppl 1:83–90.
10. Galić T. Ishodi liječenja bolesnika s opstrukcijskom apnejom tijekom spavanja intraoralnom udlagom [dissertation]. Split: University of Split, School of Medicine; 2015.
11. Včeva A, Đanić D, Đanić Hadžibegović A, Šimunjak B, Filipović B, Mihalj H, et al. Smjernice za opstruktivnu apneju u spavanju. Med Jad. 2020;50:249–56.
12. Ramar K, Dort LC, Katz SG, Lettieri CJ, Harrod CG, Thomas SM, 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;11(7):773–827.
13. De Meyer MD, Vanderveken OM, De Weerdt S, Marks LA, Cárcamo BA, Chavez AM, et al. Use of mandibular advancement devices for the treatment of primary snoring with or without obstructive sleep apnea (OSA): A systematic review. Sleep Med Rev. 2021;56:101407.
14. Mukherjee S, Galgali SR. Obstructive sleep apnea and periodontitis: A cross-sectional study. Indian J Dent Res. 2021;32(1):44–50.
15. Chen Y, Chen X, Huang X, Duan Y, Gao H, Gao X. Analysis of Salivary Microbiome and Its Association With Periodontitis in Patients With Obstructive Sleep Apnea. Front Cell Infect Microbiol. 2021;11:752475.
16. Al-Jewair TS, Al-Jasser R, Almas K. Periodontitis and obstructive sleep apnea's bidirectional relationship: a systematic review and meta-analysis. Sleep Breath. 2015;19(4):1111–20.
17. Khodadadi N, Khodadadi M, Zamani M. Is periodontitis associated with obstructive sleep apnea? A systematic review and meta-analysis. J Clin Exp Dent. 2022;14(4):e359–65.
18. Loke W, Girvan T, Ingmundson P, Verrett R, Schoolfield J, Mealey BL. Investigating the association between obstructive sleep apnea and periodontitis. J Periodontol. 2015;86(2):232–43.
19. Keller JJ, Wu CS, Chen YH, Lin HC. Association between obstructive sleep apnoea and chronic periodontitis: a population-based study. J Clin Periodontol. 2013;40(2):111–7.
20. Gunaratnam K, Taylor B, Curtis B, Cistulli P. Obstructive sleep apnoea and periodontitis: a novel association? Sleep Breath. 2009;13(3):233–9.
21. Kale SS, Kakodkar P, Shetiya SH. Assessment of oral findings of dental patients who screen high and no risk for obstructive sleep apnea (OSA) reporting to a dental college- A cross-sectional study. Sleep Sci. 2018;11(2):112–7.
22. Stazić P, Roguljić M, Đogaš Z, Lušić Kalcina L, Pavlinac Dodig I, Valić M, et al. Periodontitis severity in obstructive sleep apnea patients. Clin Oral Investig. 2022;26(1):407–15.
23. Gottlieb DJ, Vezina RM, Miller BR, et al. Sleep apnea and oral health: the effects of obstructive sleep apnea on the teeth and gums. J Clin Sleep Med. 2006;2(4):395–400.
24. Mason KL, Song SA, Epstein LM. The impact of obstructive sleep apnea on oral health and its potential therapeutic implications. Dent Clin North Am. 2013;57(4):765–72.
25. Stamatakis KD, O'Connor GT, Kales SN. Sleep apnea and periodontal disease: A review of the evidence. Chest. 2005;128(5):3252–61.
26. Al-Maweri SA, Tarakji B, Tashkandi E, et al. The effect of mandibular advancement appliances in the treatment of obstructive sleep apnea and its effect on salivary flow. J Clin Sleep Med. 2015;11(3):253–8.
27. Magliocca KR, Helman JI. Obstructive sleep apnea: diagnosis, medical management and dental implications. J Am Dent Assoc. 2005;136(8):1121–9.
28. Ngiam J, Balasubramaniam R, Darendeliler MA, Cheng AT, Waters K, Sullivan CE. Clinical guidelines for oral appliance therapy in the treatment of snoring and obstructive sleep apnoea. Aust Dent J. 2013;58(3):408–19.
29. Bernhardt O, Giannakopoulos NN, Heise M, Meyer A, Norden D, Schlieper J, et al. Mandibular advancement device: prescription in adult dental sleep medicine - guideline of the German Society of Dental Sleep Medicine. Sleep Breath. 2022; doi:10.1007/s11325-022-02601-6.
30. Pecotic R, Pavlinac Dodig I, Valic M, Ivkovic N, Dogas Z. The evaluation of the Croatian version of the Epworth sleepiness scale and STOP questionnaire as screening tools for obstructive sleep apnea syndrome. Sleep Breath. 2012;16(3):793–802.
31. Chung F, Yegneswaran B, Liao P, Chung SA, Vairavanathan S, Islam S, et al. STOP questionnaire: a tool to screen patients for obstructive sleep apnea. Anesthesiology. 2008;108(5):812–21.
32. Chung F, Abdullah HR, Liao P. STOP-Bang Questionnaire: A Practical Approach to Screen for Obstructive Sleep Apnea. Chest. 2016;149(3):631–8.
33. Grigg-Damberger MM. The AASM Scoring Manual four years later. J Clin Sleep Med. 2012;8(3):323–32.
34. Berry RB, Albertario CL, Harding SM, Lloyd RM, Quan SF, et al. The AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications. Darien (IL): American Academy of Sleep Medicine; 2018.
35. Berstein P, Higga Ebba J. Snoring Versus Obstructive Sleep Apnea: A Case Report. Perm J. 2006;10(2):21–3.
36. Wickramasinghe H. Obstructive Sleep Apnea [Internet]. 2020 [cited 2025 Jun 1]. Available from: https://emedicine.medscape.com/article/295807-overview
37. Al-Jewair TS, Nazir MA, Al-Masoud NN, Alqahtani ND. Prevalence and risks of habitual snoring and obstructive sleep apnea symptoms in adult dental patients. Saudi Med J. 2016;37(2):183–90.
38. Yildirim Y, Yilmaz S, Güven M, Kılınç F, Kara AV, Yilmaz Z, et al. Evaluation of Anthropometric and Metabolic Parameters in Obstructive Sleep Apnea. Pulm Med. 2015;2015:189761.
39. Quintana-Gallego E, Carmona-Bernal C, Capote F, Sánchez-Armengol A, Botebol-Benhamou G, Polo-Padillo J, et al. Gender differences in obstructive sleep apnea syndrome: a clinical study of 1166 patients. Respir Med. 2004;98(10):984–9.
40. Kalchiem-Dekel O, Westreich R, Regev A, Novack V, Goldberg M, Maimon N. Snoring intensity and excessive daytime sleepiness in subjects without obstructive sleep apnea. Laryngoscope. 2016;126(8):1696–701.
41. Zieliński J, Zgierska A, Polakowska M, Finn L, Kurjata P, Kupść W, Young T. Snoring and excessive daytime somnolence among Polish middle-aged adults. Eur Respir J. 1999;14(4):946–50.
42. Endeshaw Y, Rice TB, Schwartz AV, Stone KL, Manini TM, Satterfield S, et al. Snoring, daytime sleepiness, and incident cardiovascular disease in the health, aging, and body composition study. Sleep. 2013;36(11):1737–45.
43. Cruz MM, Soca R, Kryger M. How much is too much after all? Primary snoring as a remaining unsolved issue. J Clin Sleep Med. 2020;16(6):991.
44. Hofauer B, Braumann B, Heiser C, Herzog M, Maurer JT, Plößl S, et al. Diagnosis and treatment of isolated snoring-open questions and areas for future research. Sleep Breath. 2021;25(2):1011–7.
45. Mayo Clinic. Obstructive sleep apnea [Internet]. 2018 [cited 2025 Jun 1]. Available from: http://www.mayoclinic.org/diseases-conditions/obstructive-sleep-apnea/diagnosistreatment/treatment/txc-20206034
46. Pavlin M, Gubeljak N, Predan J, Ćelić R. Evaluation of the bond strength between the acrylic teeth and reinforced or non-reinforced complete denture base. Acta Stomatol Croat. 2024;58(3):218–32.
47. Bandić R, Vodanović K, Vuković Kekez I, Medvedec Mikić I, Galić I, Kalibović Govorko D. Thickness variations of thermoformed and 3D-printed clear aligners. Acta Stomatol Croat. 2024;58(2):145–55.