ACTA
STOMATOLOGICA
CROATICA
www.ascro.hr

Acta stomatol Croat. 2024;58(2):110-122.
DOI: 10.15644/asc58/2/1

ORIGINAL SCIENTIFIC PAPER
IZVORNI ZNANSTVENI RAD

Vedran Radujković[1], Arijana Lovrenčić-Huzjan[2, 3, 4], Ivan Puhar[5]

Periodontal Disease in Patients with Ischemic Stroke – an Exploratory Study

Parodontna bolest kod pacijenata s ishemijskim moždanim udarom – eksplorativna studija

[1] PhD student, University of Zagreb School of Dental Medicine, Zagreb, Croatia
Doktorand Stomatološkog fakulteta Sveučilišta u Zagrebu, Hrvatska
[2] Clinical Department of Neurology, University Hospital Center Sestre Milosrdnice, Zagreb, Croatia
Klinički odjel za neurologiju KBC-a Sestre milosrdnice, Zagreb, Hrvatska
[3] University of Zagreb School of Dental Medicine, Gundulićeva 5, Zagreb, Croatia
Stomatološki fakultet Sveučilišta u Zagrebu, Hrvatska
[4] University of Zagreb School of Medicine, Šalata 2, Zagreb, Croatia
Medicinski fakultet Sveučilišta u Zagrebu, Hrvatska
[5] Department of Periodontology, University of Zagreb School of Dental Medicine, Gundulićeva 5, Zagreb, Croatia
Zavod za parodontologiju Stomatološkog fakulteta Sveučilišta u Zagrebu, Hrvatska

Abstract

Objective: The aim of this study was to assess the periodontal disease parameters in patients with ischemic stroke. **Materials and methods:** The study included 21 patients with ischemic stroke and a control group that was matched in number, age, and gender. All participants underwent a standard periodontal examination. The inclusion criterion of this study was the presence of at least 15 teeth. Periodontal epithelial surface area, periodontal inflamed surface area (PISA), and periodontal disease stage were determined. All participants were given a questionnaire to determine oral health-related quality of life (OHQL). Stroke risk factors were assessed. **Results:** Stroke patients had a significantly higher OHQL score than the control group (20.81 vs. 12.57) and a full-mouth plaque score (FMPS, 27.57 vs. 16.83), while full-mouth bleeding score (FMBS) was significantly higher in the control group than in the hospital group (10.17 vs. 6.42). For PISA, statistically significant negative correlations were found for smoking, cholesterol levels, and LDL levels, while significant positive correlations were found for FMBS, clinical attachment level and probing depth. **Conclusion:** Tooth loss due to advanced periodontal disease combined with oral hygiene limitations remains the most significant obstacle for a more meaningful understanding of data represented by specific parameters that characterize the two diseases investigated in this study. Further studies on a larger sample size of patients with periodontitis stage 1-3 are required.

Received: April 23, 2024
Accepted: June 1, 2024

Address for correspondence
Ivan Puhar
University of Zagreb
School of Dental Medicine
Department of Periodontology
Gundulićeva 5, HR-10000 Zagreb,
Croatia
Phone: +385 14899219
puhar@sfzg.hr

MeSH Terms: Periodontitis; Ischemic Stroke; Carotid Intima-Media Thickness; Quality of Life; Risk Factors
Author Keywords: Periodontitis; Ischemic Stroke; Carotid Intima-Media Thickness; Quality of Life

Vedran Radujković ORCID ID: 0009-0002-2703-3462
Arijana Lovrenčić-Huzjan ORCID ID: 0000-0002-6911-4159
Ivan Puhar ORCID ID: 0000-0002-7683-6563

Introduction

Periodontal diseases are widespread in the global population with gingivitis affecting up to 90% of adults (1), and severe generalized periodontitis affecting 5-15% (2). The cause of periodontitis and subsequently the cause of periodontal tissue destruction are oral microorganisms and the host's immune-inflammatory response (3). There are more than 500 Gram-positive and Gram-negative species of bacteria found in dental plaque. Over a period of time the composition of dental plaque starts to change to a predominantly Gram-negative anaerobic structure that is associated with periodontal disease. The microorganisms and their byproducts may enter the bloodstream even in the course of mastication or

Uvod

Parodontne bolesti česte su u globalnoj populaciji s gingivitisom koji pogađa do 90 % odraslih (1), a teški generalizirani parodontitis pogađa od 5 do 15 % (2). Uzrok parodontitisa, a zatim i destrukcije parodontnog tkiva, oralni su mikroorganizmi i imunosno-upalni odgovor domaćina (3). U zubnome plaku nalazi se više od 500 Gram-pozitivnih i Gram-negativnih vrsta bakterija. S vremenom se sastav zubnoga plaka počinje mijenjati u pretežno Gram-negativnu anaerobnu floru koja je povezana s parodontnom bolešću. Mikroorganizmi i njihovi nusprodukti mogu ući u krvotok čak i tijekom žvakanja ili raznih stomatoloških pregleda ili zahvata (4, 5). Povećani subgingivalni prostor i mikroulce-

while undergoing various dental exams or procedures (4, 5). The enlarged subgingival space and the micro ulceration of gingival epithelia are likely to be the two main factors facilitating long-term systemic inflammatory burden (6).

Previous research has associated periodontitis with many systemic diseases and conditions such as preterm birth (7), pulmonary disease (8), and diabetes (9). Inflammation has proven to be one of the causes of atherosclerosis (10). When the biologic model of periodontal disease as a cause of bacteremia is taken into consideration (11), a need arises for a classification of periodontal disease that is capable of measuring the quantity of periodontal tissue affected by inflammation. Periodontal inflamed surface area (PISA) represents the amount of periodontal tissue that is inflamed and is calculated in mm^2. Therefore, it might be the most suitable tool to estimate the systemic inflammatory burden caused by periodontal disease (12).

Periodontal disease and general health are, in all probability, interlinked (13). Therefore, individuals suffering from periodontal disease may be at a greater risk of systemic diseases such as stroke, respiratory infections (14) and other cardiovascular diseases (15, 16).

Stroke is a notable cause of mortality and disability in the global population. There are two main types of stroke, ischemic which is caused either by a thrombotic or embolic event, and hemorrhagic, which is caused by a rupture in a blood vessel (17). Approximately 80% of all strokes are of the ischemic type (18). Major risk factors for stroke include hypertension, hyperlipidemia, diabetes mellitus, and tobacco use, atrial fibrillation, smoking, carotid stenosis, physical inactivity, high body mass index (BMI), poor nutrition, kidney dysfunction, chronic or recent inflammation (19, 20). A comprehensive research review reports the need for further investigation of the causal relationship between periodontal disease and stroke using periodontal classifications that are able to quantify the inflammatory burden (12, 21). The objective of this research was to explore the correlation between potential risk factors for stroke and periodontal disease.

Material and methods

The study included two groups of participants obtained from two different sites - the hospital group consisted of 21 patients at the University Clinical Hospital Center Sestre Milosrdnice, Department of Neurology, that have been diagnosed with ischemic stroke (test group), and a control group from Community Healthcare Centre "Zagreb-Centar" that was matched in number, age, and gender (n=21). All participants were required to have at least 15 teeth. Exclusion criteria for all participants were: periodontal treatment in the past 12 months, antibiotic therapy within the last 6 months, recent acute or chronic infections, pregnancy, and drug or alcohol abuse.

This study was approved by the Ethics Committee for Research of the University of Zagreb School of Dental Medicine (05-PA-30-XXIX-9/2021) and University Clinical Hospital Center Sestre Milosrdnice (003-06/21-03/030, 251-29-11-21-01-6). All participants have signed an informed consent form after a full explanation of the periodontal examination.

racije epitela gingive vjerojatno su dva glavna čimbenika koji olakšavaju dugotrajno sustavno upalno opterećenje (6).

U dosadašnjim istraživanjima parodontitis se povezivao s mnogim sustavnim bolestima i stanjima kao što su prijevremeni porođaj (7), plućne bolesti (8) i dijabetes (9). Dokazano je da je upala jedan od uzroka ateroskleroze (10). Kada se kao uzrok bakterijemije uzme u obzir biološki model parodontne bolesti (11), pojavljuje se potreba za klasifikacijom parodontne bolesti kako bi se mogla izmjeriti količina parodontnog tkiva zahvaćenog upalom. Upaljena parodontna površina (PISA) pokazuje količinu upaljenoga parodontnog tkiva i izračunava se u četvornim milimetrima. Stoga bi to mogao biti najprikladniji alat za procjenu sustavnoga upalnog opterećenja uzrokovanog parodontnom bolesti (12).

Parodontna bolest i opće zdravlje vrlo su vjerojatno uzajamno povezani (13). Zato osobe koje boluju od parodontne bolesti mogu biti izložene većem riziku od sistemskih bolesti kao što su moždani udar, respiratorne infekcije (14) i druge kardiovaskularne bolesti (15, 16).

Moždani udar značajan je uzrok smrtnosti i invaliditeta u globalnoj populaciji. Dva su glavna tipa moždanog udara – ishemijski koji je prouzročen trombotičkim ili emboličkim događajem i hemoragijski koji je izazvan rupturom krvne žile (17). Otprilike 80 % svih moždanih udara ishemijskog je tipa (18). Glavni čimbenici rizika za moždani udar uključuju hipertenziju, hiperlipidemiju, šećernu bolest, pušenje, fibrilaciju atrija, karotidnu stenozu, tjelesnu neaktivnost, visok indeks tjelesne mase (BMI), lošu prehranu, disfunkciju bubrega te kroničnu ili nedavnu upalu (19, 20). Opsežan pregled studija pokazuje da je potrebno i dalje istraživati uzročnu vezu između parodontne bolesti i moždanog udara korištenjem klasifikacija parodontitisa koje mogu kvantificirati upalno opterećenje (12, 21). Cilj ovog istraživanja bio je istražiti povezanost potencijalnih čimbenika rizika za moždani udar i parodontne bolesti.

Materijali i metode

Istraživanje je obuhvatilo dvije skupine sudionika s dvaju različitih mjesta – bolničku skupinu činio je 21 pacijent KBC-a Sestre milosrdnice i Klinike za neurologiju kojima je dijagnosticiran ishemijski moždani udar (testna skupina), a kontrolna skupina iz Doma zdravlja Zagreb – Centar bila je podudarna u broju, dobi i spolu (n = 21). Svi sudionici morali su imati najmanje 15 zuba. Kriteriji za isključivanje bili su parodontno liječenje u posljednjih 12 mjeseci, antibiotska terapija u posljednjih šest mjeseci, nedavne akutne ili kronične infekcije, trudnoća i zlouporaba droga ili alkohola.

Studiju je odobrilo Etičko povjerenstvo Stomatološkog fakulteta Sveučilišta u Zagrebu (05-PA-30-XXIX-9/2021) i Kliničkoga bolničkog centra Sestre milosrdnice (003-06/21-03/030, 251-29-11-21-01-6). Svi sudionici potpisali su informirani pristanak poslije detaljnoga objašnjenja parodontološkog pregleda.

Svi su sudionici podvrgnuti parodontološkom pregledu koji je obuhvaćao mjerenje dubine sondiranja (PPD), rece-

All participants were submitted to a periodontal examination that included periodontal probing pocket depth (PPD), gingival recession, bleeding on probing (BOP), and plaque index (PI) measurements by a single experienced and calibrated examiner using a standard periodontal probe (PCP-15, Hu-Friedy, Chicago, IL, USA) and dental mirror. All of the measurements were performed on six sites per tooth. The collected data were used to calculate periodontal epithelial surface area (PESA) and, periodontal inflamed surface area (PISA) using a Microsoft Excel sheet available at www.parsprototo.info. Full-mouth bleeding score (FMBS), full-mouth plaque score (FMPS), median clinical attachment loss (CAL), median PPD and periodontal disease stage according to the 2017 classification (22) were also calculated.

All participants were given an extensive questionnaire that included information regarding their age, gender, body mass index (BMI), marital status, education, smoking behavior (expressed as pack-years), alcohol consumption, frequency of dental exams, physical activity, diabetes, hypertension, cholesterol levels, and oral health-related quality of life (OHQL). Additionally, in the hospital group CRP, HDL, LDL, total cholesterol, and triglycerides levels were measured.

Carotid intima media thickness (cIMT) measurements were made using an ultrasonography device (Philips Medical Systems' HD11 platform) with a 13 MHz linear probe. All hospital group patients were categorized according to TOAST classification (23).

As there were no significant deviations from normality within the control and the hospital group, comparisons of the quantitative variables between these groups were performed using a t-test for independent observations. The categorical data between the control group and the hospital group were compared using a chi-square test. For the analysis of PISA and PESA scores by different patient characteristics, either parametric or non-parametric tests were chosen depending on the data distribution (evaluated by the Shapiro-Wilk test) as follows: the t-test was used for comparisons among different scores for alcohol consumption, TOAST, and stage of periodontitis, while the Mann-Whitney U test was used for comparisons by gender, marital status, education level, employment status, physical activity, diabetes and hypertension. The correlation between PISA/PESA and the number of lost teeth was analyzed using Pearson's correlation analysis. Due to the violation of the normality assumption, the correlations of PISA and PESA with other quantitative variables, including patient demographics, dental status, periodontal status, and laboratory findings, were analyzed using Spearman correlation analysis. Statistical analysis was performed in SPSS v 25.0 (IBM, Armonk, NY, USA). The significance level was set at α=0.05. However, due to the exploratory nature of the study, p-values between 0.05 and 0.10 were considered marginally significant.

Results

The descriptive statistics of the patient characteristics in the control group and the hospital group with the re-

siju gingive, krvarenje pri sondiranju (BOP) i indeks plaka (PI). To je s pomoću standardne parodontne sonde (PCP- 15, Hu-Friedy, Chicago, IL, SAD) i stomatološkog zrcala obavio iskusan i kalibrirani ispitivač. Sva su mjerenja učinjena na šest mjesta po zubu. Prikupljeni podatci korišteni su za izračunavanje površine parodontnog epitela (PESA) i upaljene parodontne površine (PISA) korištenjem Microsoft Excel liste dostupne na stranici www.parsprototo.info. Također je izračunat indeks krvarenja na razini usta (FMBS), indeks plaka na razini usta (FMPS), medijan razine kliničkoga pričvrstka (CAL), medijan PPD-a i stadij parodontne bolesti prema klasifikaciji iz 2017. godine (22).

Svi sudionici ispunili su opsežan upitnik koji je obuhvaćao podatke o njihovoj dobi, spolu, indeksu tjelesne mase (BMI), bračnom statusu, obrazovanju, pušačkom ponašanju (izraženo kao kutija/godine), konzumaciji alkohola, učestalosti stomatoloških pregleda, tjelesnoj aktivnosti, šećernoj bolesti, hipertenziji, razini kolesterola i kvaliteti života povezanoj s oralnim zdravljem (OHQL). Uz to, u bolničkoj skupini izmjerene su razine CRP-a, HDL-a, LDL-a, ukupnoga kolesterola i triglicerida.

Mjerenja debljine intime-medije karotide (cIMT) obavljena su ultrazvučnim uređajem (Philips Medical Systems HD11 platforma) s linearnom sondom od 13 MHz. Svi sudionici iz bolničke skupine kategorizirani su prema TOAST klasifikaciji (23).

Budući da nije bilo značajnih odstupanja od normalnosti unutar kontrolne i bolničke skupine, usporedbe kvantitativnih varijabli između tih skupina provedene su s pomoću t-testa za neovisna promatranja. Kategorički podatci između kontrolne i bolničke skupine uspoređeni su s pomoću hi-kvadrat testa. Za analizu PISA i PESA rezultata prema različitim karakteristikama pacijenata odabrani su parametarski ili neparametarski testovi, ovisno o distribuciji podataka (procijenjeno Shapiro-Wilkovim testom) na sljedeći način: t-test je korišten za usporedbe između različitih rezultata za konzumaciju alkohola, TOAST i stadij parodontitisa, a Mann-Whitneyjev U-test upotrijebljen je za usporedbu prema spolu, bračnom statusu, stupnju obrazovanja, statusu zaposlenja, tjelesnoj aktivnosti, šećernoj bolesti i hipertenziji. Korelacija između PISA/PESA-e i broja izgubljenih zuba analizirana je Pearsonovom korelacijskom analizom. Zbog kršenja pretpostavke normalnosti, korelacije PISA-e i PESA-e s drugim kvantitativnim varijablama, uključujući demografiju pacijenata, dentalni i parodontni status te laboratorijske nalaze, analizirane su korištenjem Spearmanove korelacijske analize. Statistička analiza provedena je u SPSS v 25.0 (IBM, Armonk, NY, SAD). Razina značajnosti postavljena je na α = 0,05. Međutim, zbog eksplorativne prirode studije, p-vrijednosti između 0,05 i 0,10 smatrane su marginalno značajnima.

Rezultati

U tablici 1. rezultati su usporedbe demografskih i deskriptivnih statističkih podataka bolničke i kontrolne sku-

Table 1 Mean values with standard deviations in parentheses for quantitative patient variables in control and hospital group.
Tablica 1. Srednje vrijednosti sa standardnim devijacijama u zagradama za kvantitativne varijable pacijenata u kontrolnoj i bolničkoj skupini

Variable • Varijabla	Control group • Kontrolna skupina (n = 21)	Hospital group • Bolnička skupina (n = 21)	p-value* • p-vrijednost*
Patient age (years) • Dob pacijenta (godine)	65.76 (13.30)	65.43 (13.04)	0.935
Time of last dental examination (years ago) • Posljednji stomatološki pregled (prije koliko godina)	1.64 (2.12)	2.43 (4.23)	0.456
Smoking (pack years) • Pušenje (kutija/godine)	8.67 (15.34)	8.26 (11.48)	0.923
Body mass index • Indeks tjelesne mase	27.79 (5.70)	28.05 (6.52)	0.898
OHQL	12.57 (6.29)	20.81 (10.24)	0.003
PISA (mm^2)	122.34 (86.27)	77.17 (69.26)	0.069
PESA (mm^2)	1097.00 (222.03)	971.50 (206.97)	0.065
FMBS	10.17 (6.10)	6.42 (5.62)	0.045
FMPS	16.83 (7.17)	27.57 (15.13)	0.005
CAL (mm)	2.87 (0.26)	2.97 (0.19)	0.151
PPD (mm)	2.63 (0.20)	2.70 (0.15)	0.205
Number of teeth • Broj zubi	22.05 (4.06)	20.10 (4.25)	0.136

* T-test for independent observations. Statistically significant differences are marked by bold numbers. • * T-test za nezavisna opažanja. Podebljanim brojevima označene su statistički značajne razlike.
OHQL – oral health-related quality of life; PISA – periodontal inflamed surface area; PESA – periodontal epithelial surface area; FMBS – full-mouth bleeding score; FMPS – full-mouth plaque score; CAL – clinical attachment level; PPD – probing pocket depth • OHQL – kvaliteta života povezana s oralnim zdravljem; PISA – parodontna upaljena površina; PESA – površina parodontnog epitela; FMBS – indeks krvarenja; FMPS – indeks plaka; CAL – razina kliničkog pričvrstka; PPD – dubina sondiranja

Table 2 Descriptive statistics for categorical patient variables in control and hospital group.
Tablica 2. Deskriptivna statistika za kategoričke varijable pacijenata u kontrolnoj i bolničkoj skupini

		Control group • Kontrolna skupina (n = 21)	Hospital group • Bolnička skupina (n = 21)	Total • Ukupno	p-value* • p-vrijednost*
Gender • Spol	Male • Muški	13 (61.9%)	13 (61.9%)	26 (61.9%)	1.000
	Female • Ženski	8 (38.1%)	8 (38.1%)	16 (38.1%)	
Marital status • Bračni status	Single • Samac	3 (14.3%)	0 (0%)	3 (7.1%)	0.157
	Married • U braku	16 (76.2%)	17 (81.0%)	33 (78.6%)	
	Widowed • Udovac/udovica	2 (9.5%)	4 (19.0%)	6 (14.3%)	
Education level • Razina naobrazbe	Elementary school • Osnovna škola	2 (9.5%)	4 (19.0%)	6 (14.3%)	0.675
	High school • Srednja škola	12 (57.2%)	11 (52.4%)	23 (54.7%)	
	University degree • Fakultet	7 (33.3%)	6 (28.6%)	13 (31.0%)	
Employment status • Zaposlenost	Retired • Umirovljen	16 (76.2%)	14 (66.6%)	30 (71.4%)	0.480
	Unemployed • Nezaposlen	2 (9.5%)	1 (4.8%)	3 (7.2%)	
	Employed • Zaposlen	3 (14.3%)	6 (28.6%)	9 (21.4%)	
Alcohol consumption • Konzumacija alkohola	1	12 (57.1%)	9 (42.9%)	21 (50.0%)	0.475
	2	8 (38.1%)	9 (42.9%)	17 (40.5%)	
	3	1 (4.8%)	3 (14.2%)	4 (9.5%)	
Physically active • Fizička aktivnost	Yes • Da	9 (42.9%)	4 (19.0%)	13 (31.0%)	0.095
	No • Ne	12 (57.1%)	17 (81.0%)	29 (69.0%)	
Diabetes • Šećerna bolest	Yes • Da	3 (14.3%)	8 (38.1%)	11 (26.2%)	0.079
	No • Ne	18 (85.7%)	13 (61.9%)	31 (73.8%)	
Hypertension • Hipertenzija	Yes • Da	10 (47.6%)	9 (42.9%)	19 (45.2%)	0.757
	No • Ne	11 (52.4%)	12 (57.1%)	23 (54.8%)	
Stage of periodontitis • Stadij parodontitisa	0	5 (23.9%)	4 (19.0%)	9 (21.4%)	0.531
	1	1 (4.8%)	3 (14.3%)	4 (9.5%)	
	2	4 (19.0%)	4 (19.0%)	8 (19.0%)	
	3	4 (19.0%)	1 (4.8%)	5 (11.9%)	
	4	7 (33.3%)	9 (42.9%)	16 (38.1%)	

* Chi-square test. Statistically significant differences are marked by bold numbers.
* Hi-kvadrat test; podebljanim brojevima označene su statistički značajne razlike

Table 3 Correlation coefficients and p-values of the Spearman correlation analysis between PISA/PESA and patient demographics, dental status, periodontal status, and laboratory findings.
Tablica 3. Koeficijenti korelacije i p-vrijednosti Spearmanove korelacijske analize između PISA/PESA-e i demografskih podataka pacijenata, dentalnoga i parodontnog statusa te laboratorijskih nalaza

	PISA		PESA	
	Spearman correlation coefficient • Spearmanov koeficijent korelacije	**p-value* • p-vrijednost***	**Spearman correlation coefficient • Spearmanov koeficijent korelacije**	**p-value* • p-vrijednost***
Patient age • Dob pacijenta	0.218	0.165	-0.408	0.007
Smoking • Pušenje	**-0.469**	**0.002**	0.062	0.699
Cholesterol • Kolesterol	**-0.467**	**0.033**	0.311	0.170
HDL	-0.300	0.187	0.041	0.859
LDL	-0.523	0.015	0.394	0.077
Triglycerides • Trigliceridi	0.172	0.457	-0.161	0.487
CRP	-0.143	0.536	-0.254	0.267
HbA1c	0.095	0.746	-0.290	0.314
cIMT Right • Desna cIMT	-0.055	0.812	-0.399	0.073
cIMT Left • Lijeva cIMT	-0.086	0.712	**-0.645**	**0.002**
AV Right • Desna AV	-0.055	0.811	-0.010	0.966
AV Left • Lijeva AV	-0.053	0.820	0.213	0.353
Body mass index • Indeks tjelesne mase	0.021	0.904	-0.131	0.441
OHQL	-0.177	0.263	**-0.628**	**<0.001**
Number of teeth • Broj zuba	0.132	0.405	**0.874**	**<0.001**
FMBS	**0.914**	**<0.001**	-0.008	0.962
FMPS	-0.155	0.326	-0.229	0.145
CAL	**0.323**	**0.037**	-0.268	0.086
PPD	**0.433**	**0.004**	-0.224	0.154

* Statistically significant differences are marked by bold numbers. • Podebljanim brojevima označene su statistički značajne razlike.
HDL – high-density lipoprotein; LDL – low-density lipoprotein; CRP – C-reactive protein; HbA1c – glycated haemoglobin; cIMT – carotid intima media thickness; AV – arteria vertebralis; OHQL – oral health-related quality of life; FMBS – full-mouth bleeding score; FMPS – full-mouth plaque score; CAL – clinical attachment level; PPD – probing pocket depth • HDL – lipoprotein visoke gustoće; LDL – lipoprotein niske gustoće; CRP – C-reaktivni protein; HbA1c – glikozilirani hemoglobin; cIMT – debljina intime-medije karotide; AV – arteria vertebralis; OHQL – kvaliteta života povezana s oralnim zdravljem; FMBS – indeks krvarenja; FMPS – indeks plaka; CAL – razina kliničkog pričvrstka; PPD – dubina sondiranja

sults of the comparisons between the groups are shown in Table 1. There were 16 female and 26 male patients with a mean age of 65 years. The hospital group had a significantly higher OHQL score than the control group (20.81 vs. 12.57) and FMPS (27.57 vs. 16.83), while FMBS was significantly higher in the control group compared to the hospital group (10.17 vs. 6.42). There were no significant differences among the groups in other patient characteristics. The categorical patient variables are summarized in Table 2. There were no statistically significant differences between the control group and the hospital group. Table 3 shows the results of the Spearman correlation analysis between PISA/PESA and various patient characteristics. For PISA, statistically significant negative correlations were found for smoking, cholesterol levels, and LDL levels, while significant positive correlations were found for FMBS, CAL, and PPD. For PESA, significant negative correlations were found for patient age, left cIMT, and OHQL, while a significant positive correlation was found for the number of teeth.

The boxplots in Figure 1 show the comparisons of PISA values between the subgroups of patients according to their different characteristics. There were no statistically significant differences in any of the comparisons. The boxplots in Figure 2 show the comparisons of PESA values between the

pine. U istraživanju je sudjelovalo 16 žena i 26 muškaraca (srednja dob 65 godina). Bolnička skupina imala je statistički značajno veći OHQL rezultat u usporedbi s kontrolnom skupinom (20,81 prema 12,57) i FMPS (27,57 prema 16,83), a FMBS je bio statistički značajno veći u kontrolnoj skupini (10,17 prema 6,42). Preostale usporedbe između skupina nisu pokazale statistički značajne razlike. Usporedba kategoričkih varijabli pacijenata prikazana u tablici 2. nije pokazala statistički značajne razlike između kontrolne i bolničke skupine. U tablici 3. su rezultati analize Spearmanova koeficijenta korelacije između PISA/PESA-e i različitih karakteristika pacijenata. U slučaju PISA-e statistički značajne negativne korelacije ustanovljene su za pušenje, razinu kolesterola i LDL-a. Statistički značajne pozitivne korelacije utvrđene su za FMBS, CAL i PPD. U slučaju PESA-e statistički značajne negativne korelacije utvrđene su u odnosu na dob pacijenata, lijevi cIMT i OHQL, a statistički značajne pozitivne korelacije utvrđene su za broj zuba.

Slika 1. prikazuje usporedbu PISA vrijednosti s podgrupama pacijenata prema njihovim različitim karakteristikama. Usporedbom nisu prikazane statistički značajne razlike. Na slici 2. je usporedba PESA vrijednosti s podgrupama pacijenata. Statistički značajno veće PESA vrijednosti ustanovljene su ispitanicima s visokim stupnjem obrazovanja uspore-

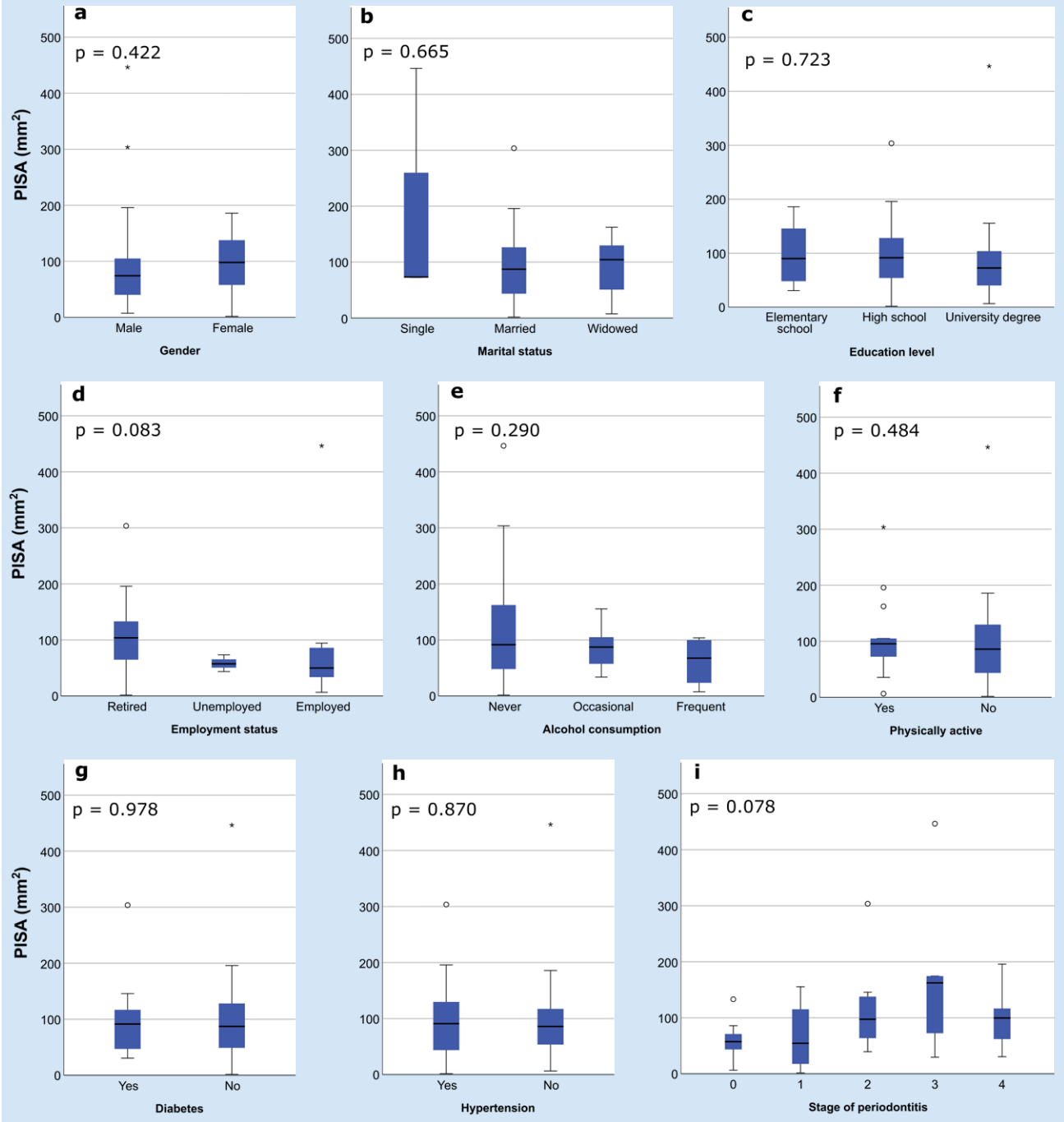

Figure 1 Comparisons of PISA values according to gender (a), marital status (b), education level (c), employment status (d), alcohol consumption (e), physical activity (f), diabetes (g), hypertension (h), and stage of periodontitis (i). All statistical comparisons showed non-significant results, hence only the p-values for the *omnibus* test are indicated in each panel.

Slika 1. Usporedbe PISA vrijednosti prema spolu (a), bračnom statusu (b), stupnju obrazovanja (c), statusu zaposlenja (d), konzumaciji alkohola (e), tjelesnoj aktivnosti (f), šećernoj bolesti (g), hipertenziji (h) i stadiju parodontitisa (i); sve statističke usporedbe pokazale su neznačajne rezultate, stoga su u svakoj ploči naznačene samo p-vrijednosti za *omnibus* test

subgroups of patients according to their different characteristics. Significantly higher PESA was found for the patients with a university degree compared to the other two lower educational levels. PESA was significantly higher in employed patients than in retired patients, as well as in patients without hypertension compared to patients with hypertension. In addition, stage 3 periodontitis resulted in a significantly higher PESA compared to stages 1, 2, and 4. PISA and PESA values of the hospital group showed no significant differ-

do s preostalim dvjema skupinama niže obrazovanih. PESA je bila značajno veća kad je riječ o pacijentima koji su zaposleni u odnosu na umirovljene, te o pacijentima bez hipertenzije u odnosu na one s hipertenzijom. Kod pacijenata s trećim stadijem parodontitisa, PESA vrijednosti bile su značajno veće nego kod pacijenata koji se nalaze u 1, 2 i 4. stadiju. PISA i PESA vrijednosti unutar bolničke skupine nisu pokazale statistički značajne razlike u odnosu prema podskupinama unutar TOAST klasifikacije (slika 3.). PISA vrijednosti nisu

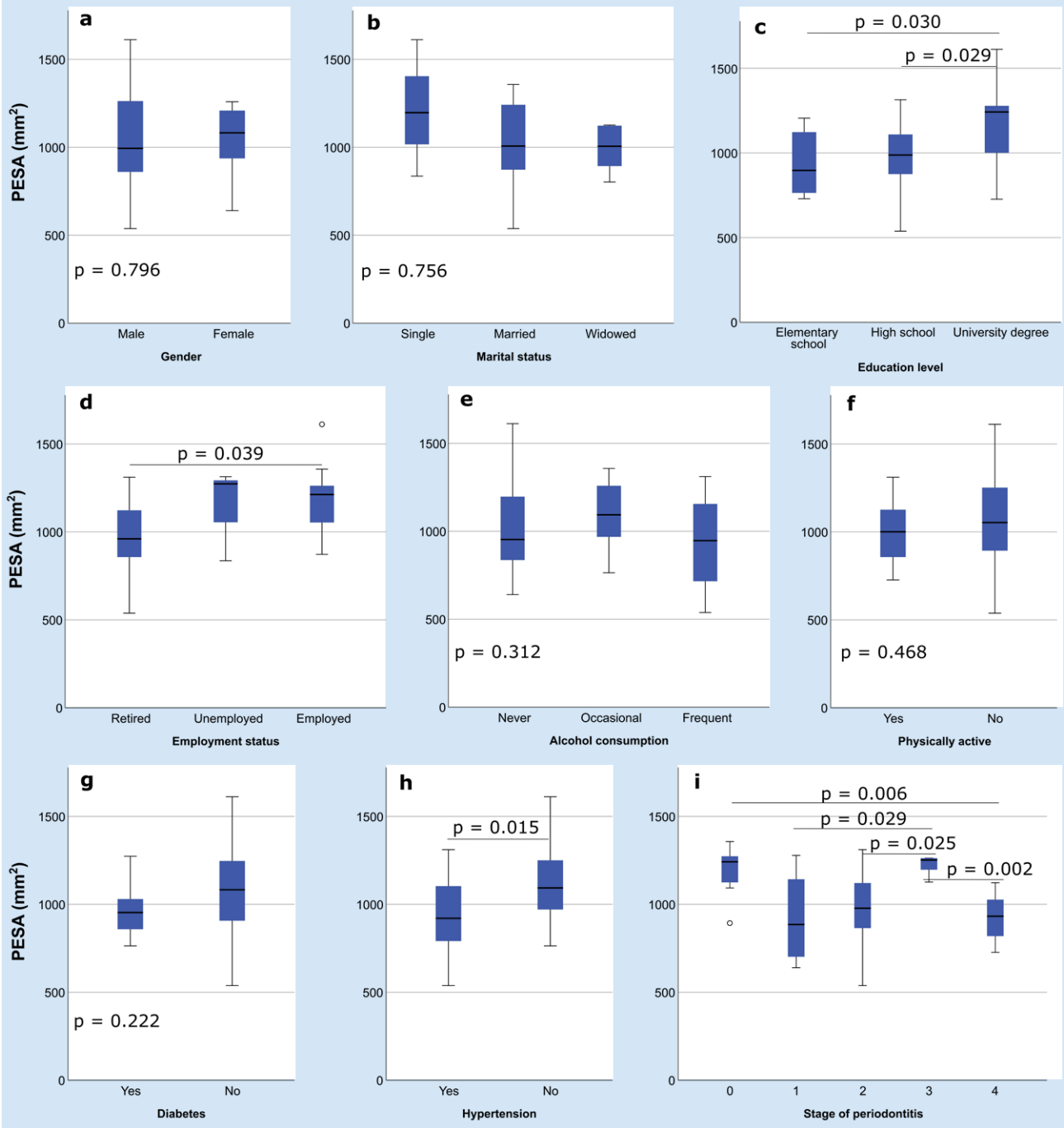

Figure 2 Comparisons of PESA values according to gender (a), marital status (b), education level (c), employment status (d), alcohol consumption (e), physical activity (f), diabetes (g), hypertension (h), and stage of periodontitis (i). Horizontal lines denote statistically significant differences between the marked groups. For comparisons that produced non-significant results, the p-values for the *omnibus* test are indicated.

Slika 2. Usporedbe PESA vrijednosti prema spolu (a), bračnom statusu (b), stupnju obrazovanja (c), statusu zaposlenja (d), konzumaciji alkohola (e), tjelesnoj aktivnosti (f), šećernoj bolesti (g), hipertenziji (h) i stadiju parodontitisa (i); horizontalne linije označavaju statistički značajne razlike između označenih skupina; za usporedbe koje su dale neznačajne rezultate, naznačene su p-vrijednosti za *omnibus* test

ence among the patient subgroups characterized by various TOAST scores (Figure 3). While PISA was not significantly correlated with the number of lost teeth (p = 0.197), PESA showed a highly significant correlation with the number of lost teeth with a high correlation coefficient R = 0.828. Figure 4 shows PISA values plotted as a function of cholesterol and LDL levels, i.e. the two laboratory parameters that

pokazale statistički značajnu razliku u usporedbi s brojem izgubljenih zuba (p = 0,197), za razliku od PESA vrijednosti koje su pokazale statistički iznimno značajnu korelaciju s visokim korelacijskim koeficijentom R = 0,828. Na slici 4. vrijednosti su PISA-e iscrtane usporedo s razinom kolesterola i LDL-a, a to su dva laboratorijska parametra koji su pokazali statistički negativnu korelaciju s PISA-om. Unatoč očito veli-

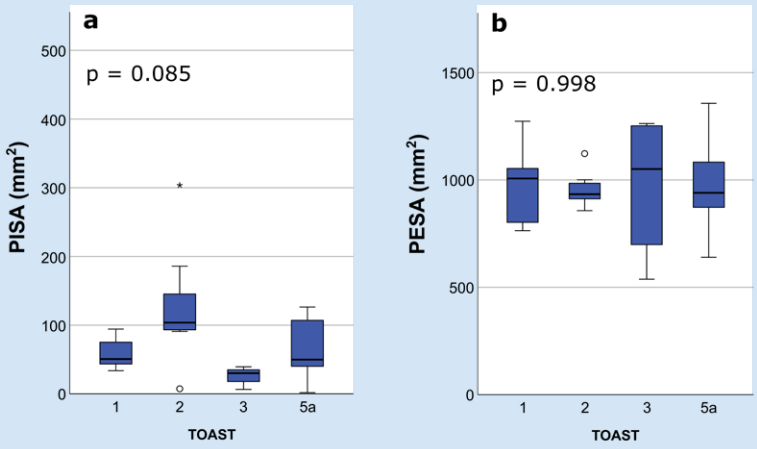

Figure 3 Comparison of PISA (a) and PESA (b) among the values of TOAST score in the hospital group. Statistical comparisons showed non-significant results, hence only the p-values for the *omnibus* test are indicated in each panel.

Slika 3. Usporedba PISA-e (a) i PESA-e (b) između vrijednosti TOAST rezultata u bolničkoj skupini; statističke usporedbe pokazale su neznačajne rezultate, stoga su u svakom panelu naznačene samo p-vrijednosti za *omnibus* test

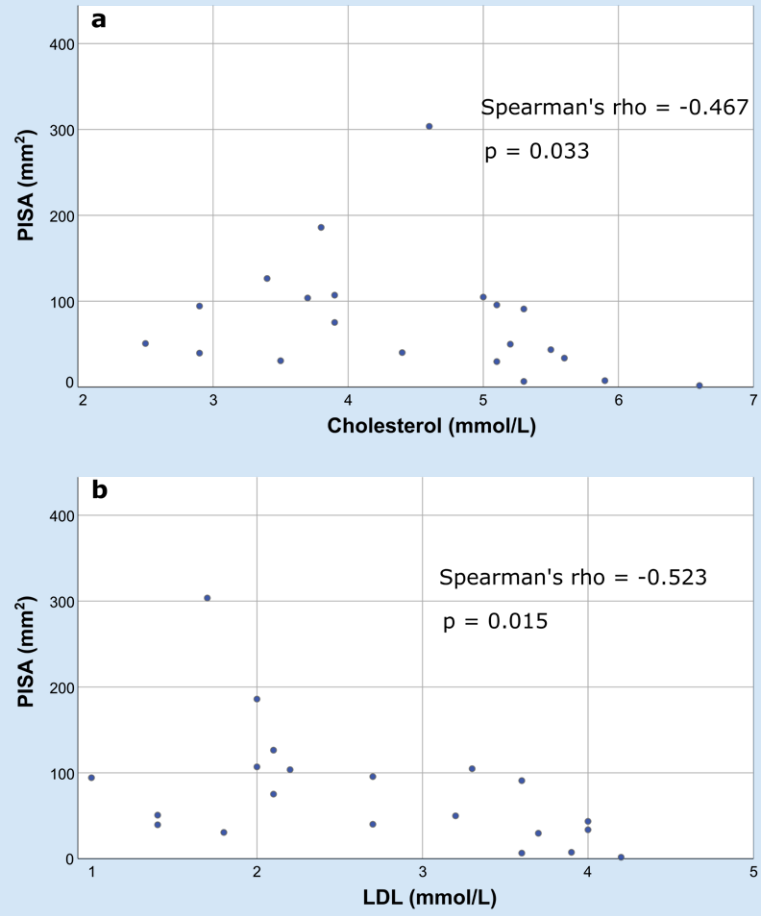

Figure 4 Scatterplots of PISA against blood cholesterol levels (a) and LDL levels (b). Each dot represents a single patient.

Slika 4. Dijagrami raspršenosti PISA-e u odnosu na razinu kolesterola u krvi (a) i razinu LDL-a (b); svaka točka predstavlja jednog pacijenta

showed a significant negative correlation with PISA. Despite the apparently large data scatter, the non-parametric correlation analysis showed significant negative correlations of PISA with cholesterol levels (ρ = -0.467) and LDL levels (ρ = -0.523).

Discussion

This exploratory study was performed with the intention to have better understanding of the periodontal status in patients with ischemic stroke by comparing the hospital group of post-stroke patients with the control group of healthy subjects with the same demographic characteristics.

koj raspršenosti podataka, neparametrijska korelacijska analiza pokazala je značajnu negativnu korelaciju PISA-e s razinom kolesterola (p = -0,467) i razinom LDL-a (p = -0,523).

Rasprava

Ova eksplorativna studija provedena je sa svrhom boljeg razumijevanja parodontnog statusa kod pacijenata s ishemijskim moždanim udarom usporedbom skupine bolničkih pacijenata poslije preboljeloga ishemijskoga moždanog udara i kontrolne skupine zdravih pacijenata s istim demografskim

Although periodontitis is not an independent stroke predictor, evidence has been presented that the collective effect of several chronic infections may increase the risk of atherosclerosis and stroke. This proof of interactions between chronic infections presents periodontitis as a possible contributing factor (24).

Numerous studies have explored the association between oral health and ischemic stroke. These studies differ in their methodological details, tools used for oral assessment, and the direction of relationship between the two diseases. Yet they remain unified in their hypothesis that periodontal disease which takes place in the mouth can propagate systematically (25). As stated by the Standards for reporting chronic periodontitis prevalence and severity in epidemiologic studies, socioeconomic, behavioral, and demographic factors were evaluated in the present study (25). These factors showed no significant differences between the hospital and control groups in part due to the inclusion criteria used for recruiting the subjects for the control group.

Tooth loss has been associated with stroke in several studies (27-30). Periodontitis has been established as a major cause of tooth loss (31). Since lost teeth were no longer present for inspection these findings might further impede a meaningful comparison by underestimating the effect of periodontal disease, which is a chronic disease and patients are likely to have developed it before the ischemic stroke (32-34). Other research has found that patients with fewer than 23 teeth were in a higher risk group for stroke than patients with 28 teeth or more (35). The inclusion criterion of this study was the presence of at least 15 teeth. Therefore, it was not possible to investigate such a hypothesis, as only 2 of the total 42 subjects could be classified in the latter category with 28 or more teeth due to the high number of lost teeth. Although the control group had a higher average number of teeth than the hospital group (22.05 vs. 20.10, respectively), the difference was not statistically significant (p=0.136) due to the small sample size and high variability within each group.

PESA and PISA values in the control group were higher than in the hospital group but only with marginal significance (p=0.069 and p=0.065, respectively). This difference could be due to the high correlation (R=0.828) between the number of teeth and the PESA/PISA values. Since the control group had a higher average number of teeth, it therefore also had higher PESA/PISA values than the hospital group. Hence the marginally significant difference in PESA and PISA scores between the control group and the hospital group can be attributed to differences in a more fundamental underlying variable, namely the number of teeth.

Oral health related quality of life (OHQL) is a highly subjective notion. Despite that, oral health may impede vital functions such as eating, swallowing, speaking, and breathing (36). The results of the OHQL in the present study indicate a statistically higher quality of life in the control group (p=0.003). In addition, a pronounced negative correlation with a Spearman correlation coefficient of -0.628 ($p < 0.001$) was found between PESA and OHQL. This is consistent with the finding of a negative correlation between periodon-

karakteristikama. Iako parodontitis nije nezavisni prediktor za ishemijski moždani udar, istraživanja su pokazala da zajednički učinak više kroničnih upalnih stanja može povećati rizik od nastanka ateroskleroze i moždanog udara. Taj dokaz o interakcijama između kroničnih infekcija ističe parodontitis kao mogući čimbenik koji pridonosi nastanku ishemijskoga moždanog udara (24).

Autori mnogobrojnih studija istraživali su ulogu oralnog zdravlja u nastanku ishemijskoga moždanog udara te ističu da se njihova istraživanja razlikuju u metodologiji, alatima procjene oralnoga zdravlja i smjeru povezanosti između dviju bolesti. Ono što im je svima zajedničko jest pretpostavka da parodontna bolest koja se pojavljuje u usnoj šupljini može djelovati sistemski (25). Socioekonomski, bihevioralni i demografski čimbenici uključeni su u ovu studiju u skladu sa standardima za prijavljivanje prevalencije i težine kroničnoga parodontitisa u epidemiološkim studijama (26). Navedeni čimbenici nisu pokazali značajne razlike između bolničke i kontrolne skupine što je dijelom prouzročeno kriterijima uključivanja koji su korišteni pri formiranju kontrolne skupine.

Gubitak zuba povezan je s nastankom moždanoga udara u više studija (27 – 30). Parodontitis je dokazani uzrok gubitka zuba (31). Budući da izgubljeni zubi više nisu bili dostupni za pregled, ovi bi nalazi mogli dodatno spriječiti smislenu usporedbu podcjenjujući učinak parodontne bolesti koja je kronična te se pacijentima vjerojatno pojavila prije ishemijskoga moždanog udara (32 – 34). Druga istraživanja dokazala su da pacijenti s manje od 23 zuba imaju veći rizik za nastanak ishemijskoga moždanog udara od onih s 28 i više zuba (35). Kriteriji za uključivanje u ovu studiju bili su 15 ili više zuba u zubnome nizu. Zbog toga autori ove studije nisu mogli istražiti navedenu hipotezu s obzirom na to da su samo dva pacijenta, od ukupno njih 42, pripadala u kategoriju s 28 ili više zuba. Iako je kontrolna skupina imala veći prosječni broj zuba (22,05 prema 20,10), ta razlika nije se pokazala statistički značajnom (p = 0,136) zbog malog uzorka pacijenata i velikih varijacija unutar skupina.

PISA i PESA vrijednosti bile su više u kontrolnoj skupini u usporedbi s bolničkom skupinom, iako su bile samo granično statistički značajne (p = 0,069 i p = 0,065). Postoji mogućnost da se ta razlika pojavila zbog visoke korelacije (R = 0,828) između broja zuba i vrijednosti PISA-e i PESA-e. Ako se uzme u obzir da je kontrolna skupina imala veći prosječni broj zuba, imala je i veće PISA i PESA vrijednosti od bolničke skupine. Iz toga proizlazi da se granično značajne razlike u PISA i PESA vrijednostima mogu pripisati fundamentalnoj varijabli u podlozi, konkretno broju zuba.

Kvaliteta života povezana s oralnim zdravljem (OHQL) vrlo je subjektivni pojam. Unatoč tomu, loše oralno zdravlje može ometati osnovne vitalne funkcije poput prehrane, gutanja, govora i disanja (36). Rezultati istraživanja oralnoga zdravlja i kvalitete života u ovoj studiji pokazuju statistički značajno bolju kvalitetu života u kontrolnoj skupini (p = 0,003). Također, naglašena negativna korelacija sa Spearmanovim koeficijentom korelacije od -0,628 ($p < 0,001$) utvrđena je između PESA-e i OHQL. To je u skladu s nalazima prethodne studije u kojoj je istaknuta negativna korelacija

tal epithelial surface area (PESA) and OHQL in a previous study, and supports the notion that tooth loss and edentulism represent one of the least favorable conditions for oral health (37). Interestingly, there was no significant correlation between PISA and OHQL. This lack of correlation may be explained by the consideration that the severity of chronic periodontal disease increases PISA scores (due to a higher overall inflammatory burden) when the number of teeth is maintained, but the progression of periodontitis over a period of time eventually decreases PISA scores as overall PESA decreases due to tooth loss. When a sample of subjects with a wide range of tooth loss is evaluated, as in the present study, the severity of periodontitis may not be accurately reflected in an increase in PISA scores because this increase is counteracted by the effect of more severe periodontitis, which reduces the number of teeth. Such an effect of tooth loss on the available epithelial surface (either inflamed or not) was highly pronounced in our study, as shown by the results for PESA, where the maximum values were about twice as high as the minimum values. Subsequently, more severe periodontitis is expected to increase the OHQL score, leading to a positive correlation between PISA and OHQL, but only if the number of teeth remains constant. If the PISA score decreases due to tooth loss, the expected positive correlation between PISA and OHQL is masked by the overall effect of tooth loss on the decrease in PISA and PESA. Similarly, the significant negative correlation of PESA with patient age (ρ=-0.408, p=0.007) is due to elderly subjects experiencing greater tooth loss.

Full-mouth plaque scores (FMPS) were significantly higher in the hospital group, which is consistent with other recent studies that have shown similar results and reveal the need for professional help in maintaining oral hygiene for stroke patients recovering in a hospital setting (38). It has been reported that 50% of stroke patients are unable to perform daily tasks independently (39). Adaptation, regeneration, and neuroplasticity of the brain tissues happen mostly in the first 3-6 months. Unfortunately, if affected, dominant hand movement recovery is often prolonged leading to inadequate oral hygiene (40). The average CAL and PPD did not significantly differ between the control group and the hospital group. When averaged, these variables provide little insight into the true extent of periodontal disease, as the contribution of a single deep pocket is diluted by a disproportionately large number of sites with normal PPD and CAL. Although both groups had statistically similar number of teeth, it should be noted that the number of teeth varied widely within each group, with values (min-max) of 15-27 in the control group and 14-28 in the hospital group. This within-groups variability had a stronger influence on PISA and PESA than other factors, diminishing the effect size of other, subtler factors and making it more difficult to detect statistically significant effects. In fact, most of the statistically significant differences in PESA values found among the different subgroups of subjects are due to variability in the number of teeth. For example, the significant difference in PESA for educational level (elementary school < high school < university degree) most likely reflects the positive relationizmeđu PESA vrijednosti i OHQL-a i ide u prilog zaključku da je gubitak zuba iznimno negativan ishod za oralno zdravlje (37). Zanimljivo je da nije postojala statistički značajna razlika između PISA-e i OHQL-a. Taj nedostatak korelacije može se objasniti činjenicom da ozbiljnost kronične parodontne bolesti povećava PISA vrijednosti (zbog većega ukupnoga upalnog opterećenja) kada se broj zuba održava, ali progresija parodontitisa tijekom godina na kraju smanjuje PISA vrijednosti jer se ukupna PESA smanjuje zbog gubitka zuba. Kada se procjenjuje uzorak ispitanika sa širokim rasponom gubitka zuba, kao u ovoj studiji, ozbiljnost parodontitisa možda se neće točno odraziti na povećanje PISA vrijednosti jer je to povećanje neutralizirano učinkom težine parodontitisa koji smanjuje broj zuba. Taj utjecaj gubitka zuba na prisutnu epitelnu površinu (s upalom ili bez nje) bio je vrlo izražen u ovoj studiji, kao što pokazuju rezultati PISA-e – najveće vrijednosti bile su dva puta veće od minimalnih. Kao posljedica može se očekivati da će teži oblik parodontitisa povećati rezultate na OHQL testu, što dovodi do pozitivne korelacije između PISA-e i OHQL-a, ali samo uz uvjet da broj zuba ostane konstantan. Ako se PISA vrijednost smanji zbog gubitka zuba, gubi se očekivana pozitivna korelacija zbog učinka gubitka zuba na smanjenje PISA i PESA vrijednosti. Slično se značajna negativna korelacija PESA-e s dobi pacijenata (ρ = -0,408, p = 0,007) može objasniti činjenicom da što je pacijent stariji, to je vjerojatnije je da će se pojaviti gubitak zuba.

FMPS rezultati bili su značajno veći u bolničkoj skupini, što je u skladu s drugim studijama u kojima su postignuti slični rezultati, te je zaključeno da je pacijentima koji se oporavljaju u bolničkom okruženju potrebna profesionalna pomoć u održavanju oralne higijene (38). Naime, 50 % pacijenata koji se preboljeli ishemijski moždani udar nisu u mogućnosti samostalno obavljati svakodnevne zadatke (39). Adaptacija, regeneracija i neuroplastičnost moždanih tkiva traje većinom prvih 3 do 6 mjeseci. Kako je oporavak pokretnosti dominantne ruke često prolongiran, to rezultira neodgovarajućom oralnom higijenom (40). Prosječne CAL i PPD vrijednosti nisu se značajno razlikovale između kontrolne i bolničke skupine. U prosjeku te varijable ne daju jasan uvid u pravo stanje parodontne bolesti jer je postojanje jednoga dubokoga parodontnog džepa umanjeno disproporcionalno većim brojem mjesta s normalnim CAL i PPD vrijednostima. Iako su obje skupine imale statistički sličan broj zuba, potrebno je istaknuti da je broj zuba uvelike varirao unutar samih skupina, s vrijednostima (minimalna – maksimalna) od 15 do 27 u kontrolnoj skupini i od 14 do 28 u bolničkoj. Ta varijabilnost unutar grupa znatnije je utjecala na PISA i PESA vrijednosti nego drugi čimbenici, smanjujući veličinu učinka drugih, suptilnijih čimbenika i otežavajući otkrivanje statistički značajnih učinaka. Zapravo, većina statistički značajnih razlika u vrijednostima PESA-e pronađenih među različitim podskupinama ispitanika, posljedica je varijabilnosti u broju zuba. Na primjer, značajna razlika u PESA vrijednostima, s obzirom na razinu obrazovanja (osnovna škola < srednja škola < fakultet), najvjerojatnije pokazuje pozitivan odnos između broja zuba i više razine obrazovanja. Na isti način, značajna razlika u PESA vrijednostima između umirovljenih i zaposle-

ship between the number of teeth and higher educational level. In the same manner, the significant difference in PESA between retired and employed subjects is due to the differences in the number of teeth. The effect of tooth loss can also be observed in the ranking of significantly different PESA values according to the stage of periodontitis, with PESA increasing with periodontitis stages 1 < 2 < 3, peaking at stage 3, and then decreasing significantly towards stage 4. The increase from stage 1 to stage 3 is due to the increased epithelial exposure at higher stages, while the decrease observed with the progression of periodontitis from stage 3 to stage 4 is due to the fact that tooth loss in stage 4 subjects counteracts the overall epithelial exposure, resulting in a net decrease in PESA. This tendency of more severe periodontitis to not accurately reflect the intensity of inflammation in PISA was very pronounced in the present study, and is most likely the cause of the inability of the analysis to detect significant effects of various factors on PISA scores.

Patients with ischemic stroke had a worst periodontal status than their healthy counterparts; 42. 9% of hospital group of patients were affected by severe periodontal disease (stage IV) in this exploratory study, which is in line with studies that were conducted on other populations with the same diagnosis (41).

Low-density lipoprotein (LDL) and cholesterol levels showed a statistically significant negative correlation with PISA. This was a surprising result, as elevated LDL and cholesterol levels are usually associated with pro-inflammatory conditions (42). Nevertheless, the negative correlation of LDL and cholesterol levels with PISA observed in our hospital group subjects might have been influenced by the use of statins in lipid-lowering therapy for the prevention of recurrent stroke based on the Stroke Prevention by Aggressive Reduction in Cholesterol Level Trial (43). Another significant negative correlation was observed between PISA and smoking (ρ = -0.469, p = 0.002), which can be explained by the local vasoconstrictive effect of smoking (44).

Despite the significantly higher FMPS in the hospital group compared to the control group (27.57 vs. 16.83, respectively), an inverse result was found for full mouth bleeding score (FMBS), which was statistically higher in the control group (10.17) than in the hospital group (6.42). As the presence of dental plaque is etiologically strongly associated with gingival bleeding (45), our results of more plaque but less bleeding in the hospital group seem contradictory. Nevertheless, a possible reason for this apparent inconsistency could be found in the increased preventive use of antibiotics in critical care patients as infection is one of the most common post-stroke complications and contributes significantly to the death rate (46). Studies have shown that the systemic use of penicillin and metronidazole exhibited a significant statistical and clinical BOP reduction in short and intermediate-term (47). The same reasoning may explain the marginally significant (p=0.065) result of higher PISA scores in the control group compared to the hospital group.

nih ispitanika posljedica je razlika u broju zuba. Učinak gubitka zuba također se može uočiti u rangiranju značajno različitih PESA vrijednosti prema stadiju parodontitisa, pri čemu PESA raste sa stadijima parodontitisa 1 < 2 < 3, dostiže vrhunac u stadiju 3, a zatim znatno opada prema stadiju 4. Povećanje od stadija 1 do 3 posljedica je povećane eksponiranosti epitela u višim stadijima, a smanjenje uočeno s progresijom parodontitisa od stadija 3 do 4 posljedica je činjenice da gubitak zuba kod ispitanika u stadiju 4 umanjuje ukupnu eksponiranost epitela, što je rezultiralo neto smanjenjem PESA-e. Ta tendencija ozbiljnijeg parodontitisa da ne odražava točno intenzitet upale u PISA-i bila je vrlo izražena u ovoj studiji i najvjerojatnije je uzrok nemogućnosti analize da otkrije značajne učinke različitih čimbenika na PISA vrijednosti.

Pacijenti s ishemijskim moždanim udarom imali su lošiji parodontni status u odnosu na ispitanike kontrolne skupine. U ovoj eksploratornoj studiji 42,9 % pacijenata u bolničkoj skupini bilo je zahvaćeno teškom parodontnom bolesti (stadij 4), što je u skladu sa studijama provedenima na drugim populacijama s istom dijagnozom (41).

Razina LDL-a i kolesterola pokazala je statistički značajnu negativnu korelaciju s PISA vrijednostima. Taj je nalaz iznenadio jer su povišene razine LDL-a i kolesterola uobičajno povezane s proupalnim procesima (42). Unatoč tomu, na negativnu korelaciju LDL-a i razine kolesterola s PISA-om, uočenu kod ispitanika iz bolničke skupine, mogla je utjecati upotreba statina u terapiji snižavanja lipida za prevenciju ponovnoga moždanog udara na temelju *Stroke Prevention by Aggressive Reduction in Cholesterol Level Triala* (43). Još jedna značajna negativna korelacija pronađena je između PISA-e i pušenja (ρ = -0469, p = 0,002), a može se objasniti lokalnim vazokonstriktivnim djelovanjem pušenja (44).

Unatoč statistički značajno višim vrijednostima FMPS-a u bolničkoj skupini u usporedbi s kontrolnom (27,57 prema 16,83), inverzni rezultat utvrđen je za FMBS koji je bio statistički veći u kontrolnoj skupini (10,17) nego u bolničkoj (6,42). Dentalni plak etiološki je povezan s krvarenjem gingive (45) pa se rezultati istraživanja koji pokazuju veću prisutnost plaka i manje krvarenja čine kontradiktornima. Mogući uzrok može se pronaći u preventivnom korištenju antibiotika kod pacijenata na intenzivnim i postintenzivnim odjelima, jer je infekcija jedan od najznačajnijih kontributora mortalitetu i komplikacijama poslije moždanoga udara (46). U studijama je istaknuto da se sistemskim djelovanjem penicilina i metronidazola postiže značajno kratkoročno i srednjeročno kliničko i statističko smanjenje BOP-a (47). Isti zaključak može se primijeniti i na marginalno značajni rezultat (p = 0,065) viših PISA vrijednosti u kontrolnoj skupini nego u bolničkoj.

Conclusion

Tooth loss due to advanced periodontal disease combined with oral hygiene limitations remains the most significant obstacle for a more meaningful understanding of data represented by specific parameters that characterize the two diseases investigated in this study. Therefore, further studies on a larger sample size of patients with periodontitis stage 1-3 are required.

Conflict of interest: The authors declare no conflict of interest.

Author's contribution: **V.R.** – performed the research; **A.L.H.** and **I.P.** – supervised the research; **V.R., A.L.H.** and **I.P.** – wrote the manuscript. All the authors discussed, reviewed, and approved the contents within the manuscript.

Zaključak

Gubitak zuba zbog napredovale parodontne bolesti, u kombinaciji s ograničenjima oralne higijene, ostaje najznačajnija prepreka za smislenije razumijevanje podataka koji su prikazani specifičnim parametrima koji karakteriziraju dvije bolesti istraživane u ovoj studiji. Stoga su potrebna daljnja istraživanja na većem uzorku pacijenata s parodontitisom stadija 1–3.

Sukob interesa: Autori nisu bili u sukobu interesa.

Doprinos autora: **V. R.** – istraživanje; **A. L. H.** i **I. P.** – nadzor istraživanja; **V. R., A. L. H.** i **I. P.** – pisanje teksta. Svi autori pregledali su i odobrili tekst.

Sažetak

Cilj: Željelo se procijeniti parametre parodontne bolesti kod bolesnika s ishemijskim moždanim udarom. **Materijali i metode:** Istraživanje je obuhvatilo 21 bolesnika s ishemijskim moždanim udarom i kontrolnu skupinu ujednačenu prema broju, dobi i spolu. Svi sudionici bili su podvrgnuti standardnom parodontološkom pregledu. Kriterij za uključivanje bilo je najmanje 15 preostalih zuba. Određena je također površina parodontnog epitela, površina parodontne upale (PISA) i stadij parodontne bolesti. Svi sudionici dobili su upitnik za određivanje kvalitete života povezane s oralnim zdravljem (OHQL). Procijenjeni su čimbenici rizika za moždani udar. **Rezultati:** Bolesnici s moždanim udarom imali su znatno viši rezultat OHQL-a od kontrolne skupine (20,81 prema 12,57) i indeks plaka (FMPS, 27,57 prema 16,83), a indeks krvarenja (FMBS) bio je znatno viši u kontrolnoj skupini nego u bolničkoj (10,17 prema 6,42). Za PISA-u su utvrđene statistički značajne negativne korelacije za pušenje, razinu kolesterola i razinu LDL-a, a značajne pozitivne korelacije nađene su za FMBS, razinu kliničkoga pričvrstka i dubinu sondiranja. **Zaključak:** Gubitak zuba zbog napredovale parodontne bolesti, u kombinaciji s ograničenjima oralne higijene, ostaje najznačajnija prepreka za smislenije razumijevanje podataka koji su prikazani specifičnim parametrima koji karakteriziraju dvije bolesti istraživane u ovoj studiji. Potrebna su daljnja istraživanja na većem uzorku pacijenata s parodontitisom stadija 1–3.

Zaprimljen: 23. travnja 2024.
Prihvaćen: 1. lipnja 2024.

Adresa za dopisivanje
Ivan Puhar
Sveučilište u Zagrebu
Stomatološki fakultet
Zavod za parodontologiju
Gundulićeva 5, 10 000 Zagreb,
Hrvatska
tel: +385 14899219
puhar@sfzg.hr

MeSH pojmovi: parodontitis; ishemijski moždani udar; debljina stijenke karotidne arterije; kvaliteta života; čimbenici rizika
Autorske ključne riječi: parodontitis, ishemijski moždani udar, debljina karotidne intime-medije, kvaliteta života

References

1. Eke PI, Thornton-Evans GO, Wei L, Borgnakke WS, Dye BA, Genco RJ. Periodontitis in US Adults: National Health and Nutrition Examination Survey 2009-2014. J Am Dent Assoc. 2018 Jul;149(7):576-88.
2. Burt B; Research, Science and Therapy Committee of the American Academy of Periodontology. Position paper: epidemiology of periodontal diseases. J Periodontol. 2005 Aug;76(8):1406-19.
3. Kinane DF, Stathopoulou PG, Papapanou PN. Periodontal diseases. Nat Rev Dis Primers. 2017 Jun 22;3:17038.
4. Bosnjak A, Plancak D, Curilovic Z. Advances in the relationship between periodontitis and systemic diseases. Acta Stomatol Croat. 2001;35(2):267–71.
5. Vitkov L, Singh J, Schauer C, Minnich B, Krunić J, Oberthaler H, et al. Breaking the Gingival Barrier in Periodontitis. Int J Mol Sci. 2023 Feb 25;24(5):4544.
6. Ribeiro CCC, Carmo CDS, Benatti BB, Casarin RVC, Alves CMC, Nascimento GG, Moreira ARO. Systemic circulating inflammatory burden and periodontitis in adolescents. Clin Oral Investig. 2021 Oct;25(10):5855-65.
7. Meriç P, Silbereisen A, Emingil G, Öztürk VÖ, Bostanci N. Clinical, oral immunological and microbiological shifts during and after pregnancy. Clin Oral Investig. 2023 Dec 29;28(1):60.
8. Ledić K, Marinković S, Puhar I, Spalj S, Popović-Grle S, Ivić-Kardum M, Samarzija M, Plancak D. Periodontal disease increases risk for chronic obstructive pulmonary disease. Coll Antropol. 2013 Sep;37(3):937-42.
9. Shinjo T, Nishimura F. The bidirectional association between diabetes and periodontitis, from basic to clinical. Jpn Dent Sci Rev. 2024 Dec;60:15-21.
10. Moriya J. Critical roles of inflammation in atherosclerosis. J Cardiol. 2019 Jan;73(1):22–7.
11. Sato A, Arai S, Sumi K, Fukamachi H, Miyake S, Ozawa M, et al. Metagenomic Analysis of Bacterial Microflora in Dental and Atherosclerotic Plaques of Patients With Internal Carotid Artery Stenosis. Clin Med Insights Cardiol. 2024 Feb 6;18:11795468231225852.
12. Nesse W, Abbas F, Van Der Ploeg I, Spijkervet FK, Dijkstra PU, Vissink A. Periodontal inflamed surface area: Quantifying inflammatory burden. J Clin Periodontol. 2008;35(8):668–73.
13. Tonetti MS, Jepsen S, Jin L, Otomo-Corgel J. Impact of the global burden of periodontal diseases on health, nutrition and wellbeing of mankind: A call for global action. J Clin Periodontol. 2017 May;44(5):456-62.
14. Molina A, Huck O, Herrera D, Montero E. The association between respiratory diseases and periodontitis: A systematic review and meta-analysis. J Clin Periodontol. 2023 Jun;50(6):842-87.
15. Vražić D, Miovski Z, Strozzi M, Puhar I, Badovinac A, Božić D, et al. Periodontal disease and its association with angiographically verified coronary artery disease. Acta Stomatol Croat. 2015 Mar 15;49(1):14–20.
16. Puhar I, Lovrenčić-Huzjan A, Šodec-Šimičević D, Strineka, M, Božić D, Plančak, D. Carotid intima-media thickness in patients with chronic and aggressive periodontitis. Acta Stomatol Croat. 2012;46(4):255-62.
17. Dorairaj Prabhakaran, Shuchi Anand, Thomas A Gaziano, Jean-Claude Mbanya, Yangfeng Wu et al. Cardiovascular, Respiratory, and Related Disorders, 3rd edition. Washington (DC): The International Bank for Reconstruction and Development / The World Bank; 2017.
18. Saini V, Guada L, Yavagal DR. Global Epidemiology of Stroke and Access to Acute Ischemic Stroke Interventions. Neurology. 2021 Nov 16;97(20 Suppl 2):S6-S16.

19. Guzik A, Bushnell C. Stroke epidemiology and risk factor management. Continuum (Minneap. Minn.). 2017;23(1):15–39.
20. Ekker MS, Verhoeven JI, Schellekens MMI, Boot EM, van Alebeek ME, Brouwers PJAM, et al. Risk Factors and Causes of Ischemic Stroke in 1322 Young Adults. Stroke. 2023 Feb;54(2):439-47.
21. Costea CA, Christodorescu R, Soancă A, Roman A, Micu IC, Stratul ȘI, et al. Periodontitis in Ischemic Stroke Patients: Case Definition Challenges of the New Classification Scheme (2018). J Clin Med. 2022 Jan 20;11(3):520.
22. Caton JG, Armitage G, Berglundh T, Chapple ILC, Jepsen S, Kornman KS, et al. A new classification scheme for periodontal and peri-implant diseases and conditions - Introduction and key changes from the 1999 classification. J Periodontol. 2018 Jun;89 Suppl 1:S1-S8.
23. Chen PH, Gao S, Wang YJ, Xu AD, Li YS, Wang D. Classifying Ischemic Stroke, from TOAST to CISS. CNS Neurosci Ther. 2012 Jun;18(6):452-6.
24. Meschia JF, Bushnell C, Boden-Albala B, Braun LT, Bravata DM, Chaturvedi S, et al. Guidelines for the primary prevention of stroke. Stroke. 2014 Dec;45(12):3754–832.
25. Leira Y, Seoane J, Blanco M, Rodríguez-Yáñez M, Takkouche B, Blanco J, et al. Association between periodontitis and ischemic stroke: A systematic review and meta-analysis. Eur J Epidemiol. 2016 Jun 14;32(1):43–53.
26. Holtfreter B, Albandar JM, Dietrich T, Dye BA, Eaton KA, Eke PI, et al. Standards for reporting chronic periodontitis prevalence and severity in epidemiologic studies. J Clin Periodontol. 2015 May;42(5):407–12.
27. Del Brutto OH, Mera RM, Zambrano M, Del Brutto VJ. Severe edentulism is a major risk factor influencing stroke incidence in rural Ecuador (The Atahualpa Project). Int J Stroke. 2017 Feb;12(2):201-4.
28. Fagundes NCF, Couto RSD, Brandão APT, Lima LAO, Bittencourt LO, Souza-Rodrigues RD, et al. Association between Tooth Loss and Stroke: A Systematic Review. J Stroke Cerebrovasc Dis. 2020 Aug;29(8):104873.
29. You Z, Cushman M, Jenny NS, Howard G; REGARDS. Tooth loss, systemic inflammation, and prevalent stroke among participants in the reasons for geographic and racial difference in stroke (REGARDS) study. Atherosclerosis. 2009 Apr;203(2):615-9.
30. Lee HJ, Choi EK, Park JB, Han KD, Oh S. Tooth Loss Predicts Myocardial Infarction, Heart Failure, Stroke, and Death. J Dent Res. 2019 Feb;98(2):164-70.
31. Haworth S, Shungin D, Kwak SY, Kim HY, West NX, Thomas SJ, et al. Tooth loss is a complex measure of oral disease: Determinants and methodological considerations. Community Dent Oral Epidemiol. 2018 Dec;46(6):555-562.
32. Sen S, Giamberardino LD, Moss K, Morelli T, Rosamond WD, Gottesman RF, et al. Periodontal Disease, Regular Dental Care Use, and Incident Ischemic Stroke. Stroke. 2018 Feb;49(2):355-62.
33. Leira Y, Vivancos J, Diz P, Martín Á, Carasol M, Frank A. The association between periodontitis and cerebrovascular disease, and dementia. Scientific report of the working group of the Spanish Society of Periodontology and the Spanish Society of Neurology. Neurologia (Engl Ed). 2024 Apr;39(3):302-11
34. Pradeep AR, Hadge P, Arjun Raju P, Shetty SR, Shareef K, Guruprasad CN. Periodontitis as a risk factor for cerebrovascular accident: a case-control study in the Indian population. J Periodontal Res. 2010 Apr;45(2):223-8.
35. Oluwagbemigun K, Dietrich T, Pischon N, Bergmann M, Boeing H. Association between Number of Teeth and Chronic Systemic Diseases: A Cohort Study Followed for 13 Years. PLoS One. 2015 May 6;10(5):e0123879.
36. Haag DG, Peres KG, Balasubramanian M, Brennan DS. Oral Conditions and Health-Related Quality of Life: A Systematic Review. J Dent Res. 2017 Jul;96(8):864-74.
37. Kassebaum NJ, Smith AGC, Bernabé E, Fleming TD, Reynolds AE, Vos T, et al; GBD 2015 Oral Health Collaborators. Global, Regional, and National Prevalence, Incidence, and Disability-Adjusted Life Years for Oral Conditions for 195 Countries, 1990-2015: A Systematic Analysis for the Global Burden of Diseases, Injuries, and Risk Factors. J Dent Res. 2017 Apr;96(4):380-387.
38. Lupi SM, Pascadopoli M, Maiorani C, Preda C, Trapani B, Chiesa A, Esposito F, Scribante A, Butera A. Oral Hygiene Practice among Hospitalized Patients: An Assessment by Dental Hygiene Students. Healthcare (Basel). 2022 Jan 6;10(1):115.
39. O'Dell MW. Stroke rehabilitation and motor recovery. Continuum (Minneap. Minn.). 2023 Apr;29(2):605–27.
40. Belagaje SR. Stroke rehabilitation. Continuum (Minneap Minn). 2017 Feb;23(1):238–53.
41. Sen S, Curtis J, Hicklin D, Nichols C, Glover S, Merchant AT, et al. Periodontal disease treatment after stroke or transient ischemic attack: The Premiers study, a randomized clinical trial. Stroke. 2023 Sept;54(9):2214–22.
42. Rufail ML, Schenkein HA, Koertge TE, Best AM, Barbour SE, Tew JG, et al. Atherogenic lipoprotein parameters in patients with aggressive periodontitis. Journal of Periodontal Research. 2007 May 18;42(6):495–502.
43. Amarenco P, Bogousslavsky J, Callahan A 3rd, Goldstein LB, Hennerici M, Rudolph AE, et al; Stroke Prevention by Aggressive Reduction in Cholesterol Levels (SPARCL) Investigators. High-dose atorvastatin after stroke or transient ischemic attack. N Engl J Med. 2006 Aug 10;355(6):549-59.
44. Silva H. Tobacco Use and Periodontal Disease-The Role of Microvascular Dysfunction. Biology (Basel). 2021 May 17;10(5):441.
45. Reiniger AP, Maier J, Wikesjö UM, Moreira CH, Kantorski KZ. Correlation between dental plaque accumulation and gingival health in periodontal maintenance patients using short or extended personal oral hygiene intervals. J Clin Periodontol. 2021 Mar 23;48(6):834–42.
46. Rashid MH, Kabir A, Waris MU, Salman U, Zain S. Role of Prophylactic Antibiotics in Critical Care of Stroke Patients - A Preventive Approach to Post-stroke Infections? Cureus. 2020 Mar 2;12(3):e7158.
47. Kherul Anuwar AH, Saub R, Safii SH, Ab-Murat N, Mohd Taib MS, Mamikutty R, et al. Systemic antibiotics as an adjunct to subgingival debridement: A network meta-analysis. Antibiotics. 2022 Nov 28;11(12):1716.