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Obesity and Oral Health – Is There an Association?

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A B S T R A C T

Obesity has been associated with several chronic diseases, such as coronary heart disease, stroke, adverse pregnancy outcomes, diabetes, and mortality; however it has not been until recently that an increased body mass index (BMI) was also related to dental health, especially periodontitis. We conducted a research to determine whether oral health was related to BMI using a cross-sectional design. Of 320 non-smoking subjects aged 31–60 years recruited from the patients referred to Dental Clinic at the Clinical Hospital Center in Rijeka, Croatia, a detailed dental health status was completed for 292 subjects. Measurements of weight and height, education level and frequency of toothbrushing were also recorded. Dental index comprising information on caries, periodontitis, periapical lesions, and missing teeth was used as a measure of dental health. Dental index and education level both correlated significantly with BMI, however for the dental index this correlation was rather weak. The same could not be proven for the frequency of tooth brushing. Multivariate linear analysis showed that BMI was most dependent upon the number of missing teeth (88.6%), followed by the number of carious lesions (8.3%). Persons with an increased BMI had slightly worse dental health, as represented by higher dental index, regardless of their toothbrushing routines, and lower levels of education. Prevention programs should aim at rising both the general health awareness and improving oral health.

***Key words**: adults, dental health, diet, oral hygene, tooth loss*

Introduction

Ever since the breakthrough study led by Mattila et al. in 1989[1], the scientific community has been intrigued by a possible association between oral conditions and systemic outcomes. Several diseases deserved attention: coronary heart disease, stroke, adverse pregnancy outcomes, diabetes, but also mortality[2]. Commonly postulated mediators included infection, chronic inflammation, and genetic predisposition to both oral and systemic disease. Nutrition was also mentioned, but only as an alternative mediator[3]. Several studies have established associations between nutrient intake and systemic diseases, and many of them proved that certain dietary patterns can reduce cardiovascular disease risk. Furthermore, it was proved that saturated fats may play role in increasing risk for breast and colorectal cancer[4–6].

However, studies addressing the possible association of nutritional status and oral health yielded conflicting results. In studies where only periodontitis was studied (as a component of oral health), some authors found increased odds ratio of periodontal disease for obese subjects[7–12], while in some studies the statistical significance of such findings was limited to younger adults[13,14]. When tooth loss was analyzed, results were more uniform: it could be concluded that the greater number of missing teeth and fewer occluding pairs of teeth meant increased body mass index (BMI), at least in free-living population of people[15,16]. Very few studies were performed on possible relation between obesity and dental caries in adults[8,17], as well as obesity and overall dental health[18,19]. Again conflicting results were obtained: obesity alone could not be used as predictor of dental decay, but nevertheless poor oral health was often found in obese persons.

Relationship between oral health and obesity may go two ways: oral infectious diseases (caries, periodontitis, periapical lesions such as granulomas and periapical abscesses) impact the functional ability to eat leading to changes in diet displacing nutrient-dense foods and favoring softer foods rich in sugars and saturated fats, finally promoting conditions such as obesity[20,21]. On the other hand, obesity is often marked by an imbalanced diet rich in sugars which stimulate the growth of cariogenic bacteria, such as *lactobacilli* and *mutans streptococci* and favoring development of carious leasions.[22] Obesity has also been associated with an impaired im-

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mune response and increased risk for infectious diseases such as periodontitis[23]. Therefore, we conducted this investigation to determine whether there were associations between obesity (expressed through BMI) and overall oral health (as represented by dental index) in a homogenous group of Eastern European non-smoking, non-diabetic men and women aged 31–60 years.

Patients and Methods

This study has been designed as a cross-sectional. Sample size was calculated for each analyzed factor (frequency of toothbrushing, education level, number of missing teeth and dental index) upon completion of a pilot study undertaken on a sample of 50 patients. It was calculated that minimum 100 patients were necessary to form a representative sample. The study subjects were recruited from the patients who came consecutively to the Dental Clinic, Clinical Hospital Centre in Rijeka, Croatia, which with its specialist care covers the area of three Croatian counties (including both urban and rural areas). Inclusion criteria applied were the age 31–60 years, independent living status, willingness to participate in the investigation, and possession of orthopantomogram not older than 3 months (no new orthopantomograms were taken solely for the study purposes, due to risks posed by radiation). Exclusion criteria applied were smoking (for previous smokers inclusion criterion was non-smoking status for at least 5 years), presence of neoplasms, autoimmune diseases, pregnant women, and chronic diseases which are known to be confounders for periodontitis (such as coronary heart disease, diabetes, and cerebrovascular disease). Between September 2008 and June 2009 a total of 320 patients of both genders (mean age 48.9±11.4 years) were recruited. Total of 17 patients refused participation due to personal reasons. Full clinical dental examination was completed for 292 subjects, 159 women (54.5%) and 133 (45.5%) men – the remainder of the sample included persons who were either edentulous or refused probing. Measurements of weight and height were performed using a hard ruler set vertically and secured with a stable base and a digital scale, both certified by the Croatian State Office for Standardization and Metrology. Education level and frequency of toothbrushing were also recorded as part of the questionnaire approved for this research by the Scientific Board of the Medical Faculty, University of Rijeka. The study protocol was independently reviewed and approved by the Research Ethics Committee of the Medical Faculty, University of Rijeka and research has been conducted in full accordance with ethical principles, including the World Medical Association Declaration of Helsinki (version VI, 2002). Subjects who agreed to participate signed an informed consent form, and at the conclusion of the study were provided with reports of their oral status and significant findings.

TABLE 1
SCHEME FOR CALCULATING THE DENTAL INDEX USED TO EVALUATE ORAL HEALTH

Type of disease	Score
Caries:	
No carious lesions	0
1–3 Carious lesions	1
4–7 Carious lesions	2
≥8 Carious lesions or retained roots	3
Periodontitis:	
None	0
CAL ≤4 mm	1
CAL 4–6 mm	2
CAL >6 mm, periodontal abscess	3
Number of periapical lesions:	
None	0
1	1
2	2
≥3	3
Tooth loss:	
None	0
1–3 missing teeth	1
4–7 missing teeth	2
≥8 missing teeth	3

CAL – clinical attachment loss

Obesity

BMI was used as an indicator of overweight/obesity; it was computed from weight in kilograms divided by square height in meters, and divided into 4 categories, according to the WHO[24]: underweight (BMI≤18.5 kg/m^2), normal weight (BMI 18.5 to 24.9 kg/m^2), overweight (BMI 25 to 29.9 kg/m^2), and obese (BMI≥30 kg/m^2). Two subjects were classified as underweight and these were excluded from the study.

Oral health status

In order to assess oral health status, every tooth was inspected by a single examiner (JP) both clinically and radiographically¸ using recent (<3 months) orthopantomograms, for the presence of carious lesions, severity of periodontitis, presence of periapical lesions, furcation involvement, pericoronitis, and periodontal abscess; the number of missing teeth and retained roots was also recorded. The arithmetic sum of the scores which explained the severity of dental disease formed the »dental index«, based on previously published papers by Mattila et al.[25] and Janket et al.[26] (Table 1).

Statistical analysis

Statistical analysis of data was performed by using Statistica for Windows, release 8.1 (Stasoft, INC., Tulsa, OK, USA). The data on dental index were presented as the mean ± standard deviation (SD). For these results we used one-way analysis of variance (one-way ANOVA) to test the differences between groups according to category

TABLE 2
BASELINE CHARACTERISTICS ACCORDING TO THE CATEGORY OF BMI (ONE-WAY ANOVA)

Factor	Normal BMI <25	Overweight BMI 25–30	Obese BMI >30	Statistic
Toothbrushing frequency N, (%)				
Never	1 (1)	2 (1.4)	0 (0)	
Once a day	16 (16.8)	18 (12.7)	12 (21.8)	χ^2=1.22; p=0.544
Twice a day	51 (53.7)	81 (57)	25 (45.5)	χ^2=30.1; p=0.001*
More than twice a day	27 (28.4)	41 (28.9)	18 (32.7)	χ^2=9.37; p=0.009*
Education level N, (%)				
Elementary school or no schooling	16 (16.8)	34 (23.9)	20 (36.4)	χ^2=7.66; p=0.022*
High school diploma	53 (55.8)	74 (52.1)	32 (58.2)	χ^2=16.64; p=0.028*
Baccalaureate	10 (10.5)	19 (13.4)	2 (3.6)	χ^2=14.00; p=0.001*
College/university graduate, Master of science, or PhD	16 (16.8)	15 (10.6)	1 (1.8)	χ^2=13.18; p=0.001*
Dental index	$\overline{X}$±SD			
	16.0±10.3	18.2±8.1	19.4±9.6	F=2.77; p=0.064

*indicated significant difference between the groups according to category of BMI

of BMI. The analysis of the presence or degree of examined parameters was performed using Pearson χ^2-test. The correlation analysis was expressed by Pearson correlation coefficient for quantitative variables or Spearman correlation coefficient for qualitative variables. Multivariable analysis was performed using a linear regression model.

All statistical values were considered significant at the level set at $p<0.05$.

Results

In total, 292 subjects formed the basis for this investigation. There were 96 subjects (32.8%) with normal weight (BMI<25), 143 (49%) subjects who were overweight (BMI from 25 to 30), and 53 (18.1%) obese subjects (BMI>30). Statistical data regarding BMI category, and dental index and education level are presented in Table 2.

Both dental index and education level correlated significantly with BMI. However, the differences in mean dental index between persons with normal weight, those who were overweight and persons who were obese, using one-way ANOVA, were not statistically significant. Correlation between dental index and BMI is presented in Figure 1. The value of Spearman rank coefficient of correlation between education level and BMI was 0.203 ($p<0.005$).

Frequency of toothbrushing did not correlate significantly with BMI. Obese subjects did not brush their teeth less; in fact, they were most likely to brush their teeth more than twice a day. Value of Spearman rank coefficient of correlation between toothbrushing and BMI was 0.013 ($p>0.005$).

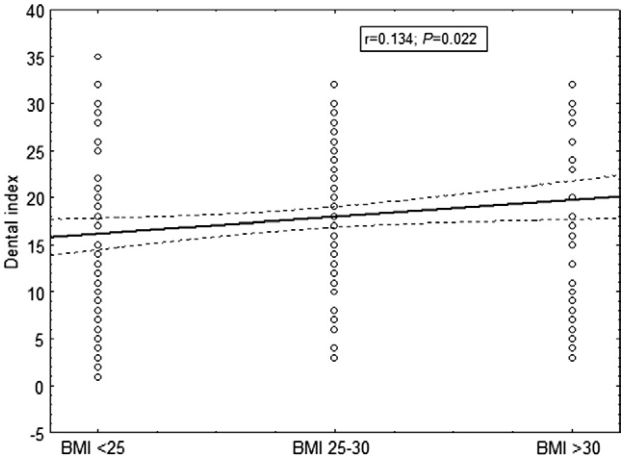

Fig. 1. Correlation between dental index and BMI. Correlation between dental index and category of BMI is positive and statistically significant (r=0.134; p=0.026).

Since the results showed that dental index correlated significantly to BMI, we wondered which components of dental index were the greatest contributors to this correlation. Multivariate linear regression showed that BMI was most dependent upon the number of missing teeth, followed by the number of carious lesions and severity of periodontal disease. Contribution of the number of periapical lesions was neglectable. The percent of contribution of each examined factor is presented in Table 3.

Discussion and Conclusion

The main finding of this study was that dental index and education level correlated significantly with BMI among non-smoking older adults, regardless of their

TABLE 3
THE PERCENT OF CONTRIBUTION OF EXAMINED FACTORS ON DENTAL INDEX (MULTIVARIATE LINEAR REGRESSION)

Factor	β	$SE_β$	p	r	The percent of contribution
Caries	0.148	0.001	<0.001	0.576	8.3
Periodontitis	0.115	0.001	<0.001	–0.321	3.6
Number of missing teeth	0.918	0.001	<0.001	0.974	87.7
Total number of periapical lesions	0.072	0.001	<0.001	–0.057	0.4

toothbrushing routines. However, significant association between category of BMI and mean dental index could not be proven, regardless of this significant, but weak correlation. This might be caused by the relatively large number of investigated subjects (when compared to calculated sample size). Of the examined dental index components, tooth loss was most strongly associated with BMI, followed by the number of carious lesions. These findings only partially agree with those from Sweden[27] where the investigators found a significant relationship between age and tooth loss, but only in those aged 30–60 years. Linden et al.[12] found that Northern Irish people aged 60–70 years who were obese had fewer teeth, had spent fewer years in full-time education and had poorer oral hygiene. In addition, Hilgert et al.[16] proved that in older Brazilian people (>60 years) edentulousness and dentition with 1–8 teeth were significantly associated with obesity. Different conclusions were drawn from the investigation led by Sheiham et al. within the National Diet and Nutrition Survey[28]; adults aged 65 years and older without teeth were significantly more likely to be underweight than those with 11 or more teeth. Furthermore, dentate people with less than 21 natural teeth were 2 times more likely to be obese than those with 21–32 teeth. Therefore the authors concluded that people with more than 20 were more likely to have a normal BMI.

There are very few published investigations relating the number of carious lesions to obesity in adults[29,30]. Tuomi[17] concluded that obesity alone could not be used as a predictor of dental decay. If measures of overall oral health were used, our findings may be correlated with those by Griffin et al.[18] who found that obesity was significantly associated with self-reported poor oral health. One of the investigations similar to our own was led recently by de Andrade et al. in Brazil[19]. The authors evaluated oral health using decayed-missing-filled teeth (DMFT) index, where the missing component accounted for 88.8% of the index, almost the same as in our investigation (88.6%), but the correlation between the number of DMF teeth and BMI was not significant. NHANES III study also used DMFT for analysis of possible relationship between obesity and oral health. Important conclusion was that the number of DMFT increased more rapidly with waist-to-hip ratios than with increasing BMI[8]. Our decision to use dental index as a measure of oral health was based on previously published investigations by Mattila et al.[25] and Janket et al.[26]. Mattila's total dental index and Janket's asymptotic dental score did not include only measures of caries visible upon oral examination, but also measures of periodontal disease and endo- dontic pathologies which required radiographic examination. These procedures gave us a more detailed insight into overall oral health.

It can be argued that poor oral health, and especially high number of missing teeth, leads to changes in nutrition and may therefore contribute to weight change, depending on age and population characteristics[31]. Oral disease epidemiology is obviously very complex and co--morbidity and socio-economic status may confound the nutrition-oral health association. In our and many other studies it was proved that lower education level also means greater BMI. It can be argued that possible prevention and education programs should therefore target this population, and measures to reduce obesity and treat oral infectious diseases should become a part of national health care programs, as advocated by the World Health Organization (www.who.int).

The strength of this investigation was selection of study participants, who were all non-smokers, and previous smokers had to comply with the criterion of non--smoking status for more than 5 years.This study however has a drawback: this was a cross-sectional study which did not allow us to gain an insight into progression of oral health – BMI relationship over time. Future investigations should be prospective longitudinal studies in non-smoking population with similar health awareness, and measures of obesity should include not only BMI but also waist circumference.

This investigation found that obese persons aged 31–-60 years had somewhat worse dental health, regardless of their toothbrushing routines, and lower levels of education. It is rather obvious that obesity alone can not be used as the sole predictor of oral health, and that many other factors, probably socio-economic in nature, may play a more important role then just dietary habits[32,33]. Whether oral conditions precede or follow weight change will certainly remain an open question for quite a while; in addition, it is still impossible to discern whether there is a direct causal relationship between oral health and obesity, or this correlation is merely accidental. Nevertheless, the present findings call for joint prevention programs by both general and specialist health practitioners on one side, and dental professionals on the other, aimed at raising the general health awareness and improving oral health.

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PREKOMJERNA TJELESNA TEŽINA I ZDRAVLJE USNE ŠUPLJINE – DA LI POSTOJI POVEZANOST?

SAŽETAK

Dokazano je da je prekomjerna tjelesna težina povezana s nekoliko kroničnih bolesti, kao što su koronarna srčana bolest, moždani udar, prerano rođenje djece niske porođajne težine, šećerna bolest, te smrtnost; ipak tek je nedavno utvrđena povezanost povećanog indeksa tjelesne mase (ITM) i zubnog zdravlja, posebice parodontitisa. Proveli smo presječno istraživanje kako bismo utvrdili da li je stanje usne šupljine povezano s ITM. Od ukupno 320 nepušača starosti 31–60 godina probranih iz skupine pacijenata upućenih na Kliniku za stomatologiju Kliničkog bolničkog centra u Rijeci, Hrvatska, detaljni zubni status je u potpunosti zabilježen kod 292 ispitanika. Također su zabilježeni podaci o visini i težini, stupnju obrazovanja te učestalosti četkanja zubi. Kao mjera zubnog zdravlja korišten je dentalni indeks koji je sadržavao podatke o rasprostranjenosti karijesa, parodontitisa, periapeksnih lezija te broja zubi koji nedostaju. Dentalni indeks te stupanj obrazovanja su oba značajno korelirali s ITM. Učestalost četkanja zubi nije bila statistički značajno povezana s ITM. Multivarijantna linearna analiza je pokazala da je ITM najviše ovisio o broju zuba koji nedostaju (88,6%), te broju karijesnih lezija (8,3%). Osobe s povećanim ITM su imale nešto lošije zubno zdravlje, izraženo dentalnim indeksom, bez obzira na četkanje zubi, te niži stupanj obrazovanja. Programi prevencije bi stoga trebali biti usmjereni ka podizanju svijesti o općem zdravlju kao i poboljšanju zdravlja usne šupljine.