

# ASSESSMENT OF THE ASSOCIATION BETWEEN DENTATE STATUS AND SELF-RATED GENERAL HEALTH

## OCENA POVEZANOSTI MED ZOBNIM STATUSOM IN SAMOOCENO SPLOŠNEGA ZDRAVJA

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### ABSTRACT

#### Keywords:

self-rated health,  
oral health, missing  
teeth, preserved teeth,  
public health policy

**Objective.** Aiming at preparing the basis for evidence-based dental public health policy making in Slovenia, the objective of the study was to assess the strength of association between oral health status measured by the number of missing teeth and self-rated health (SRH).

**Methods.** The study was designed as a pooled individual-level data study from four national cross-sectional studies carried out in the period 2001-2012, based on CINDI Health Monitor methodology. Altogether, 34,412 participants were included. A logistic regression model with poor SRH as observed outcome and the number of teeth as explanatory factor (adjusted for selected biologic, socio-economic and health factors) was proposed.

**Results.** In the sample, women represented 55.7% and men 44.3%, median age was 45 years. Persons with more missing teeth more likely rated their health as poor. The association was persistent even when different confounding variables were included in the model. In the group with 1-5 missing teeth, in comparison to the group with none missing teeth, OR was 1.23 ( $p=0.049$ ), whereas for the group with 6-10 missing teeth, OR was 1.32 ( $p=0.019$ ); for the group with >10 missing teeth, but not all, OR was 1.77 ( $p<0.001$ ), and for the group with all missing teeth, OR was 2.19 ( $p<0.001$ ).

**Conclusion.** Study results showed clear association of SRH with dentate status, which confirms the oral-general health connection. This indicates the need for the development of proper dental public health policies for better oral health, and presents a new view on the importance of preserving teeth.

### IZVLEČEK

#### Ključne besede:

samoocena zdravja,  
ustno zdravje,  
manjkajoči zobje,  
ohranjeni zobje,  
javnozdravstvene  
politike

**Namen.** Z namenom priprave podlage za pripravo na dokazih temelječe politike ustnega javnega zdravja v Sloveniji je bil cilj raziskave ocena povezanosti stanja ustnega zdravja, merjenega s samoporočanim številom manjkajočih zob in samoocene lastnega zdravja.

**Metode.** Zasnovo raziskave je predstavljala analiza združenih podatkov na individualni ravni, pridobljenih v štirih zaporednih nacionalnih presečnih raziskavah v Sloveniji, izvedenih v obdobju 2001-2012 po metodologiji CINDI Health Monitor. Skupno je bilo v analizo vključenih 34.412 udeležencev. Ženske so predstavljale 55,7% in moški 44,3%, mediana starosti je bila 45 let. V modelu logistične regresije je bila opazovana spremenljivka samoocena lastnega zdravja kot slabega, pojasnjevalna spremenljivka pa samoporočano število manjkajočih zob (upoštevani izbrani biološki, socialno-ekonomski in z zdravjem povezani moteči dejavniki).

**Rezultati.** Osebe z več manjkajočimi zobmi imajo višje obete za to, da ocenjujejo svoje zdravje kot slabo, kar velja tudi po prilagoditvi za nekatere biološke, socialne in zdravstvene dejavnike. Razmerje obetov za nizko samooceno lastnega zdravja v primerjavi s skupino brez manjkajočih zob je bilo pri osebah z 1-5 manjkajočimi zobmi 1,23 ( $p=0,049$ ), za skupino s 6-10 manjkajočimi zobmi 1,32 ( $p=0,019$ ), za skupino z več kot 10 manjkajočimi zobmi 1,77 ( $p<0,001$ ) in za skupino z vsemi manjkajočimi zobmi 2,19 ( $p<0,001$ ).

**Zaključek.** Raziskava je pokazala jasno povezanost med samoocenjenim splošnim zdravjem in zobnim statusom, kar potrjuje povezanost ustnega in splošnega zdravja. Rezultati tudi nakazujejo potrebo po razvoju primernih politik ustnega javnega zdravja za boljše ustno zdravje in hkrati nakazujejo tudi nov pogled na pomen ohranitve zob.

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## 1 INTRODUCTION

Mouth with teeth and oral tissues play an important role in human lives. Compartmentalisation of oral health has been replaced by the belief that it is an integral part of general health and has an influence quality of life. To maintain and improve oral health, it is essential to carry out hygiene measures and perform dental check-ups regularly. Retention of functional, aesthetic and natural dentition of not less than 20 teeth throughout life is World Health Organization's (WHO's) goal, actually a milestone on the road to retention of all natural teeth (1). It is based on the evidences that masticatory ability is related to the number of teeth, and that this ability is impaired when the patient has less than 20 well-distributed teeth (2); in addition, it is in agreement with short dental arch (SDA) concept (3). Regular dental check-ups are also important, because multiple systemic diseases and imbalances have different signs in oral cavity, and sometimes these manifestations are disease-specific (4). Oral-systemic connection is bidirectional, as studies show association of periodontal disease with cardiovascular diseases, diabetes mellitus, and pregnancy outcomes (5).

Trying to understand the potential oral-systemic association, it is important to consider a wider look on health, which - besides biomedical status - takes into account also the patient's ability to perform daily activities (6). This broader multidimensional view is used in the concept of health surveys which encompass traditional clinical assessment and also the individual's subjective assessment of health status impact on his or her own wellbeing and daily functioning (7). Health-related quality of life (HRQoL) with the inclusion of the patient's perspective represents measurement tools with a more holistic approach to health. It is affected by the individual's physical health, psychological state, personal beliefs, social relationships, and the relationship to salient features of the individual's environment (8). On the same theoretic base, measurements of Oral Health-Related Quality of Life (OHRQoL) was developed (9).

One similar and simpler measurement, which is a part of self-rated quality of life tools, is self-rated health (SRH). It represents personal and subjective perception of one's own health, and it could be biased according to social desirability, expectations and relative deprivation (10). Researchers have explored different influences and correlations between self-perceived health status and characteristics of one's social environment (11). The importance of SRH can be explained by simplicity and the fact that researchers confirmed SRH has an independent effect on mortality (12-14), morbidity (15) and hospitalizations (16). Self-assessment of health is a widely used method in epidemiology, and can be assessed through different questionnaires. Most widely used are single-item indicators that differ in the number

of available answers, but, in general, they represent a parallel assessment of subjective health (10). A study in Slovenia using SRH showed that PSRH is associated with multimorbidity and unhealthy life-style (17). Subjective evaluation of health is used also in econometric analyses and health technology assessment (18).

Multiple biological mechanisms are connecting oral diseases to systemic health (5). Tooth loss represents the main consequence of persistent or past oral diseases, injuries, or compromised possibilities of dental healthcare utilization. It can affect someone's appearance, psychical state and well-being (19). But does it influence self-rated general health, which is connected to other confirmed negative health outcomes? This was the main question we wanted to answer with our study.

Aiming at preparing the basis for evidence-based policy making in the field of dental public health in Slovenia, the objective of the study was to assess the strength of association between oral health status measured by the number of missing teeth and self-rated health (SRH), controlled for some characteristics of one's social environment and major health problems.

## 2 METHODS

The study was designed as a pooled individual-level data study from four cross-sectional studies, based on the methodology of the WHO Countrywide Integrated Non-Communicable Disease Intervention (CINDI) Health Monitor database (CHM) in Slovenia (CHMS). The surveys were conducted in 2001, 2004, 2008 and 2012, and the number of participants invited was 15379, 15297, 15963, and 16000, respectively, in the frame of CINDI Slovenia.

Based on the CHM Core Questionnaire (20, 21), Slovene self-administered postal questionnaire was created. In 2012, also the possibility for online responses existed. Different approaches, including extensive media campaigns, a lottery with prizes enhancing healthy behaviour, and up to two reminder letters, were used.

SRH by participants was the observed outcome. It was measured through a single question: "How would you assess your present state of health?" Five-level Likert-like scale with answers "very good," "good," "fair," "poor" and "very poor" was used. For the purpose of the analysis, the new variable PSRH was created, in which participants who rated their health as poor or very poor were pooled in a group of interest (PSRH: 0=no, 1=yes).

Dentate status as explanatory factor of interest was self-assessed by the question: "How many teeth are you missing?" Predefined answers were: 0 - none, 1 - 1 to 5, 2 - 6 to 10, 3 - more than 10 but not all, 4 - all teeth are missing/I have dentures.

Confounders gender, age, educational level, type of work and self-classified social class were assessed. Additionally, information on self-reported persistence of diagnosed diseases, self-confirmed pain in the last 30 days, and admission to the hospital in the past twelve months was included. Ages of the participants were recoded from the reported year of birth and arranged into five categories, starting with 25-29, then three 10-year categories, 30-39, 40-49 and 50-59, and the last category from 60 to 64 years (the participants aged 65-74 were excluded from the analysis). In the assessment of the education level, participants were able to choose one out of seven categories (1 - incomplete primary, 2 - primary, 3 - vocational, 4 - secondary, 5 - college, 6 - university and 7 - postgraduate), which represented their highest level of education achieved. For the needs of the analysis, the last two categories were combined into one. The question about the type of work consisted of 10 different categories of self-classification. For most judicious use of this data, we combined them into 4 categories, according to work characteristics. These categories were, namely: 1 - heavy work (agriculture, farming, forestry, industry, mining and construction), 2 - administrative and intellectual work (work in office, light physical work, services, higher management, research, development, and students), 3 - housekeeping (housekeeper and pensioners) and 4 - unemployed (at the time of the study). Self-reported social class was assessed by the question: "In your opinion, which social class do you belong to?" Participants could choose one of the answers: 1 - lower, 2 - labour, 3 - middle, 4 - upper-middle, and 5 - upper); for the needs of the analysis, upper-middle class and upper class were combined. Self-reported diseases of participants were assessed by the question: "Do you have any of conditions, confirmed by a physician?" Participants chose between answers: 1 - No, 2 - Yes, it was confirmed in the last year, and 3 - Yes, it was confirmed more than a year ago. During statistical analysis the last two answers were combined into a single category. From the list of questions, six diseases, which have impact on daily activities, were included into the analysis, namely: myocardial infarction, angina pectoris, heart failure, cerebrovascular insult, back illness, and rheumatism or arthritis. The participants were categorized into categories according to the number

of confirmed conditions (1 - without any of the specified conditions, 2 - one of the specified conditions, 3 - more than one of the specified conditions). We also included the information on some pain symptoms in the last month (chest pain during physical activity, back pain, shoulder/neck pain, joint pain, headache and toothache). It was assessed by the question: "Have you had any of the following symptoms or complaints during the last 30 days?" Participants could choose between two answers: 1 - Yes and 2 - No. The answers were again combined into three groups depending on the number of reported problems (1 - with none of the problems, 2 - with one of the problems, 3 - with more of the problems). The information on hospital admissions was included as well. Data were assessed from the question: "How many times, during the last twelve months, were you admitted into the hospital?". Participants answered the question with the number of admissions. For the purpose of the analysis, answers were aligned into groups according to the number of admissions: none, one time and multiple times. Finally, the year of the survey was included in the analysis as a confounder.

The association between PSRH and the number of missing teeth as explanatory variable, adjusted for confounders, was assessed univariately, using chi-square tests. The association was assessed multivariately, using binary multiple logistic regression (LR). The dummy variables were created for explanatory and confounding variables, using the simple method. In all statistical tests,  $p \leq 0.05$  was considered significant. The IBM SPSS for Windows Version 21.0 (SPSS Inc., Chicago, IL., USA) software was used.

### 3 RESULTS

In the pooled sample, there were 34412 participants, aged 25-64 (2001: 9034, 2004: 8528, 2008: 7352, 2012: 9498), whose questionnaires were eligible for analysis. Response rate was 62.9% in 2001, 57.4% in 2004, 49.0% in 2008, and 59.6% in 2012. There was a slight predominance of females, but participants were equally distributed across age groups - median age was 45 years. Further characteristics are presented in Table 1.

**Table 1.** Characteristics of participants taking part in the study of pooled individual-level data from four cross-sectional studies in Slovenia, from 2001-2012.

Characteristic	Category	N	%
Gender	Men	15258	44.3%
	Women	19154	55.7%
Age (years)	25-29	3585	11.4%
	30-39	7527	24.0%
	40-49	8251	26.3%
	50-59	8333	26.5%
	60-64	3695	11.8%
Educational level	Incomplete primary	1604	4.7%
	Primary	5088	15.0%
	Vocational	8960	26.4%
	Secondary	10065	29.6%
	College	2917	8.6%
	University	5318	15.7%
Type of work	Heavy work	4776	14.4%
	Administrative/intellectual work	16546	50.0%
	Housekeeping	9510	28.8%
	Unemployed (job seeker)	2234	6.8%
Social class	Lower	1002	3.1%
	Labour	11899	36.9%
	Middle	15678	48.7%
	Upper-middle	3333	10.3%
	Upper	297	0.9%

SRH was reported by 34085/34412 participants (99.0%), among them very good SRH was reported by 10.7%, good SRH was reported by 41.9%, 38.3% reported fair SRH, 7.5% poor SRH, and 1.4% reported very poor SRH. The prevalence of very good and good SRH was higher in people with less missing teeth, whereas the prevalence of fair, poor and very poor SRH was higher in persons with more missing teeth. The association between variables was highly significant ( $p < 0.001$ ).

The prevalence of PSRH was 9.0% (3076/34085). The question about dentate status was answered by 34041/34412 participants (98.9%). About two thirds of them had 5 or less missing teeth. After cross-matching, both questions were adequately answered by 33908/34412 (98.5%). The estimates of the prevalence of PSRH in each category of dentate status are presented in Table 2. The prevalence of PSRH is rising with increasing number of missing teeth. The differences were highly statistically significant ( $p < 0.001$ ). In Table 2 also estimates of prevalence of PSRH according to different socio-economic and health characteristics are presented, along with the results of univariate statistical analysis.

Complete data for LR analysis were available for 24862/34412 participants (72.2%). The results of the logistic regression model showed a statistically significant association between PSRH and dentate status, when this relationship was adjusted to several confounders. Significance of Hosmer-Lemeshow test of the model was  $p = 0.249$ ; the model explained 30.9% of variance. The OR were rising with a higher number of missing teeth and were significant for all groups of people with missing teeth, in comparison with persons with no missing teeth. Detailed results are presented in Table 3, and were robust to regrouping participants according to age categories (10-year categories) and the type of work (separating pensioners and housekeepers).

**Table 2.** Estimates of the prevalence of poor self-rated health (PSRH) according to dentate status and selected socio-economic and health-related factors in a study of pooled individual-level data from four cross-sectional studies in Slovenia, from 2001-2012.

Risk factor	Category	N <sub>tot</sub>	N <sub>PSRH</sub>	N <sub>cat</sub>	N <sub>PSRH</sub> /N <sub>cat</sub> (%)	p
Missing teeth	None	33908	206	6126	3.4%	<0.001
	1 to 5		1178	16638	7.1%	
	6 to 10		550	4763	11.5%	
	More than 10, but not all		763	4518	16.9%	
	All teeth - wear denture		353	1863	18.9%	
Gender	Men	34085	1373	15104	9.1%	0.705
	Women		1703	18981	9.0%	
Age (years)	25-29	31090	92	3565	2.6%	<0.001
	30-39		305	7472	4.1%	
	40-49		759	8154	9.3%	
	50-59		1082	8237	13.1%	
	60-64		433	3662	11.8%	
Educational level	Incomplete primary	33649	419	1587	26.4%	<0.001
	Primary		853	5039	16.9%	
	Vocational		864	8860	9.8%	
	Secondary		614	9991	6.1%	
	College		130	2895	4.5%	
	University		124	5277	2.3%	
Type of work	Heavy work	32771	562	4734	11.9%	<0.001
	Administrative/intellectual work		681	16408	4.2%	
	Housekeeping		1263	9425	13.4%	
	Unemployed (job seeker)		427	2204	19.4%	
Social Class	Lower	31936	332	990	33.5%	<0.001
	Labour		1513	11800	12.8%	
	Middle		804	15544	5.2%	
	Upper-middle/Upper		113	3602	3.1%	
Admission to hospital	No	31818	1911	27493	7.0%	<0.001
	Once		595	3291	18.1%	
	Multiple times		336	1034	32.5%	
History of health problems in the last 30 days	None	33787	226	7247	3.1%	<0.001
	One		958	17818	5.4%	
	More than one		1857	8722	21.3%	
Confirmed health problem by physician	None	33865	718	21062	3.4%	<0.001
	One		1778	10804	16.5%	
	More than one		472	999	47.2%	
Year	2001	34085	850	9009	9.4%	<0.001
	2004		796	8321	9.6%	
	2008		701	7302	9.6%	
	2012		729	9453	7.7%	

Legend: N<sub>tot</sub>=the total number of respondents, N<sub>PSRH</sub>=the number of participants with poor self-rated health, N<sub>cat</sub>=the number of respondents within the category.

**Table 3.** Results of logistic regression analysis of the association of dentate status with the prevalence of poor self-rated health (PSRH) in a study of pooled individual-level data from four cross-sectional studies in Slovenia, from 2001 to 2012.

Risk factor	Category	OR	95% CI for OR limits		p
			N <sub>cat</sub>	N <sub>PSRH</sub> / N <sub>cat</sub> (%)	
Missing teeth	None	1.00			
	1 to 5	1.23	1.00	1.51	0.049
	6 to 10	1.32	1.05	1.67	0.019
	More than 10, but not all	1.77	1.40	2.25	<0.001
	All teeth - wear denture	2.19	1.64	2.91	<0.001
Gender	Men	1.00			
	Women	1.24	1.11	1.38	<0.001
Age (years)	25-29	1.00			
	30-39	1.23	0.92	1.64	0.163
	40-49	1.71	1.29	2.26	<0.001
	50-59	1.72	1.29	2.29	<0.001
	60-64	1.35	0.97	1.87	0.074
Educational level	University	1.00			
	Incomplete primary	2.55	1.86	3.50	<0.001
	Primary	1.71	1.29	2.27	<0.001
	Vocational	1.41	1.08	1.84	0.011
	Secondary	1.47	1.14	1.89	0.003
	College	1.11	0.81	1.52	0.519
Type of work	Administrative/intellectual work	1.00			
	Heavy work	1.37	1.16	1.60	<0.001
	Housekeeping	1.21	1.02	1.42	0.027
	Unemployed (job seeker)	2.34	1.96	2.80	<0.001
Social Class	Middle	1.00			
	Lower	3.97	3.18	4.96	<0.001
	Labour	1.49	1.31	1.70	<0.001
	Upper-middle/Upper	1.06	0.83	1.36	0.640
Admission to hospital	No	1.00			
	Once	2.55	2.23	2.92	<0.001
	Multiple times	4.12	3.38	5.02	<0.001
History of health problems in the last 30 days	None	1.00			
	One	1.20	0.98	1.47	0.075
	More than one	3.83	3.12	4.70	<.001
Confirmed health problem by physician	None	1.00			
	One	2.94	2.60	3.32	<0.001
	More than one	6.93	5.58	8.60	<0.001
Year	2012	1.00			
	2001	1.53	1.31	1.78	<0.001
	2004	1.65	1.41	1.94	<0.001
	2018	1.53	1.31	1.80	<0.001

Legend: CI=confidence interval, OR=odds ratio.

#### 4 DISCUSSION

Results of our study showed that there exist differences in the prevalence of PSRH between groups according to the number of missing teeth. People with more missing teeth will more likely rate their general health as poor. Results are highly significant. The biggest likelihood of rating one's own health as poor was for people with all of their teeth lost, or for people who wore dentures. We could try to explain this by lost functionality. This relationship was significant even when some health problems and socioeconomic characteristics, known to influence SRH (11), were taken into account. This indicates the importance of oral health, reflected through the number of missing teeth in self-evaluation of health, and also addresses the general belief that oral health represents an integral part of general health.

A lower number of teeth represent some kind of a functional limitation. The literature review about SDA concept states that dentition comprised of anterior teeth and premolar region fulfils the requirements of functional dentition (22). This means that no more than 8-12 teeth should be missing. We showed that the association exists even with less teeth lost, when functionality should not be compromised. Lost functionality is not the only possible link. This could be risk factors that are associated with oral diseases, which cause tooth loss, and other non-communicable diseases (smoking, alcohol consumption). Systemic effects of periodontal disease, one of the main reasons for tooth loss in adults, can also represent biologic plausibility (5). The drop in prevalence of PSRH in 2012 is somewhat strange in the light of economic crisis, but these results were also observed in some other studies (23). It is possible that the effect of economic crisis has not yet been expressed in poorer SRH, or that its rise is the consequence of changes in community and personal conceptualisation of health.

We showed the association of health issues with PSRH. This also included former hospitalisation. The association between hospitalization and PSRH rises with a higher number of admissions, which may reflect possibilities of more serious diseases. Even PSRH is associated with hospitalisation (16), we also believe that it could be interpreted as a sign of a more serious disease that could be associated with PSRH. In the oldest age group, a drop in the prevalence of PSRH was observed. This could be attributed to changes in personal concepts of health, but other researchers also confirmed improving SRH with age when adjusted to some functional disabilities (24).

The question arises whether SRH is a proper measurement tool in the context of oral health. Studies show small, but significant association between oral and general health-related quality of life, suggesting that the functioning of the mouth or body could be seen as a link between these

concepts (25). Masticatory performance is significantly correlated to the number of missing teeth, and it is not in association with the age of the subjects (26). This means that in context of our research, where we study the influence of the number of missing teeth, which definitely represents functional limitation, general health measures could be used.

Even though tooth loss has not been put in association with SRH until now, studies that connect tooth loss with some health outcomes exist. Researchers confirmed associations of tooth loss and disease risk, disease development and increased mortality (27-30). We have shown that a greater number of missing teeth implies bigger odds for PSRH. We know that PSRH is a good predictor of mortality among patients with chronic heart failure too (14). This points to a possible underlying mechanism between SRH and health outcome, which involves teeth and should be a matter of further research.

The study has some limitations. Firstly, it is related to the cross-sectional study design that limits direct conclusions on causality. Another limitation is the self-assessment of data, where more socially desirable answers may be chosen and the final sample may consist mainly from persons more prone to participate. Some of these limitations were addressed by other authors, and they believe that they did not affect the study findings to a great extent (11, 31). Another limitation may arise from the fact that participants might not be sure about the number of missing teeth or might misunderstand the question about the presence of confirmed diseases by their physician. Cohort study with a clinical assessment of oral health status and longitudinal design could overcome some of the aforementioned limitations. Additionally, one can argue that regarding the sample structure, some overlaps in participants across the surveys were possible. However, only about 6% of adult population, aged 25-64 years, was invited to participate in each survey. Consequently, the probability of inclusion of the same person in all studies is very small. One can also argue against selected age groups; however, the same classification/grouping was used by other authors, who analysed CHMS data (11). Although some arguments against a single-item question to assess SRH can be raised, this simple measure represents a comprehensive screening tool for the patient's health status (32).

Nonetheless, the study has some important strengths. The most important one is that, although Slovenia is a small European country, the results could represent a contribution to dental public health in a wider context, since, according to our best knowledge, there does not yet exist any study that would analyse the relationship between PSRH and dentate status. Additionally, results were obtained on a relatively large sample.

Because PSRH is associated with a greater number of missing teeth, which is indeed associated with increased mortality, tooth loss could be another useful predictor of health complications. Results showed that oral health has an important influence on the SRH, even when known confounders are taken into account. This shows that oral and systemic health should not be treated separately, and reflects the importance of oral health itself. All possible measures must be taken to preserve a higher number of natural teeth. This also points out to the need for greater concern about oral health status of the population and more extensive research on the field of public oral health. That will make possible to develop and implicate proper strategies and programmes, to advocate oral health, and to get wider support as well as raise awareness about the importance of oral health in the community. Oral health education for all population groups would help preserve higher number of teeth, and it will possibly have positive effects on SRH.

As far as the future research in the field is concerned, it would be worth placing the question about SROH and other questions related to oral health in future CHMS surveys. That would help to clarify possible associations between oral and general health and help to make further decisions on our way to better health and wellbeing in general.

## 5 CONCLUSION

PSRH is associated with a higher number of missing teeth. Because PSRH is connected with negative health outcomes, this association should not be neglected. Preserving natural teeth should be considered a global goal for better oral and general health.

## CONFLICTS OF INTEREST

The authors declare that no conflicts of interest exist.

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## ETHICAL APPROVAL

The research protocol was approved for each survey by the Ethical Committee of the Republic of Slovenia.

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