Relationship of depressive symptoms to edentulousness, dental health, and dental health behavior

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We investigated the relationship of edentulousness, dental health, and dental health behavior to depressive symptoms in the 55-year-old population of Oulu (a medium-sized Finnish town), 780 of whom (78%) participated. The dental examination included an assessment of oral health status. Depressive symptoms were determined with the Zung Self-Rating Depression Scale (ZSDS). The participants were also asked about their dental health behavior, smoking habits, health, life satisfaction, and factors related to their work. Depressive symptoms were associated with edentulousness among non-smoker men. When further evaluated by logistic regression analysis, edentulousness was independently associated with depressive symptoms in this subpopulation (odds ratio = 6.4, confidence interval = 1.4–29.2) after adjusting for confounding factors. Depressive symptoms were not associated with dental caries, periodontal status, or number of teeth. The dentate women with high rates of depressive symptoms had a more negative attitude towards preserving their natural teeth, used sugary products more frequently, reported a longer time since their last dental visit, and tended to have a lower percentage of filled tooth surfaces than the non-depressed dentate women. The aspect of depression should be borne in mind by dentists when treating edentulous patients. On the other hand, certain subgroups of depressed patients might benefit from dental implant therapy. Thus, the importance of teamwork between clinicians, psychiatrists, and dentists is emphasized.

☐ *Dental health; dental health behavior; depressive symptoms; edentulousness; smoking*

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In view of the emotional and symbolic importance of the mouth and its basic function in mental development, the significance of oral and dental health in a person's psychological well-being should not be underestimated. During the past two decades, increasing interest has been shown in the individual's subjective experiences and interpretations of oral conditions and the relation of oral health values to other health and life values (1). A more holistic perspective of oral health has given rise to the concept of oral health-related quality of life (2), which has also been associated with depression (3).

The consequences of dental diseases, as impacts, may interfere with enjoying life and maintaining positive self-image (4). Edentulousness is often accompanied by high levels of functional limitation and physical disability (5, 6) and thus by impairment of oral health-related quality of life. By means of prospective analysis Locker et al. (7) showed that self-perceived oral health at 3 years had a significant independent effect on psychological well-being and life satisfaction at 7 years.

Knowing that a loss of motivation is one of the volitional symptoms of depression (8), one may presume that depression could have a negative impact on oral hygiene. Using the Hospital Anxiety and Depression Scale (HAD), Kurer et al. (9) found an association between mean depression scores and oral hygiene in a group of 51 regular dental attenders. Monteiro da Silva et al. (10) also used the HAD Scale to investigate whether depression could predict dental plaque levels in patients with adult periodontitis but found no association.

Baker et al. (11) presented the Minnesota Multiphasic Personality Inventory (MMPI) to investigate the relationships between periodontal disease and personality factors, but no correlation could be shown between the depressive personality pattern and periodontal status. Mobley & Smith (12) found periodontal disease to be slightly related to depression as measured on the MMPI. Monteiro da Silva et al. (13) found significantly increased depression and loneliness in patients with rapidly progressive adult-onset periodontitis compared with a group with regular chronic adult periodontitis and a control group. In a recent study by Genco et al. (14), depression measured with the Brief Symptom Inventory was related to periodontal disease after adjusting for age, sex, and smoking. In a 3-year longitudinal study Drake et al. (15) found that those older Blacks who showed fewer symptoms of depression were more likely to have lost at least one tooth. Among the risk factors associated with periodontal disease and ultimate tooth loss, smoking is the best-documented one (16–18). In many studies smoking has also been associated with depression (19, 20).

The association between depression and dental caries is still an open question. However, the increased risk of dental caries in patients taking antidepressant medication has been widely acknowledged (21–23). In our previous study (24) we found an association between depressive

symptoms and increased lactobacillus counts, which, in turn, shows the subject to be at risk for dental caries.

Previously reported results on the association of dental diseases and depression are somewhat contradictory. Furthermore, the earlier studies have ignored edentulousness and its possible effect on depressive symptoms, which, considering the negative impact often accompanying edentulousness, is an obvious shortcoming in this field of research. In the present study we investigated the relationship of edentulousness, dental health, and dental health behavior to depressive symptoms in a population aged 55 years.

Subjects and methods

The present study was part of a more extensive epidemiological research project and included examinations of general and oral health. All the 55-year-old-inhabitants of Oulu (a provincial capital in Northern Finland with 100,000 inhabitants) were invited to take part in the study, and 77% of them (780 people, 345 men and 435 women) participated. Non-response analysis with regard to sex and dental state included 49% of the men and 39% of the edentulous subjects, compared with 44% and 32% of the subjects examined, respectively.

Postal questionnaires were mailed to the target population and checked at the clinical examination, when the subjects were also interviewed about their smoking habits. Dental examinations were performed by two dentists, who recorded the occurrence of decayed surfaces (primary and secondary dentin caries and root caries) separately for each tooth surface using the diagnostic criteria recommended by the World Health Organization (25). An orthopantomograph was used to supplement the clinical diagnosis. Periodontal status included recording of the probing pocket depth ($\geq$4 mm) at the four surfaces of each tooth, and the occurrence of pockets was expressed as a percentage of the surfaces at risk. The dentists were calibrated before the examinations. The interexaminer agreement on caries diagnosis was 99.1%, and $\kappa = 0.77$. Intraexaminer agreement was 99.7% and $\kappa = 0.77$ for T. K. Sakki; the corresponding values for S. S. Anttila were 99.5% and 0.80. The interexaminer agreement was 92.9% and $\kappa = 0.72$ in the diagnosis of periodontal pockets. The intraexaminer agreements and the kappa statistics were 96.7% ($\kappa = 0.80$) and 95.3% ($\kappa = 0.78$) for T. K. Sakki and S. S. Anttila, respectively. Oral hygiene status (good or moderate versus poor) was estimated clinically, using plaque accumulation on teeth or dentures as the main criterion.

The questionnaire included information on the present occupation or, if retired or unemployed, the last occupation (white-collar worker versus blue-collar worker), self-perceived health (very good or good versus moderate or poorer), life satisfaction (very good or good versus moderate or poorer), work satisfaction (very good or good versus moderate or poorer), attitude towards the preservation of one's natural teeth (very important versus fairly important or unimportant), use of sugar in coffee or tea (no versus yes), consumption of sweets, snacks, or soft drinks (never or occasionally versus once or twice a week or daily), time elapsed since the last dental visit (less than 3 years versus at least 3 years or never), frequency of dental visits (at least once in 1–2 years versus rarely or never), frequency of tooth brushing (twice a day versus once a day or rarely), regular use of any extra cleaning methods, such as toothpicks, dental floss, interdental brush, or 'solo' brush (yes versus no). On the basis of their smoking behavior, the subjects were divided into non-smokers versus regular smokers, ex-smokers, and occasional smokers.

Depressive symptoms were determined with the Zung Self-Rating Depression Scale, which was completed for 768 subjects (338 men and 430 women). The ZSDS questionnaire includes 20 items (26), each with 4 reply alternatives. The items measure common psychic and somatic symptoms, including the criteria generally used in diagnosing depression. The scores were calculated as total raw sum points on a scale of 20 to 80, using the method described by Zung (26). The validity of the ZSDS has been tested against the diagnosis of major depression on the basis of the DSM-III criteria among elderly patients (aged 60 years or more) of medical clinics (27, 28). With a cutoff of 39/40 raw sum points, the sensitivity of the ZSDS ranged from 79% to 100% and the specificity from 55% to

Table 1. Prevalence of high rate of depressive symptoms (ZSDS* $\geq$ 40) in relation to sex, dental status, and smoking

	Men					Women				
	Dentate		Edentulous			Dentate		Edentulous		
Smoking	*n*†	(%)	*n*	(%)	*P* value	*n*	(%)	*n*	(%)	*P* value
Non-smoker	93	(16)	12	(50)		184	(23)	95	(32)	
Smoker	169	(22)	64	(17)	0.014	73	(25)	78	(28)	NS‡
Total	262	(20)	76	(22)	NS	257	(23)	173	(30)	NS

* ZSDS = Zung Self-Rating Depression Scale.
† *n* = size of denominator group.
‡ NS = not significant.

Table 2. Logistic regression analysis among non-smoker men with depressive symptoms (ZSDS* ≥ 40 versus ZSDS ≤ 39) as the outcome variable ($n = 104$)

Variable	Level	Odds ratio	95% confidence interval	*P* value
Self-perceived health	Good	1.0		
	Moderate or poor	5.7	(1.1, 29.8)	0.027
Life satisfaction	Good	1.0		
	Impaired	2.8	(0.8, 9.9)	0.082
Work satisfaction	Good	1.0		
	Impaired	1.8	(0.5, 6.2)	0.332
Occupational status	White-collar worker	1.0		
	Blue-collar worker	0.4	(0.1, 1.5)	0.153
Dental status	Dentate	1.0		
	Edentulous	6.4	(1.4, 29.2)	0.011

* Zung Self-rating Depression Scale.

57%. In a study of Finnish men and women aged 65 years or more, the sensitivity of the ZSDS was 87.4%, and specificity 61.5% with a cutoff of 39/40 (S.-L. Kivelä, unpublished results). A cutoff of 39/40 was recommended by Zung for studying working-aged populations (29).

When analyzing the associations of depressive symptoms and continuous variables like dental caries, periodontal pockets, fillings, and number of teeth, the non-parametric Wilcoxon two-sample test was used. Cross-tabulation and the chi-square statistics were used to evaluate the associations between pairs of variables. The Zung scale was also used as continuous variable when the correlations were calculated with the Spearman rank correlation coefficient. When the occurrence of depressive symptoms and smoking status were cross-tabulated jointly with dental status (Table 1), statistical testing of difference of proportions was used. Logistic regression models were fitted separately for non-smoker and smoker men, respectively, with the occurrence of depressive symptoms as the outcome variable. Self-perceived health, life satisfaction, work satisfaction, occupational status, and dental status (dentate versus edentulous) were the predictor variables, and they were selected on the basis of bivariate analysis. The logistic analyses also used family income and education as indicators of social status instead of occupation, but the results were similar. The PLR program of the BMDP statistical software was used in fitting the logistic models.

Results

After adjusting for the main confounding factors, sex and smoking, it turned out that depressive symptoms were associated with edentulousness among men who had never smoked ($P = 0.014$) (Table 1). This relationship emerged also in the logistic regression analysis fitted for non-smoker men (Table 2), in which edentulousness was independently associated with depressive symptoms (odds ratio (OR) = 6.4; confidence interval (CI) = 1.4–29.2) after controlling for self-perceived health, life satisfaction, work satisfaction, and occupational status. No such association was found among smoker men (Table 3). When the groups analogous to Table 1 were compared by using the Zung scale as a continuous variable, the results remained the same (data not shown). Smoking was not associated with depressive symptoms in the whole population; however, edentulous smoker men had fewer depressive symptoms

Table 3. Logistic regression analysis among smoker men with depressive symptoms (ZSDS* ≥ 40 versus ZSDS ≤ 39) as the outcome variable ($n = 226$)

Variable	Level	Odds ratio	95% confidence interval	*P* value
Self-perceived health	Good	1.0		
	Moderate or poor	3.6	(1.1,11.1)	0.034
Life satisfaction	Good	1.0		
	Impaired	1.4	(0.7,2.9)	0.336
Work satisfaction	Good	1.0		
	Impaired	2.4	(1.2,4.9)	0.019
Occupational status	White-collar worker	1.0		
	Blue-collar worker	0.6	(0.3,1.3)	0.201
Dental status	Dentate	1.0		
	Edentulous	0.7	(0.3,1.5)	0.372

* Zung Self-rating Depression Scale.

Table 4. Decayed surfaces*, periodontal pockets ≥4 mm*, filled tooth surfaces*, and number of teeth in relation to depressive symptoms among dentate subjects ($n = 519$)

	Decayed surfaces								Periodontal pockets							
	n	X	Min.	Q_1	Med.	Q_3	Max.	*P* value	*n*	X	Min.	Q_1	Med.	Q_3	Max.	*P* value
Men																
ZSDS† ≤ 39	209	4.2	0	0	0.8	4.2	52.5		209	14.3	0	0.9	7.5	18.5	100	
ZSDS ≥ 40	53	7.5	0	0	0	4.4	100	NS	53	15.0	0	0	9.5	22.1	70.0	NS
Women																
ZSDS ≤ 39	197	2.5	0	0	0	2.3	35.0		197	8.7	0	0	3.4	12.5	76.0	
ZSDS ≥ 40	60	4.2	0	0	0	3.2	60.0	NS	60	8.4	0	0	1.8	9.4	52.3	NS

	Filled surfaces								Number of teeth							
	n	X	Min.	Q_1	Med.	Q_3	Max.	*P* value	*n*	X	Min.	Q_1	Med.	Q_3	Max.	*P* value
Men																
ZSDS ≤ 39	209	25.4	0	12.5	24.0	38.2	100		209	17.0	2	9	18	24	32	
ZSDS ≥ 40	53	21.9	0	10.0	18.4	30.5	60.0	NS	53	16.5	2	9	17	24	29	NS
Women																
ZSDS ≤ 39	197	31.8	0	20.0	33.6	43.3	74.2		197	16.9	1	8	19	24	29	
ZSDS ≥ 40	60	28.7	0	17.6	25.9	38.1	100	0.063	60	15.6	2	7	15.5	24.5	28	NS

X = mean, Min. = minimum, Q_1 = 25% quartile, Med. = median, Q_3 = 75% quartile, Max. = maximum, NS = not significant.
* As percentages of risk surfaces.
† ZSDS = Zung Self rating Depression Scale.

Table 5. Bivariate associations of depressive symptoms with undesirable dental health behavior among dentate men and women

	Men					Women				
	ZSDS ≤ 39		ZSDS ≥ 40			ZSDS ≤ 39		ZSDS ≥ 40		
	*n**	(%)	*n*	(%)	*P* value	*n*	(%)	*n*	(%)	*P* value
Preservation of natural teeth not so important	208	(21)	53	(15)	NS	195	(9)	60	(20)	0.024
Poor oral hygiene	207	(35)	53	(49)	0.065	197	(14)	60	(17)	NS
Using sugar in coffee or tea	208	(54)	53	(49)	NS	196	(32)	60	(40)	NS
Consumption of sweets, snacks or soft drinks 1–2 times a week or daily	207	(37)	53	(47)	NS	197	(38)	59	(54)	0.027
Time since the last dental visit at least 3 years	205	(37)	51	(25)	NS	195	(14)	56	(25)	0.047
Frequency of dental visits less frequent than once/1–2 years	207	(59)	53	(53)	NS	197	(34)	60	(40)	NS
Toothbrushing frequency less frequent than twice a day	208	(63)	53	(60)	NS	197	(20)	60	(17)	NS
No use of extra cleaning methods	208	(38)	53	(42)	NS	194	(28)	59	(32)	NS

* *n* = size of denominator group.

than edentulous non-smoker men ($P = 0.012$) (data not shown). Smoking was strongly associated with edentulousness both in men and in women ($P = 0.001$, $P = 0.001$, respectively) (data not shown).

Depressive symptoms were not associated with the number of decayed tooth surfaces, periodontal pocketing, or the number of teeth among men or women. Likewise, no association was found between these variables when smoking status was controlled for (data not shown). The dentate women with a high rate of depressive symptoms tended to have a lower percentage of filled tooth surfaces than non-depressed dentate women ($P = 0.063$) (Table 4). There was a weak although not statistically significant correlation between depressive symptoms and edentulousness among women ($r_s = 0.09$, $P = 0.07$, $n = 430$, Spearman rank correlation).

The dentate women with high rates of depressive symptoms did not consider it so important to preserve their own teeth as did the women with fewer depressive symptoms ($P = 0.024$). They also consumed sweets, snacks and soft drinks more often ($P = 0.027$), and a longer time had elapsed since their last visit to a dentist ($P = 0.047$). Among dentate men none of these associations could be found. Depressive symptoms were not associated with the tooth-brushing frequency, the frequency of dental visits, the use of sugar in coffee or tea, the use of extra cleaning methods, or the dentist's view of the subject's oral hygiene either in men or in women (Table 5).

Discussion

Caries and periodontal disease, the most common causes of edentulousness, have multifactorial etiologies with many local and general factors affecting their manifestation. Consequently, it is extremely difficult to show and interpret the relationship between general health and dental health. This relationship will not necessarily appear otherwise except in small subgroups, in which the effect of confounding factors is not very dominant. These difficulties emerged also in this study of depressive symptoms.

An independent association was found between depressive symptoms and edentulousness among men who had never smoked, even after controlling for the most important confounding variables. However, no such association was found among smoker men. Although no causal relationships can be shown from a cross-sectional study, it is very tempting to speculate about this divergence of results between smokers and non-smokers. As many studies have shown, smokers do have poorer dental health than non-smokers (16, 30); moreover, they are more at risk of tooth loss (31, 32). They brush and floss their teeth less frequently than non-smokers (33) and have dental visits less frequently than non-smokers (34). Smokers' health behavior and attitudes appear to be less favourable to oral health than those of non-smokers (35), and it has been discussed that smoking may be a proxy variable for other health behavior and attitudes that culminate in a decision by the dentist to extract a tooth or the patient to demand it (31). Assuming there is a difference in valuation and attitude towards oral health among smokers and non-smokers, one might think that oral and dental health is less important for smokers than non-smokers, and the emotional impact of edentulousness and its effect on subjective psychological well-being might therefore also be of minor importance for them. Among non-smoker men, on the other hand, the association between edentulousness and depressive symptoms was even stronger than the relationship between depressive symptoms and self-perceived health or work satisfaction, which were the most significant associations among smoker men (Table 3). Differences with regard to sex and edentulousness between non-participants and the subjects examined were small, and consequently, the risk of bias in the results is small.

Dentate depressed women used sugary products more frequently than non-depressed women and tended to have a lower percentage of filled tooth surfaces, which might be due to avoidance of dental services. This is supported by the finding that depressed dentate women reported a longer time since their last visit to a dentist (Table 5). They also showed a more negative attitude towards preserving their natural teeth. These findings suggest that depressive

symptoms and oral health behavior may be associated to some extent among women. Among men this was not the case. The more negative orientation of depressed dentate women did not appear as an increased amount of dental diseases among them. However, it is possible that the subjects at risk have already lost all their teeth. In fact, there was a slight although not statistically significant correlation between depressive symptoms and edentulousness among women. As is known, women formerly lost their teeth earlier than men (36), which was the case also in this study population. This cannot be explained only by differences in dental disease frequencies (36), because of lower amounts of dental caries and periodontal disease among women, seen also in this study. Consequently, dental diseases are not necessarily the most important reason for edentulousness among women. It has been discussed that before modern dental care, edentulousness and, consequently, full dentures may have been a matter of treatment choice for women because of esthetic aspects (36). Socioeconomic factors and, in this age group, the availability of dental care may naturally have influenced the decisions. Nevertheless, whether depressive symptoms have had a slight increasing effect on edentulousness among women is difficult to show because of a diverse and complicated background to edentulousness among them. On the other hand, among those who have chosen full dentures for esthetic reasons, the psychological impact of edentulousness may have been lower.

There are certain features in depression that support the possibility of long-term effects of depressive symptoms (37) even though measured at one point in time. Longitudinal studies are still needed to further clarify the relationship of depressive symptoms and oral health. However, this cross-sectional study showed an association between edentulousness and depressive symptoms among non-smoker men. We therefore suggest that the subject of depression should be considered by dentists when treating edentulous patients; certain subgroups of depressed patients, on the other hand, might benefit from dental implant therapy. Thus, the present study further underlines the importance of teamwork between clinicians, psychiatrists, and dentists.

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