Oral health and health-related quality of life in type 2 diabetic patients and non-diabetic controls

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The aim of the present study was to identify factors in oral health and also diabetes-related and socio-economic components that could be associated with the subject's health-related quality of life (HRQL). One-hundred-and-two randomly sampled type 2 diabetic and 102 age-matched and gender-matched non-diabetic subjects from the same residential area were studied cross-sectionally using the SF-36 questionnaire. Although the HRQL profiles were similar in nature, the control subjects indicated a more favorable health status in their HRQL scores than did type 2 diabetic subjects. Certain oral health factors contributed to deterioration of the patient's HRQL. Multiple regression analyses including both groups were used to determine variables explaining variance in the different HRQL domains. Dissatisfaction with teeth and mouth, feeling of dry mouth and poor financial status contributed to about one-fourth of the explanation of the variance in all health domains. Having diabetes played an important role in the domains Physical Functioning, Role functioning—Physical, General Health, and Social Functioning. Age was important for Physical Functioning and Role functioning—Physical. Our study indicates that different factors may be associated with impaired HRQL, especially among type 2 diabetic subjects, although only a partial understanding of its relation to oral health could be demonstrated. □ *Health-related quality of life (HRQL); oral health; type 2 diabetes*

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Many research reports have established that there is a relationship between diabetes mellitus and oral manifestations (1–7), and, traditionally, many dental and medical outcome variables behind this relationship have been studied.

The associations between oral health and quality of life have not been given much attention (8–10), and according to Locker (9) the reason is due to the historic separation of medicine and dentistry. In recent years there has been an increasing interest in this area, however, with many studies showing that social factors are as important as clinical findings in explaining the health outcomes of oral disorders (11–14). Moreover, oral conditions may affect the economic, social, and psychological well-being of individuals (9–11, 15). Missing teeth, oral clefts, and severe dental caries can bring embarrassment, withdrawal and anxiety. When edentulousness, dry mouth, soft tissue lesions or poorly fitting dentures influence eating, speaking, swallowing, and choice of food, both systemic poor health and quality of life can be compromised (15, 16).

Dentistry has the technology to prevent oral disease and loss of teeth. Complementary to traditional oral measures, the dental profession can make a contribution to the quality of life of individuals and society by including the patients' own experiences of their well-being and quality of life. Many studies have considered oral health and general health as being inseparable (8, 17, 18), and a multi-dimensional assessment of oral health outcomes could lead to oral health being considered more closely as part of general health (8, 9, 19, 20).

The terms, quality of life, well-being, health, and health-related quality of life (HRQL) are often used interchangeably in the medical and social science literature. The boundary is difficult to delineate and has been characterized as unclear (10, 21). According to Gift & Atchison (22), quality of life is a broad term that supersedes those elements that influence health. The term, HRQL, on the other hand, has been created to give more precision to the rather loose use of the term quality of life (11). There is often a discrepancy between the patient's assessment and the health professional's valuation of functional status and well-being (8, 23), therefore definitions of HRQL accentuate the patient's own valuation of physical, psychosocial and social functioning.

We performed this study to increase our understanding of how oral health affects different aspects of everyday life, especially among type 2 diabetic subjects. We set out to identify factors in oral health (examined and/or self-perceived) as well as diabetes-related and socio-economic components that could be associated with the subject's HRQL.

Subjects and methods

Patients with type 2 diabetes

One-third ($n = 210$) of all type 2 diabetic patients ≤75 years of age and living in northern Dalecarlia in Sweden were randomly selected (by means of a table of random

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numbers). Twenty-three patients were unable to participate because of ill health and 29 declined to participate. A total of 158 patients (75.2%) were interviewed about diabetes self-care and health. They were all offered a clinical oral examination free of charge at two Public Dental Service (PDS) clinics (reported elsewhere) (7) and were requested to complete a questionnaire on oral self-care (reported elsewhere) (24) and the SF-36 HRQL questionnaire for the purpose of the present study. One-hundred-and-two of the 158 patients (64.6%) agreed to participate in the oral health examination.

Dropout analysis. To ascertain that the sample studied did not differ from the original randomized sample in any important variables, descriptive data on non-respondents were analyzed and no differences could be found. Formation of the study population and dropouts has been discussed in previous studies (7, 24).

Non-diabetic control group

The control subjects were matched from the register at the same PDS clinic as the diabetic patients visited for the clinical oral examination (7) and consisted of 102 age-matched and gender-matched non-diabetic subjects. At the clinical examination they received the same questionnaire on oral self-care and SF-36.

Swedish reference group

Sullivan et al. (25) have presented reference values for SF-36 HRQL in the Swedish population ($n = 8930$). To ascertain how well our study groups, type 2 diabetic subjects ($n = 102$) and the age-matched and gender-matched controls ($n = 102$), corresponded to this Swedish reference group for HRQL, data on an age-matched and gender-matched reference group ($n = 102$) were ordered from the Swedish population study.

Questionnaire

Health-related quality of life SF-36. HRQL was measured using the Swedish version of the SF-36 questionnaire (25, 26), which is a short form of the Medical Outcomes Survey (MOS) questionnaire (27, 28). The SF-36 is a self-administered questionnaire including 36 items. It is designed to assess eight health domains: 1) physical functioning (PF), the extent to which health problems limit physical activities; 2) role functioning—physical (RP), the extent to which physical health interferes with or limits usual role activities; 3) bodily pain (BP), intensity of pain and its effect on normal activities; 4) general health perceptions (GH), personal evaluation of health, both current and health expected; 5) vitality (VT), including 'feeling full of pep' versus 'tired and worn out'; 6) social functioning (SF), the extent to which physical health or emotional problems interfere with normal social activities; 7) role functioning—emotional (RE), the extent to which emotional problems interfere with or limit usual daily role activities; 8) mental health (MH), including depression and anxiety. Items are scored 0–100, where high score indicates better health/more favorable health state. The references for HRQL in the matched subsample of the Swedish SF-36 population study show that a mean score of 75.67 can be expected for PF; 69.71 for RF; 69.53 for BP; 69.26 for GH; 69.0 for VT; 87.71 for SF; 79.55 for RE; and 81.68 for MH (25). The SF-36 questionnaire has proved to have a high level of reliability and validity (25, 29). In the total Swedish population study, the level of reliability measured with Cronbach's alpha was 0.79–0.90 (25). In the present study, Cronbach's alpha was 0.76–0.92.

Self-care and self-perceived oral health. The questions on oral self-care and self-perceived oral health were included in the same booklet as SF-36 and were almost identical to the questions in the epidemiological studies of Uhrbom & Bjerner (30). Initially, demographic questions on general socio-economic conditions, e.g. education, occupation and financial status, were asked. The questions asked had predetermined response alternatives, but also open questions were put.

Questions concerning oral self-care included:

- dental visits (regularity and intervals, reason for not visiting, feelings when confronted with the dental service and oral health information obtained)
- oral health behavior (oral health habits, e.g. brushing of teeth, proximal cleaning, and fluoride use).

Questions concerning self-perceived oral health dealt with:

- patients' experiences of their oral condition (satisfaction/dissatisfaction with teeth and mouth, problems, functions, e.g. chewing ability).

Clinical and X-ray examination

Oral conditions were measured at clinical and X-ray examinations (7). The number of natural teeth, removable dentures and the prevalence of edentulousness were recorded. The examination also comprised clinical findings concerning the patient's natural teeth, periodontal conditions and changes in oral mucosa. The patient's subjective feeling of oral dryness was also registered. For more detailed information on the clinical and X-ray examinations and procedures, see Sandberg et al. (7).

Glycemic control

Glycemic control was measured as the mean value of 3–4 measurements of glucosylated hemoglobin (HbA_{1c}) in 1 year. HbA_{1c} had been assayed using a liquid chromatographic method (HPLC system). The same method of analysis, with a normal range between 3.8% and 5.2%, was used at all primary health care units. The subjects

Table 1. Characteristics of patients with type 2 diabetes and non-diabetic control subjects (ns)

Characteristics		Type 2 diabetes $n = 102$	Controls $n = 102$
Age,* years			
Mean ± *s*		64.8 ± 8.4	64.9 ± 8.5
Range		34–76	34–77
Gender*			
(F/M)		38/64	38/64
Education (%)	Elementary and senior high school	92.1	89.2
	University/College degree	7.9	10.8
Occupation (%)	Blue-collar worker	81.6	74
	Self-employed/White collar worker	18.4	26
Financial status (%)	Good/very good	42.7	46.1
	Neither good nor poor	42.7	44.1
	Poor/very poor	14.6	9.8
Diabetes duration (year)			
Mean ± *s*		9.9 ± 6.1	
Treatment			
Oral anti-diabetic treatment %		68	
Insulin treatment %		22	
Combined treatment (oral anti-diabetic agents and insulin) %			
Glycaemic control			
Acceptable ($HbA_{1c} \leq 7.5\%$)		66	
Poor ($HbA_{1c} > 7.5$)		35	
HbA_{1c} (%)			
Mean ± *s*		7.1 ± 1.4	
Range		3.9–11.1	

* Matched variables; *s* = standard deviation.

were separated into glycemic groups according to the limits of the World Health Organization (31); HbA_{1c} value $\leq 7.5\%$ was considered 'acceptable' and $HbA_{1c} > 7.5\%$ 'poor' glycemic control (Table 1).

Procedures

The diabetic patients who participated in the interview concerning diabetes self-care and health were given the questionnaire and requested to fill in and return it within a week. The control subjects received the questionnaire at the clinical examination (7) and were asked to fill in and mail it to one of the authors (GS) within a week.

Information on the diabetic patient's age, duration of diabetes, anti-diabetic treatment, glycemic control and the presence of late complications was extracted from medical records at the primary health care units (Table 1).

Ethics

All patients were informed about the aims of the study and its voluntary nature. The medical ethics committee at Uppsala University approved the design of the study.

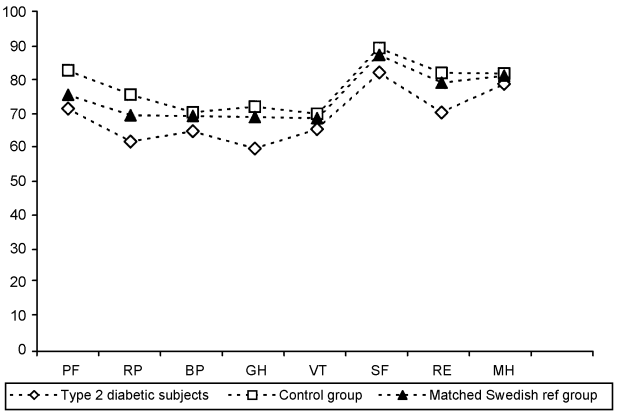
Statistical analyses

StatView 6.0 was used for all analyses. Results are presented as mean values with standard deviation (s). For comparison of means, *t* test and ANOVA were used. Chi-squared tests were used for comparing discontinuous data. Cronbach's alpha was used to test reliability (homogeneity) of the SF-36 questionnaire domains. A power calculation was performed with regard to the HRQL analyses. With 80% power ($\alpha = 0.05$), and the assumption of detection differences of at least 20% between the groups, the calculation showed that 100 subjects in each group were needed. When comparing health domains between groups, the *P* value was set to ≤ 0.01, as there could have been a risk for mass-significance. Bivariate analyses and correlational analyses (Student's *t* test and chi-squared test) were done first to determine the variables to be included in multiple regression analyses. Variables with high inter-correlation or low intercorrelation with the dependent variable were excluded to avoid bias. The variables included were: presence of diabetes; number of teeth; satisfaction with teeth and mouth; feeling of dry mouth; changes in the oral mucosa; smoking; regularity of dental visits; age; gender; occupation; financial status; and civil status. Multiple regression analysis was used to determine variables contributing to an explanation of the variance in each of the health domains. Independent variables were excluded in a stepwise procedure to find significant models explaining the variance of HRQL.

Results

Characteristics of the study population

Table 1 shows that there were no significant differences between the 102 randomly sampled type 2 diabetic



PF= Physical Functioning, RP= Role functioning-Physical, BP= Bodily Pain, GH= General Health, VT= Vitality, SF= Social Functioning, RE= Role functioning -Emotional, MH= Mental Health

Fig. 1. The HRQL profile in the group of type 2 diabetic subjects, controls, and the matched Swedish reference group.

patients and the 102 age-matched and gender-matched non-diabetic controls concerning the demographic characteristics. The table also presents characteristics regarding diabetes-related variables. More than half of the diabetic subjects (55%) had had their diabetes for less than 10 years. Patients who were on insulin treatment had longer duration than those on diet/oral or combined treatment (15/8/10 years; $P < 0.0001$) and a higher HbA_{1c} mean value than those on diet/oral treatment (7.9% vs 6.8%; $P = 0.003$) or combined treatment (7.1%, ns).

Health-related quality of life (HRQL) profile

The HRQL profile in the group of type 2 diabetic patients showed a pattern similar to that of the controls and the Swedish reference group (Fig. 1). In some of the health domains, however, type 2 diabetic patients had lower scores than the control subjects, e.g. in Physical Functioning ($P < 0.001$) and General Health ($P < 0.0001$). There was also a tendency toward lower scorings in the domains Role functioning—Physical and Social Functioning ($P = 0.016$ and $P = 0.017$). The controls and the matched Swedish reference group had almost identical scores (Fig. 1).

Oral health variables and HRQL

Number of teeth. Diabetic as well as control subjects with ≥20 natural teeth (mean age 61 ± 9 in both groups) exhibited higher HRQL scores (80 and 87) than did those without natural teeth (mean age 70 ± 6 diabetics; 72 ± 2 controls), who scored lower in the health domain Role functioning—Emotional (48 and 57) although not significantly so ($P = 0.017$ and 0.019). Diabetic subjects with few remaining natural teeth (0 and 1–9 teeth) scored lower ($P \leq 0.01$) in Physical Functioning and Role functioning—Physical than did those with ≥20 natural teeth (Table 2).

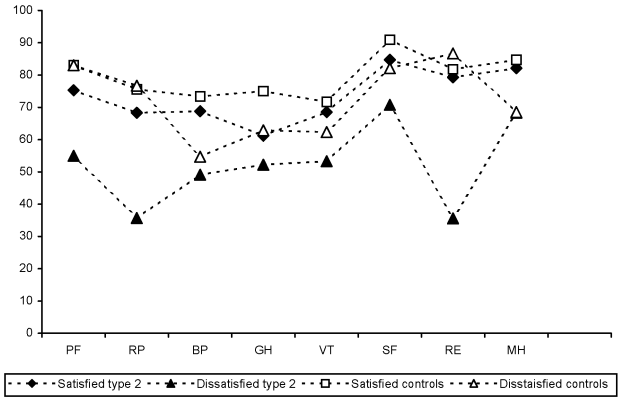
Satisfaction with teeth and mouth. High satisfaction with teeth and mouth was reported among a majority of diabetic and control subjects (83.3% vs 85.5%) (24). In all health domains except General Health, Vitality and Social Functioning, the dissatisfied diabetic subjects scored significantly lower than did those who were satisfied ($P \leq 0.01$). In the control group, the dissatisfied subjects scored significantly lower with respect to Bodily Pain ($P \leq 0.01$) and Mental Health ($P \leq 0.01$) than did those who were satisfied (Fig. 2).

Oral dryness (xerostomia) and HRQL. Oral dryness was a common complaint, especially among diabetic patients, 54% vs 28% among the controls (24). Control subjects with oral dryness compared to those without the condition displayed lower HRQL scores in all health domains ($P \leq 0.01$) except Social Functioning and Role functioning—Emotional. By contrast, there were no differences in

Table 2. Mean value ± *s* for SF-36 health domains in relation to number of teeth among type 2 diabetic and control subjects

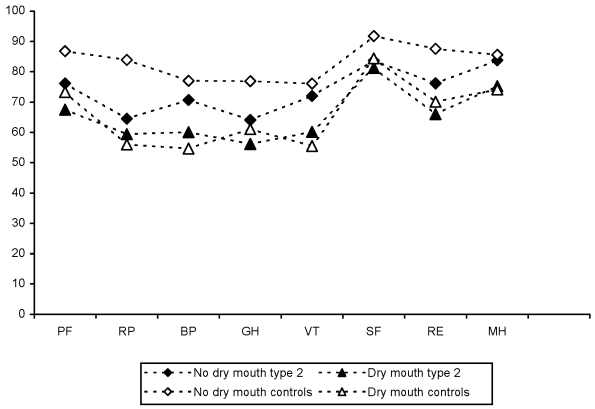
	0 teeth		1–9 teeth		10–19 teeth		≥20 teeth		
Health domains	Type 2 diabetes ($n = 13$)	Controls ($n = 7$)	Type 2 diabetes ($n = 17$)	Controls ($n = 16$)	Type 2 diabetes ($n = 25$)	Controls ($n = 26$)	Type 2 diabetes ($n = 47$)	Controls ($n = 53$)	*P* value
PF	55.0 ± 26.6^{a}	80.7 ± 11.3	60.0 ± 27.7^{b}	79.7 ± 25.9	70.8 ± 20.2	79.0 ± 22.3	$80.1 \pm 22.6^{a,b}$	86.0 ± 18.9	a)** b)**
RP	34.1 ± 40.7^{a}	57.1 ± 42.6	38.5 ± 45.2^{b}	78.3 ± 37.6	69.0 ± 39.5	68.0 ± 41.2	$72.7 \pm 36.9^{a,b}$	81.3 ± 32.8	a)** b)**
BP	59.9 ± 27.8	65.1 ± 23.8	56.4 ± 31.0	68.7 ± 26.6	65.0 ± 24.1	62.9 ± 25.6	69.4 ± 27.9	75.8 ± 25.1	
GH	60.1 ± 24.5	72.3 ± 18.1	54.5 ± 21.3	72.1 ± 18.3	63.3 ± 18.5	68.6 ± 24.4	59.5 ± 21.2	73.9 ± 20.9	
VT	61.2 ± 24.2	84.3 ± 18.1	56.9 ± 21.3	70.9 ± 24.8	69.2 ± 19.7	65.0 ± 23.7	67.7 ± 25.8	70.9 ± 21.7	
SF	80.7 ± 26.4	98.2 ± 4.7	75.0 ± 25.0	82.8 ± 27.0	83.9 ± 18.2	88.0 ± 23.0	84.7 ± 22.5	91.5 ± 15.5	
RE	48.5 ± 50.3	57.1 ± 46.0	56.4 ± 45.9	77.8 ± 41.1	72.5 ± 42.2	81.3 ± 32.0	80.1 ± 34.6	87.8 ± 29.5	
MH	71.1 ± 16.5	92.6 ± 13.0	77.5 ± 16.7	84.5 ± 17.8	79.5 ± 17.5	78.0 ± 24.6	82.0 ± 20.0	82.5 ± 17.4	

PF = Physical functioning; RP = Role functioning – Physical; BP = Bodily pain; GH = General health; VT = Vitality; SF = Social functioning; RE = Role functioning – Emotional; MH = Mental health.
** $P \leq 0.01$.
A superscript letter in a health domain implies a significant difference ($P \leq 0.01$) between for example [a] and [a] in that domain.
s = standard deviation.



PF= Physical Functioning, RP= Role functioning- Physical, BP= Bodily Pain, GH= General Health, VT= Vitality, SF= Social Functioning, RE= Role functioning -Emotional, MH= Mental Health

Fig. 2. The HRQL profile in diabetic and non-diabetic subjects who were satisfied and dissatisfied, respectively, with teeth and mouth.



PF= Physical Functioning, RP= Role functioning- Physical, BP= Bodily Pain, GH= General Health, VT= Vitality, SF= Social Functioning, RE= Role functioning -Emotional, MH= Mental Health

Fig. 3. The HRQL profile in diabetic and non-diabetic subjects who reported dry mouth or no dry mouth.

SF-36 scores between those with and those without oral dryness in the diabetic group in any of the health domains (Fig. 3).

Factors related to HRQL

There were three variables (*dissatisfaction with teeth and mouth*, *the patient's subjective feeling of dry mouth*, and *poor financial status*) that contributed to the explanation of the variance in all health domains of HRQL in the study population. Having type 2 diabetes was important for the domains Physical Functioning, Role functioning—Physical, General Health, Social Functioning and the variable age for Physical Functioning and Role functioning—Physical. The regression model based on data from all subjects explained one-fifth to one-fourth of the variance in the various health domains (Table 3).

Discussion

Many authors have expressed the need to go beyond the traditional disease-based measures of oral disorders when addressing the social and psychological consequences and to include the patient's well-being and quality of life (9, 20, 32). This inspired us to perform the present study in a county in mid-Sweden, where we investigated whether oral health, having diabetes and/or socio-economic variables were related to HRQL among type 2 diabetic subjects compared with age-matched and gender-matched control subjects without diabetes.

The SF-36 questionnaire, a measure of HRQL, was the base and gave the profile of the two groups in our study population, which was also compared with a matched Swedish reference group. The groups showed a pattern similar in nature, but type 2 diabetic subjects exhibited less favorable scores in some of the domains than did controls and the matched Swedish reference group. In previous studies of self-rated health it has also been found that people with diabetes scored lower than non-diabetic individuals (33, 34).

Some oral health factors, e.g. deficient number of teeth ($\leq$9), were associated with deterioration in some of the patients' HRQL domains (Physical Functioning and Role functioning—Physical). Furthermore, subjects without natural teeth tended to rate the Role functioning—Emotional domain lower than did those with 20 teeth or more. They were almost 10 years older, which may have influenced this health domain. Gift (19) asserted that it might sometimes be problematic to use number of teeth as an indicator of oral health because it was not always obvious whether teeth had been replaced or not, and it said very little about their function and appearance. It is also difficult to provide a meaningful interpretation of self-assessed physical and social functioning and appearance against clinical measures if the level of earlier dysfunction is not known (8).

In an earlier study of the present population (24), those with only natural teeth expressed most satisfaction with their teeth and mouth, but also edentulous individuals with a complete set of removable dentures were satisfied to a high degree. According to some authors (35), few natural teeth could be associated with poorer functioning than being totally edentulous or wearing full dentures. Also Allen et al. (36) found that edentulous people were relatively satisfied with wearing complete dentures. Diabetic subjects who were dissatisfied with teeth and mouth scored significantly lower in more HRQL domains than did those who were satisfied. Mere dissatisfaction with teeth and mouth may not explain the negative impact on the diabetic subject's HRQL. It is possible that dissatisfaction increases the burden of other problems caused by diabetes which might have had a negative influence on HRQL.

Table 3. Results of the multiple regression analyses of variance related to the SF-36 health domains. The analyses are based on the total group of patients ($n = 204$)

Health domains	R^2	F	*P* value	Variables explaining the variance
Physical functioning	0.23	8.83	***	Type 2 diabetes Dissatisfaction with the mouth Subjective feeling of dry mouth Age (elderly) Civil status Poor financial status
Role functioning – physical	0.20	6.26	***	Type 2 diabetes Dissatisfaction with the mouth Subjective feeling of dry mouth Age (elderly) Poor financial status
Bodily pain	0.23	17.85	***	Dissatisfaction with the mouth Subjective feeling of dry mouth Poor financial status
General health	0.27	14.72	***	Type 2 diabetes Dissatisfaction with the mouth Subjective feeling of dry mouth Poor financial status
Vitality	0.25	20.30	***	Dissatisfaction with the mouth Subjective feeling of dry mouth Poor financial status
Social functioning	0.13	6.34	***	Type 2 diabetes Dissatisfaction with the mouth Subjective feeling of dry mouth Poor financial status
Role functioning – emotional	0.18	6.96	***	Dissatisfaction with the mouth Subjective feeling of dry mouth Civil status Poor financial status
Mental health	0.23	18.78	***	Dissatisfaction with the mouth Subjective feeling of dry mouth Poor financial status

*** $P = 0.0001$.

Oral dryness is often unpleasant and painful (4) and has been shown to have a negative effect on the general quality of life (16, 37). Although oral dryness was a common complaint in our study population (54% of the diabetic and 28% of control subjects), there were no differences in the HRQL scores between diabetic subjects *with* and *without* the feeling of dry mouth. One explanation for this may be that subjects with type 2 diabetes are loaded with other problems, a conclusion which may be drawn since also those without feeling of dry mouth had relatively low HRQL scores. Furthermore, signs and symptoms of dry mouth can be dramatic, but can also be overlooked because this is a condition that accompanies disease or is a side effect of a treatment regimen rather than a disease itself (16). Surprisingly, the control subjects *with* dry mouth and those *without* differed significantly in all health domains except Social Functioning and Role functioning—Emotional. In contrast to diabetic subjects, the controls *without* dry mouth showed higher scores in the HRQL domains, which implied larger and significant differences between those *with* and *without* dry mouth.

Financial status was significantly related to all health domains in the regression models. The fact that subjects with low incomes are more likely to experience a poorer quality of life has been verified in other studies (8, 38–40). All regression models were significant, with the variables dissatisfaction with teeth and mouth, dry mouth and poor financial status being significant across all models. However, they explained only a certain proportion (approximately one-fifth to one-fourth) of the variance. Important variables that have not been measured in this study probably play an major role in health-related quality of life and account for the differences in HRQL.

Glasgow et al. (40) found that there is a need to include socio-economic factors in diabetes research, but suggested that few studies have a large enough number and adequate samples of people with diabetes to explore quality of life differences. Our power calculation showed that 100 subjects in each group were needed, which was done to detect significant differences at the 95% level. Additionally, owing to the large number of correlations computed, the *P* value was set at $p \leq 0.01$ to reduce the risk of mass significances. This study of 102 randomly sampled type 2 diabetic subjects and age-matched and gender-matched control groups from the same residential area may act as a control for factors that could affect the results. The characteristics of the type 2 diabetic group in our study also correspond quite well with type 2 diabetic subjects in other Swedish studies (41–44). Many authors are of the opinion that it is necessary to assess oral health and quality

of life over time (8, 23, 38). This study had a cross-sectional design, which is a weakness, and therefore the results provide information only about the associations between the variables and not about causality.

Our study indicates that several factors may be associated with impaired HRQL, especially among type 2 diabetic subjects, although only a partial understanding of its relation to oral health could be demonstrated. Patient-viewed assessment of functioning and well-being can form a bridge between the scientific and human aspects (45) and there is a need to include patients' experiences of their function and well-being in the assessment of oral health outcomes. A broadened understanding in that respect could help not only patients and society, but also the dental service in planning and realizing oral health promotion programs suitable for different groups of patients.

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References

1. Emrich LJ, Shlossman M, Genco RJ. Periodontal disease in non-insulin-dependent diabetes mellitus. J Periodontol 1991;62:123–31.
2. Löe H. Periodontal disease. The sixth complication of diabetes mellitus. Diabetes Care 1993;16:329–34.
3. Rees TD. The diabetic dental patient. Dent Clin North Am 1994;38:447–63.
4. Zachariasen RD. Xerostomia and the diabetic patient. J Gt Houst Dent Soc 1996;67:10–3.
5. Jones RB, McCallum RM, Kay EJ, Kirkin V, McDonald P. Oral health and oral health behaviour in a population of diabetic outpatient clinic attenders. Community Dent Oral Epidemiol 1992;20:204–7.
6. Quirino MR, Birman EG, Paula CR. Oral manifestations of diabetes mellitus in controlled and uncontrolled patients. Braz Dent J 1995;6:131–6.
7. Sandberg GE, Sundberg HE, Fjellstrom CA, Wikblad KF. Type 2 diabetes and oral health. A comparison between diabetic and non-diabetic subjects. Diabetes Res Clin Pract 2000;50:27–34.
8. Gift HC, Redford M. Oral health and the quality of life. Clin Geriatr Med 1992;8:673–83.
9. Locker D. Health outcomes of oral disorders. Int J Epidemiol 1995;24 Suppl 1:S85–9.
10. Locker D, Clarke M, Payne B. Self-perceived oral health status, psychological well-being, and life satisfaction in an older adult population. J Dent Res 2000;79:970–5.
11. Chen MS, Hunter P. Oral health and quality of life in New Zealand: a social perspective. Soc Sci Med 1996;43:1213–22.
12. Slade GD, Strauss RP, Atchison KA, Kressin NR, Locker D, Reisine ST. Conference summary: assessing oral health outcomes: measuring health status and quality of life. Community Dent Health 1997;15:3–7.
13. McGrath C, Bedi R. A study of the impact of oral health on the quality of life of older people in the UK: findings from a national survey. Gerodontology 1998;15:93–8.
14. Corson MA, Boyd T, Kind P, Allen PF, Steele JG. Measuring oral health: does your treatment really make a difference. Br Dent J 1999;187:481–4.
15. Hollister MC, Weintraub JA. The association of oral status with systemic health, quality of life, and economic productivity. J Dent Educ 1993;57:901–12.
16. Gambucci JR. Oral health concerns in older adults. Assessment and treatment. Postgrad Med 1987;81:363–7:370.
17. Norlen P, Ostberg H, Bjorn AL. Relationship between general health, social factors and oral health in women at the age of retirement. Community Dent Oral Epidemiol 1991;19:296–301.
18. Mattsson U, Heyden G, Landahl S. Comparison of oral and general health development among institutionalized elderly people. Community Dent Oral Epidemiol 1990;18:219–22.
19. Gift HC. Oral health outcomes research: challenges and opportunities. In: Slade G, editor. Measuring Oral Health and Quality of Life. North Carolina: Department of Dental Ecology, School of Dentistry, University of North Carolina; 1996. p. 26–45.
20. Slade GD. Assessing change in quality of life using the Oral Health Impact Profile. Community Dent Oral Epidemiol 1998; 26:52–61.
21. Locker D. Concepts of oral health, disease and the quality of life. In: Slade G, editor. Measuring Oral Health and Quality of Life. North Carolina: Department of Dental Ecology, School of Dentistry, University of North Carolina; 1997. p. 11–23.
22. Gift HC, Atchison KA. Oral health, health, and health-related quality of life. Med Care 1995;33 11 Suppl:NS57–77.
23. Sjödén P. Livskvalitetsmätning i onkologisk forskning och vård. In: Strang BB-FP, editor. Palliativ Medicin. Stockholm: Liber; 1995. p. 23–31.
24. Sandberg GE, Sundberg HE, Wikblad KF. A controlled study of oral self-care and self-perceived oral health in type 2 diabetic patients. Acta Odontol Scand 2001;59:28–33.
25. Sullivan M, Karlsson J, Ware J. SF-36 Hälsoenkät. Manual och tolkningsguide. Göteborg: Sektionen för vårdforskning, Medicinska fakulteten, Göteborgs Universitet och Sahlgrenska sjukhuset; 1994.
26. Ware JE, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Med Care 1992;30:473–83.
27. Ware J, Snow K, Kosinski M, Gandek B SF-36 Health Survey Manual and Interpretation Guide. Boston: Health Institute, New England Medical Centre; 1993.
28. Stewart AL, Hays RD, Ware JE, Jr. The MOS short-form general health survey. Reliability and validity in a patient population. Med Care 1988;26:724–35.
29. McHorney CA, Ware JE, Jr, Rogers W, Raczek AE, Lu JF. The validity and relative precision of MOS short- and long-form health status scales and Dartmouth COOP charts. Results from the Medical Outcomes Study. Med Care 1992; 30 5 Suppl: MS253–65.
30. Uhrbom E, Bjerner B EPIWUX-93: Department of Public Health, County of Dalarna, Falun, Report No. 23, 1993.
31. WHO. Diabetes Mellitus. Fact Sheet. Geneva: WHO/OMS, 2000, Information; 1999. Report No. 138.
32. Gift HC. Quality of life: an outcome of oral health care? [editorial]. J Public Health Dent 1996;56:67–8.
33. Ahroni JH, Boyko EJ, Davignon DR, Pecoraro RE. The health and functional status of veterans with diabetes. Diabetes Care 1994;17:318–21.
34. Stewart AL, Greenfield S, Hays RD, Wells K, Rogers WH, Berry SD, et al. Functional status and well-being of patients with chronic conditions. Results from the Medical Outcomes Study. J Am Med Assoc 1989;262:907–13.
35. Oosterhaven SP, Westert GP, Schaub RM, van der Bilt A. Social and psychologic implications of missing teeth for chewing ability. Community Dent Oral Epidemiol 1988;16:79–82.
36. Allen PF, McMillan AS, Walshaw D, Locker D. A comparison of the validity of generic- and disease-specific measures in the

assessment of oral health-related quality of life. Community Dent Oral Epidemiol 1999;27:344–52.
37. Whelton H. Introduction: The anatomy and physiology of salivary glands. In: Edgar W, O'Mullane D, editors. Saliva and oral health, 2nd ed. London: British Dental Association; 1996. p. 1–8.
38. Lloyd CE, Orchard TJ. Physical and psychological well-being in adults with Type 1 diabetes. Diabetes Res Clin Pract 1999;44:9–19.
39. Grath CM, Bedi R, Gilthorpe MS. Oral health related quality of life: views of the public in the United Kingdom. Community Dent Health 2000;17:3–7.
40. Glasgow RE, Ruggiero L, Eakin EG, Dryfoos J, Chobanian L. Quality of life and associated characteristics in a large national sample of adults with diabetes. Diabetes Care 1997;20:562–7.
41. Clauson P, Linnarsson R, Gottsater A, Sundkvist G, Grill V. Relationships between diabetes duration, metabolic control and beta-cell function in a representative population of type 2 diabetic patients in Sweden. Diabetes Med 1994;11:794–801.
42. Clauson PG, Brismar K, Hall K, Linnarsson R, Grill V. Insulin-like growth factor-I and insulin-like growth factor binding protein-1 in a representative population of type 2 diabetic patients in Sweden. Scand J Clin Lab Invest 1998;58:353–60.
43. Lundman B, Engström L. Diabetes and its complications in a Swedish county. Diabetes Res Clin Pract 1998;39:157–64.
44. Wändell P. Diabetes in primary care. Quality of life, metabolic control, drugs and socioeconomic factors. Stockholm: Karolinska institutet; 1997.
45. Locker D. The burden of oral disorders in a population of older adults. Community Dent Health 1992;9:109–24.

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