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Oral self-care among Finnish adults with diabetes mellitus – a focus on periodontal diseases

Academic dissertation

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To Sanni and Enni
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Abstract

Diabetes is a well-documented risk factor for periodontal disease, affecting disease susceptibility, progression and severity. While periodontal diseases are multifactorial in nature, oral self-care plays a central role in disease prevention, treatment and maintenance care. The aim of this study was to evaluate oral self-care and its determinants among Finnish adults with diabetes. Moreover, the effect of oral health promotion intervention related to motivation to regular dental visits was studied. The intervention was implemented in cooperation with dental health professionals and diabetes nurses. The research consisted of a nation-wide questionnaire study (n=420) and a longitudinal community trial (n=120) among type 1 and type 2 diabetes patients visiting the Salo Regional Hospital Diabetes Clinic.

Oral self-care among adults with diabetes is inadequate, particularly when this group’s increased risk for periodontal diseases is considered. In addition to commonly identified determinants of frequent oral health behaviours, the results indicated the importance of awareness and appreciation of oral health. A high prevalence of periodontal pockets (CPITN 3 or 4) among the study population was also found. Evaluation of oral health promotion revealed more improvement in periodontal health indicators among the study groups compared with the control group. Healthy life-style choices, such as cessation of cigarette smoking and regular oral self-care, proved to be modifiable determinants of periodontal treatment needs.

The results revealed deficiencies in oral health behaviours and indicated a need for oral health promotion among adults with diabetes. On the other hand, the oral self-care intervention implemented showed that it is possible to further promote periodontal health in this population. To improve the common risk factor approach and patient empowerment, cooperation among all health care professionals involved in diabetes care is highly recommended.

Key Words: diabetes mellitus, oral self-care, periodontal treatment needs, oral health promotion intervention
Abbreviations and definition of terms

AGE           advanced glycation end-product  
BLQS  baseline questionnaire study  
CPITN          community periodontal index of treatment needs  
DM           diabetes mellitus  
Ec                endothelial cell  
HbA  glycated haemoglobin A  
HbA  glycated haemoglobin A  
IL-1  interleukin-1  
IL-6              interleukin-6  
MMP                 matrix metalloprotease  
NWQS  nation-wide questionnaire study  
PGE2               prostaglandin E  
PMN        polymorphonuclear neutrophil  
RAGE          receptor for advanced glycation end-product  
TNF-α        tumour necrosis factor-α  
WHO        World Health Organization  

Compliance;  
the degree to which a person follows another’s prescribed regimen of care (Rapley 1997).  
Oral hygiene habits;  
tooth brushing, interdental cleaning, mouth rinses  
Oral health (care) habits;  
interdental cleaning, tooth brushing, dental visits (Inglehart & Tedesco 1995b).  
Oral health behaviour(s);  
personal oral health practices and use of oral health services (Andersen et al. 1995).  
Oral self-care;  
oral self-care as part of general health self-care comprises a wide spectrum of activities,  
ranging from self-diagnosis, -treatment and -prevention to seeking lay and professional care (Glavind & Nyvad 1987).
Oral health promotion;
a process of enabling people to increase control over and to improve their health (WHO 1984b).
Risk factor;
causally related and increases the probability of occurrence of disease (Pilot 1997).
Survey;
a system for collecting information to describe, compare or explain knowledge, attitudes and
behaviour (Fink 1995).
Type 1 diabetes;
due to insulin deficiency caused by autoimmune destruction of the B-cells in the pancreatic
islets (Ganong 1999).
Type 2 diabetes;
characterized by insulin resistance and impaired insulin secretion (Ganong 1999).
List of original publications

This thesis is based on the following articles, which are referred to in the text by their Roman numerals.


In addition, the thesis includes some unpublished results.
1. Introduction

Diabetes increases the risk for periodontal diseases (Yalda et al. 1994, Pinson et al. 1995, Page & Beck 1997, Salvi et al. 1997a, Soskolne 1998) and the prevalence of diabetes in patients with periodontitis is significantly higher that seen in non-periodontitis patients (Soskolne & Klinger 2001). Certain subgroups of patients with diabetes are more prone to periodontal diseases. Poor metabolic control (Tervonen & Oliver 1993, Karjalainen & Knuuttila 1996, Collin et al. 1998, Tsai 2002), other complications (Karjalainen et al. 1994, Thorstensson et al. 1996) and long duration of diabetes (Hugoson et al. 1989) have been suggested to increase the risk for periodontal diseases.

The number of people in Finland with type 1 diabetes is about 30 000 and with type 2 diabetes 150 000 (Development Programme for the Prevention and Care of Diabetes in Finland 2000). Individuals with undiagnosed diabetes are estimated to number at least 50 000 (Development Programme for the Prevention and Care of Diabetes in Finland 2000). When the proportion of patients with diabetes is evaluated only with respect to impaired metabolic control, Valle et al. (1999) found that some 51% of patients with type 1 and 46% with type 2 diabetes have poor glycaemic control (HbA1c ≥ 8.6%). These figures also describe the number of patients with diabetes at high risk for periodontal disease in Finland, if estimated by poor metabolic control alone.

Diabetes and periodontal disease have a special two-way relationship (Grossi & Genco 1998, Soskolne & Klinger 2001). Acute infections and inflammatory conditions lead to increases in glucose and insulin utilization and therefore complicate metabolic control in diabetes (Yalda 1994, Bell et al. 1999). Grossi (2001) suggested that chronic periodontal infection increases the severity of diabetes and complicates its control. However, Gustke (1999) and Taylor (1999) concluded that studies are currently insufficient to establish periodontal therapy as having a positive influence on glycaemic control in type 1 or type 2 diabetes. The role of periodontal therapy is particularly questionable if systemically administered adjunctive antibiotics are not used simultaneously (Grossi 2001).
While a variety of factors affect periodontal health, Löe (2000) concluded that instruction and motivation of patients with regular visits to the dental office and professional feedback and reinforcement seem to be the most successful approaches in preventing periodontal relapse and disease progression. Glavind & Nyvad (1987) highlighted the importance of oral self-care in the prevention and treatment of periodontal diseases. Moreover, the World Health Organization (WHO) has claimed the promotion of self-care as one of the most important primary health care strategies to reach the goal of “Health for all by the year 2000” (WHO 1984). Surprisingly, although the significance of good oral health is emphasized among individuals with diabetes, oral self-care has rarely been studied in this population.

Diabetes and periodontal health demand persistent daily self-care. They share similar psychological features (Kneckt et al. 1999, 2000), and the same principles in health promotion through patient empowerment are applicable (Anderson 1995, Schou & Locker 1997). Furthermore, oral health problems and a number of common chronic diseases, such as heart diseases, cancer and diabetes, have some common risk factors, such as smoking diet and stress. In addition, the main risk factors for the major chronic diseases tend to cluster in the same individuals (Sheiham & Watt 2000). Sheiham & Watt (2000) concluded that further improvements in oral health would only be secured through the adoption of oral health promotion policies based upon the common risk factor approach.

It seems to be evident that individuals with diabetes are in need of special care regarding their oral health, especially their periodontal health. The object of this longitudinal study was to examine oral self-care and its determinants among Finns with diabetes. Moreover, an oral health promotion programme implemented in co-operation with dental professionals and diabetes nurses was designed to provide a foundation for the reorganization of oral care among individuals with diabetes.

The concept of oral self-care includes prevention of both common oral diseases, caries and periodontal diseases. The prevalence of decayed and filled root surfaces, in particular, is higher in subjects with diabetes than in controls (Moore et al. 2001a). Higher rates of dental decay have also been found among subjects with low resting salivary flow rates (Moore et al. 2001b). The role of xerostomia, which is a well-documented symptom among people with diabetes, is unclear in periodontal diseases. However, poor glycaemic control seems to be a
risk factor also for caries among individuals with diabetes (Karjalainen et al 1997). In spite of the common features between caries and periodontal diseases in populations with diabetes, this research focused on periodontal diseases alone.
2. Literature review

2.1. Risk factors for periodontal disease

In the 1990s, a new concept for the pathogenesis of periodontal disease was introduced. Page & Kornman (1997) summarized the multifactorial nature of the disease as follows: while bacteria are essential, they are insufficient for the disease to occur; host and environmental factors, on the other hand, strongly influence the severity of the disease and the response to treatment. Identified risk factors for periodontal disease include smoking, ageing, oral hygiene status and micro-organisms, history of periodontitis, family history, genetic factors and certain systemic diseases and conditions, such as diabetes, osteoporosis and HIV infection (Genco 1996, Page & Beck 1997, Salvi et al. 1997a, Kinane 2001). In addition to these, frequency of dental visits (Page & Beck 1997), socio-economic factors and gender have been suggested (Genco 1996, Kinane 2001). Although genetic factors may markedly affect disease susceptibility, especially for early-onset periodontitis (Hart 1996, Page & Beck 1997), these factors are difficult to modify (Page & Beck 1997). Kornman (2001) concluded that diabetes, smoking and genetics identify patients at risk for periodontal disease and also for an unfavourable response to treatment.

2.2. Diabetes and periodontal diseases

Recent study reviews (Page & Beck 1997, Salvi et al 1997a) consider both type 1 and type 2 diabetes as risk factors for periodontal disease. Yalda et al. (1994) reported that the risk for periodontitis increases approximately 2- to 3-fold when diabetes is present. Even in children and adolescents, gingivitis has been shown to be more prevalent (Pinson et al. 1995) and clinical attachment loss higher (Firatli 1997) in those with diabetes than in controls, despite similar levels of plaque control. By contrast, Sbordone et al. (1998) found no significant differences in periodontal parameters between children with diabetes and their non-diabetic siblings in a 3-year longitudinal study. In their study, patients and their parents were motivated to maintain a high level of diabetic and oral health care, which might have had a positive effect on results.
2.2.1. Diabetes-related risk factors

Certain groups of people with diabetes appear to be particularly susceptible to periodontal disease. Poor glycaemic control (Seppälä & Ainamo 1994, Collin et al. 1998, Tsai et al. 2002), other organ complications (Karjalainen et al. 1994, Thorstensson et al. 1996) and a long history of disease (Hugoson et al. 1989) have been proposed to increase the risk for periodontal disease.

2.2.1.1. Metabolic control

Hyperglycaemia and poor metabolic control increase gingival bleeding in children and adolescents with diabetes (Karjalainen & Knuuttila 1996). Among adults, studies from 1990 onwards have indicated that poorly controlled diabetes is associated with increased susceptibility to gingivitis and gingival bleeding (Seppälä et al. 1993), attachment and bone loss (Saškan-Seppälä & Ainamo 1992, Seppälä & Ainamo 1994) and periodontitis (Tervonen & Oliver 1993, Collin et al. 1998, Tsai et al. 2002). A few exceptions to these results are those of Bridges et al. (1996), who apparently used only one fasting plasma glucose and glycohaemoglobin value and Thorstensson et al. (1996), where only one HbA1 measurement was taken on each occasion. Current HbA1c value did not seem to be related to the onset of complications (Nishimura et al. 1998). Karjalainen (2000) concluded in her thesis that information on long-term control is needed in the case of chronic and slowly progressing oral diseases such as dental caries and periodontitis. Tervonen & Oliver (1993) were the first to use multiple HbA1c values to determine long-term metabolic control of diabetes. Dividing patients into poorly controlled and controlled type 1 diabetes groups was used in Saškan-Seppälä (2001), where grouping was based on patients’ medical status in addition to glycated haemoglobin values.

2.2.1.2. Other diabetic complications

Periodontal disease can be considered to be a microvascular complication of diabetes (Lamster & Lalla 2001), and Nishimura et al. (1998) proposed that periodontal disease may develop as early as other microvascular diabetic complications. Advanced retinal complications seem to be associated with excessive periodontal treatment needs (Bacic et al. 1988). Karjalainen et al. (1994) found that deep periodontal pockets (≥4 mm) with calculus were significantly more frequent among patients with advanced complications compared with
patients without complications. An association seems to exist between renal disease, cardiovascular complications and severe periodontitis (Thorstensson et al. 1996). Poor metabolic control and/or multiple complications increase the risk for periodontal disease breakdown (Tervonen & Karjalainen 1997).

2.2.1.3. Long duration of the disease
Patients with long-duration (more than 10 years) type 1 diabetes exhibit more severe periodontal disease than those with short-duration (less than 7 years) diabetes or no diabetes, especially in the age group of 40-49 years (Hugoson et al. 1989). Thorstensson & Hugoson (1993) found in this same age group more periodontal destruction than in non-diabetic controls and bone loss of the same magnitude as in older patients with diabetes and concluded that age at diabetes onset appears to be a major risk factor for future periodontal destruction. However, Moore et al. (1999) demonstrated among patients with type 1 diabetes more extensive periodontal disease with late onset of disease (after 8.4 years of age) than with early onset of diabetes. Bridges et al. (1996), in studying patients with type 1 and type 2 diabetes, and Sandberg et al. (2000), who investigated patients with type 2 diabetes, both concluded that no correlation appears to exist between the duration of diabetes and the prevalence and severity of periodontal disease. However, the onset of type 2 diabetes is difficult to define precisely, since glycaemic abnormality develops gradually, with the preclinical phase lasting 5-10 years (Bell et al. 1999).

2.2.2. Hyperglycaemia - a common risk factor in diabetic complications

Diabetic complications comprise neuropathic disease, microangiopathic complications, such as retinopathy and nephropathy, and macroangiopathic complications with accelerated arteriosclerosis, including an increased incidence of stroke and myocardial infarction and low extremity gangrenes and amputations (Ganong 1999). A strong consistent relationship has been postulated between hyperglycaemia and the incidence and progression of microvascular and macrovascular complications in people with type 1 (The Diabetes Control and Complications Trial Research Group 1993) and in both type 1 and 2 diabetes (Klein 1995, Hanssen 1997). The data of the UK prospective diabetes study (UKPDS) suggests that any improvement in glycaemic control among patients with type 2 diabetes is likely to reduce the risk of diabetic complications (Stratton et al. 2000). Researchers in the dental field have
suggested that periodontal disease should be included among the complications of diabetes
2001).

One mechanism for complications in diabetes is the accumulation of sorbitol in the tissues
(Soskolne & Klinger 2001). Another well-established consequence of hyperglycaemia is non-
enzymatic glycation and oxidation of the body’s proteins and lipids (Soskolne & Klinger
2001). The best-known example of this interaction is glycated haemoglobin, which is used
clinically as a marker of long-term glucose control (HbA1c) (Lalla et al. 1998a).

2.2.2.1. Advanced glycation end-products
Non-enzymatic glycation and oxidation result in the formation of irreversible advanced
glycation end-products (AGEs), which are common to the different diabetic organ
complications (Brownlee 1992, 1994, Vlassara 1997). AGEs may also be involved in tissue
changes in the periodontium and have been demonstrated to be present in gingiva of patients
with diabetes (Schmidt et al. 1996) and diabetic mice (Lalla et al. 1998b).

Cellular receptors for AGEs (RAGEs) are present on certain critical target cells in diabetes
such as monocytes, macrophages, endothelial cells, mesangial cells and fibroblasts (Vlassara
et al. 1994, Lamster & Lalla 2001). Binding of the AGE-modified protein to the macrophage
receptor induces synthesis and secretion of cytokines, mostly of interleukin-1 (IL-1), tumour
necrosis factor-α (TNF-α) and insulin-like growth factor I (Brownlee 1994). The
consequences of AGE-induced changes in endothelial function are focal thrombosis and
excessive vasoconstriction (Brownlee 1994). Salvi et al. (1997b, 1998) indicated that patients
with type I diabetes have an elevated gingival crevicular fluid secretion of interleukin-1β (IL-
1β), prostaglandin E₂ (PGE₂) and tumour necrosis factor-α (TNF-α) compared with non-
diabetic controls. Salvi et al. (1997b) found no association between the metabolic control of
diabetes and the severity of periodontal disease, and concluded that genetic factors may be
responsible for altered monocyte cytokine secretion in type I patients. AGEs may also induce
oxidant stress, which has been proposed to be responsible in part for the diffuse vascular
injury associated with diabetes (Schmidt et al. 1996).
AGE formation alters the functional properties of several important extracellular matrix components (Brownlee 1992, 1994). This formation also results in increased cross-linking between collagen molecules (Anonymous 2000) and changes in normal vascular tissue integrity (Brownlee 1994). Seppälä et al. (1997) showed that long-term, poorly controlled type 1 diabetes is reflected in less collagen and fibroblasts but more plasma cells in inflamed connective tissue in than non-diabetic controls.

2.2.2.2. Impaired polymorphonuclear leucocyte function

Reduced PMN function has been found in patients with diabetes (Anonymous 2000). Elevated glucose concentrations have an adverse effect on PMN function, contributing in part to altered host defence (Marhofer et al. 1992). In Cutler et al. (1991), an impairment of PMN function in a patient with diabetes was accompanied by depressed chemotaxis and phagocytosis and killing of *P. gingivalis*. Nishimura et al. (1998), by contrast, found no significant impairments in neutrophil functions, such as chemotaxis, phagocytosis and bactericidal activity, among Japanese adolescents with diabetes. The result might be due to the young age of the study population, but inherited differences may also be involved in neutrophil chemotaxis (Molenaar et al. 1976).

2.2.2.3. Other possible mechanisms

Hyperglycaemia itself and exaggerated inflammation response may change the microbiological flora of patients with diabetes. Seppälä & Ainamo (1996) found that spirochetes of subgingival microflora were more frequent in periodontal pockets of poorly controlled insulin-dependent diabetes than in controlled insulin-dependent diabetes subjects, even in healthy sites. On the other hand, periodontopathogens (*P. gingivalis* and *A. actinomycetemcomitans*) examined among patients with diabetes did not differ from those of the control subjects (Christgau et al. 1998, Collin et al. 1998).

The mechanism for modulation of cytokine production in diabetes is likely to be multifaceted. Cutler et al. (1999a) proposed that diabetes-induced elevations in serum lipids (hyperlipidemia) may play a major role in cytokine production. Formation of AGEs is connected to hyperglycaemia in combination with hyperlipidemia (Iacopino 1995), and AGE binding to macrophage receptors induces production of cytokines (Brownlee 1994). Diabetes-induced elevations in serum lipids may also interact directly with neutrophils and
macrophages (Iacopino 1995). Noack et al. (2000) did not find a significant relationship between abnormal glucose tolerance and levels of periodontal disease, but hyperlipidemia was associated with a higher risk for periodontitis, a finding supported by Cutler et al. (1999b).

Taken together, diabetic complications may be a result of a combination of metabolic, genetic and other so far unknown factors. In any case, hyperglycaemia seems to play a central role in all diabetic complications, and AGEs, as a result of hyperglycaemia/hyperlipidemia, may account for the numerous tissue changes involved in complications.

2.2.3. The two-way relationship

In addition to hyperglycaemia (Grossi & Genco 1998), also hyperlipidemia (Iacopino 2001, Soskolne & Klinger 2001), genetics and common immune mechanisms (Soskolne & Klinger 2001) have been proposed to explain the relationship between periodontitis and diabetes. Soskolne & Klinger (2001) showed that patients with diabetes, as compared with non-diabetics, not only have a significantly higher prevalence of periodontitis, but also the prevalence of diabetes in patients with periodontitis is double that seen in non-periodontitis patients. Obese people and those with type 2 diabetes are often found to have elevated fasting insulin concentrations with normal or elevated glucose levels. The exact connection between obesity and insulin resistance remains unclear, but adipocytes are recognized to secrete leptin, TNF-α and other polypeptides (Donahue & Wu 2001) and to contribute to the overall burden of systemic inflammation.

To date, diabetes is the only common systemic disease to be so clearly linked to periodontal disease. Grossi & Genco (1998) summarized the two-way relationship between diabetes and periodontal disease as shown in Figure 1.
Acute infections and inflammatory conditions lead to increases in glucose and insulin utilization and therefore complicate the metabolic control of diabetes (Bell et al. 1999, Yalda et al. 1994). Grossi (2001) presented the role of chronic periodontal infection in increasing the severity of diabetes and complicating diabetes control as due to up-regulation of TNF-α and cell surface toxins. Thus, control of periodontal inflammation has the potential to influence glucose metabolism in individuals with poor metabolic control, especially when concomitant antibiotics are used (Miller et al. 1992, Grossi et al. 1997). In most studies where systemic adjunctive antibiotics have not been used, little positive effect of periodontal treatment on metabolic control has been demonstrated (Seppälä & Ainamo 1994, Aldridge et al. 1995, Westfelt et al. 1996, Christgau et al. 1998). However, Gustke (1999) and Taylor (1999) concluded that studies are currently insufficient to establish periodontal therapy as influential in improving glycaemic control in either type 1 or type 2 diabetes.
According to Taylor et al. (1996), severe periodontitis should be considered to be a risk factor for poor glycaemic control. This is supported by Grossi (2001), who concluded that the more generalized the periodontal infection, the greater the effect on glucose control. Thorstensson et al. (1996) in a follow-up study found a significantly higher prevalence of proteinuria and cardiovascular complications among patients with severe periodontal disease than among patients with no/minor periodontal disease.

2.3. Oral self-care

Oral self-care, part of general health self-care (WHO 1984c), is defined by Glavind & Nyvad (1987) as a wide spectrum of activities ranging from self-treatment, -prevention and -diagnosis to seeking lay or professional care.

Personal and professional plaque control (Löe 2000) and oral self-care (Glavind & Nyvad 1987) seem to be the most decisive factors in the prevention and treatment of the vast majority of periodontal diseases. Axelsson et al. (1991) demonstrated that preventing plaque accumulation by a variety of professional and home-based techniques was extremely effective in preventing attachment loss over a period of 15 years. Furthermore, CPITN scores, which were calculated for each individual tooth surface, indicated a marked decrease in periodontal treatment needs (Axelsson 1991). However, Bartold et al. (1998) concluded that improved oral hygiene has little effect on the incidence of severe periodontal diseases and successful management of the diseases relies on the continuous assessment of at-risk patients and regular, thorough subgingival debridement. The nature of subgingival biofilm emphasizes the importance of regular mechanical scaling and root planning in periodontal therapy (Grossi 2001), and these actions are likely to remain central components in future periodontal therapy (Page et al. 1997).

2.3.1. Oral self-care among patients with diabetes

Local factors of plaque and calculus are required for periodontal diseases to occur even among patients with a periodontal risk factor such as diabetes (Salvi et al. 1997a). Oliver & Tervonen (1993) concluded that both metabolic control and oral hygiene affect the severity of
periodontal disease, although the increased risk for periodontal disease cannot be explained by oral hygiene (Oliver & Tervonen 1993, Saftan-Seppälä & Ainamo 1992). On the other hand, Bridges et al. (1996) and Sandberg et al. (2000) found significantly more plaque, gingival bleeding and probing depths in patients with diabetes than in non-diabetics.

Despite their high risk for periodontal disease, oral self-care studies among patients with diabetes are scarce. Three previous studies, which have compared all three oral health behaviours (i.e. brushing, interdental cleaning, dental visits) among patients with diabetes and control groups are summarized in Table 1.
Table 1. Oral health behaviours in patients with diabetes and controls, presented as percentages.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Brushing, twice daily (%)</th>
<th>Interdental cleaning, daily (%)</th>
<th>No regular dental visits (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thorstensson et al. 1989</td>
<td>DM 88, Controls 75</td>
<td>LDM 89, SDM 46</td>
<td>LDM 30, SDM 31</td>
</tr>
<tr>
<td></td>
<td>DM 31, Controls 30</td>
<td>LDM 11, SDM 17</td>
<td>LDM 17, SDM 3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Brushing, at least twice daily (%)</th>
<th>Flossing, at least weekly (%)</th>
<th>Dental visits within one year (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moore et al. 2000</td>
<td>DM 72, Controls 80</td>
<td>DM 33, Controls 30</td>
<td>DM 69, Controls 76</td>
</tr>
<tr>
<td></td>
<td>DM 91, Controls 94</td>
<td>DM 52, Controls 60</td>
<td>DM 15, Controls 5</td>
</tr>
</tbody>
</table>

DM = diabetes mellitus
LDM = long-term diabetes mellitus
SDM = short-term diabetes mellitus
Collin et al. (1998) indicated that out of patients with type 2 diabetes (n=25) 80% reported daily brushing and 28% annual dental visits. For controls (n=40), the rates were 90% and 43%, respectively. The difference was not statistically significant. In Jones et al. (1992), patients with insulin-treated diabetes claimed to be more regular dental attenders (61%) and to clean their teeth once or more a day (94%) as compared with those with tablet and diet treatment (45% and 83%, respectively). Spangler & Konen (1994) studied oral health behaviours among patients with insulin-dependent (type 1) and non-insulin-dependent (type 2) diabetes. The percentage of patients with twice daily brushing was 74% (both type 1 and 2), with daily flossing 34% and 30%, respectively, and with dental visits at least annually 23% and 40%, respectively. In Syrjälä et al. (1999), the rate for brushing twice daily was 50%, interdental cleaning daily 15% and dental attendance at least once a year 54%.

Moreover, Thorstensson et al. (1989) indicated that 13% of patients with diabetes and 4% of controls reported having received emergency treatment. Sandberg et al. (2001) found that fewer patients with diabetes (85.1%) than non-diabetic controls (95.1%) visited the dentist regularly. Patients with diabetes have also been found to miss more dental appointments, which they failed to cancel, than controls without diabetes (Pohjamo et al. 1995). Karjalainen et al. (1994) reported that subjects with advanced complications were less regular with dental visits and interdental cleaning than patients with no/minor complications.

To summarize, according to the previous studies, it seems that regular tooth brushing and regular dental visits are less common among individuals with diabetes that in control subjects, results concerning interdental cleaning being conflicting. Overall, there seems to be room for improving oral health behaviours among individuals with diabetes.

2.4. Health promotion

WHO (1984b) defines health promotion as a process of enabling people to increase control over and to improve their health. Health promotion utilizes a combination of complementary strategies to alter both the conditions and ways of living to promote health and well-being. According to the Ottawa Charter of Health Promotion, contemporary health promotion actions include developing personal skills and reorienting health services (WHO 1986). Watt
et al. (2001) have identified three health promotion actions as follows: education, defined as any opportunities for learning; facilitation, defined as action taken in partnership with individuals and groups to mobilize social and material recourses for health; and advocacy, defined as action taken on the behalf of individuals and/or groups to tackle structural barriers to achieving better health.

2.4.1. Oral health promotion

Oral health promotion should follow the principles defined in the Ottawa Charter for Health Promotion. Schou (1993) presents four major factors that influence the development and course of the most prevalent oral diseases - dental caries and periodontal disease. These factors are oral hygiene, sugar consumption, use of fluoride and dental visits, and promotion of oral health at all levels (individual, community, national and global) should focus on these factors. Sheiham (1995) also included smoking cessation and prevention of tooth trauma to oral health promotion policies.

The consensus statement on oral hygiene of Federation Dental International (FDI) second world conference on oral health promotion 1999 recommended tooth cleaning twice daily, professional mechanical tooth cleaning at time intervals tailored to patients’ needs, effective interdental cleaning and use of antimicrobial agents to augment oral hygiene (Löe 2000). Motivation of patients to perform optimal oral care has been found to be essential in promoting oral health behaviours (Inglehart & Tedesco 1995a) and in preventing periodontal relapse and disease progression (Löe 2000). To motivate people successfully, one not only has to provide them with information but also must pay attention to reasons, which might restrict oral care behaviour (Syriälä et al. 1992).

2.4.2. Health behaviour models

The complexity of human health behaviour has been explained by various theoretical models. The New Century Model of oral health promotion (Inglehart & Tedesco 1995a) was used as a theoretical framework in the present study. This model is based on earlier health behaviour models.
2.4.2.1. Previous health behaviour models

Bandura (1977) stresses the effect of psychological factors and especially the significance of self-related efficacy beliefs on health behaviour. In addition to the traditional health belief variables of health motive and perceived susceptibility, severity, benefits and barriers, Rosenstock et al. (1988) incorporated self-efficacy into the concepts of the Health Belief Model, which represents an application of value-expectancy theories. In the theory of reasoned action (Ajzen & Fishbein 1980) a person’s intention is the predictor of performing a behaviour, and intentions are a function of attitudes towards the behaviour and subjective norm. Ajzen (1988) developed the theory of planned action by adding a new variable, perceived behavioural control, to the theory of reasoned action. The importance of perceived behavioural control is in its motivational implication for intentions and its ability to predict the behaviour. Marlatt & Gordon’s relapse prevention model (1985) was developed to explain relapse behaviour in alcoholics and drug addicts, and has a specific social-cognitive approach to behaviour change (Inglehart & Tedesco 1995a).

2.4.2.2. The New Century Model of oral health promotion

The New Century Model of oral health promotion (Inglehart & Tedesco 1995a) offers a comprehensive framework based on earlier health behaviour models. It can be summarized as follows: a patient’s behaviour appears to be formed by cognitive, affective and behavioural factors interacting in a complex pattern with time perspective and the patient’s situation (see Figure 2).
Figure 2. New Century Model of oral health promotion (Inglehart & Tedesco 1995a). With the permission of the publisher.
2.4.3. Patient empowerment in diabetes and dental care

Prevention and maintenance care of periodontal diseases as well as of diabetes require dedicated daily self-care. A behavioural relationship has been identified between oral health and type 1 diabetes. Syrjälä et al. (1999) found that patients with diabetes who had better tooth brushing self-efficacy, higher frequency of tooth brushing and lower level of plaque had better HbA1c (glycated haemoglobin) levels. Diabetes self-efficacy correlated with dental self-efficacy and with related health behaviours (Kneckt 1999), with some determinants being shared by oral health behaviour and diabetes self-care (Kneckt 2000).

Self-care emphasizes a person’s own role as a decision-maker in contrast to compliance, which describes the degree to which a person follows another’s prescribed regimen of care (Rapley 1997). In many diabetes programmes, the focus is on empowering people with diabetes rather than on their metabolic control and compliance (Feste 1992). Patient empowerment emphasizes that people with diabetes make choices in their care each day and these choices are affected by their emotions, thoughts, values, goals and other psychosocial aspects of living with a chronic disease (Anderson 1995). Further, patient empowering posits that the purpose of diabetes patient education is to ensure that the choices patients make are informed choices. The patient is a responsible and active decision-maker in diabetes care (Anderson 1995). According to Schou & Locker (1997), empowerment is one of the three key concepts in oral health promotion.

2.4.3.1. Awareness of oral diseases and diabetes

Horowitz (1995) and Schou & Locker (1997) stress individuals’ choices to decisions affecting their health and a right to health education, which ensures the knowledge and skills patients need to use health information effectively. Maintenance of periodontal health in particular calls for active action from the patient and use of his knowledge in comprehensive oral self-care. The results of eleven years of oral health awareness and public education programmes in New Zealand revealed little change especially in patients’ concern of bleeding gums, indicating how difficult it is to improve knowledge and change attitudes (Croxon 1998a). The results did not alter the significant role of knowledge and awareness but indicated the demand of developing oral health promotion programmes. Studies among individuals with diabetes have indicated that knowledge of oral comorbidity is generally poor, suggesting the
need for appropriate health education and health promotion to improve the oral health of patients with diabetes (Löe & Genco 1995, Moore et al. 2000, Sandberg et al. 2001).

2.4.4. Common risk factor approach

Oral health problems have risk factors in common with a number of important chronic diseases. Sheiham & Watt (2000) reported that further improvements in oral health will only be secured through the adoption of oral health promotion policies based upon the common risk factor approach; a small number of factors such as diet, stress, control, hygiene and smoking determine, in addition to a large number of systemic diseases such as diabetes and heart diseases also oral diseases such as caries, periodontal diseases and oral cancer. Moreover, they stated that the main risk factors for chronic diseases frequently cluster in the same individuals.

A general approach to health promotion, based on social, educational and economic development, is more likely to have long-term, lasting effects. According to this general approach, oral hygiene, for example, should not merely be a periodontal health/disease issue but a normal part of bodily hygiene and grooming behaviour (Pilot 1997).
3. Study aims and hypothesis

3.1. Aims

Oral self-care and its determinants among adults with diabetes in Finland were studied to evaluate the effect of oral health promotion intervention on oral health behaviours and periodontal health indicators and to assess changes in periodontal treatment needs during the two-year study period.

Specific aims were to study the following among adults with diabetes:
- oral health behaviours (tooth brushing, interdental cleaning and dental visits) (I, III)
- periodontal health indicators (CPITN index, visible plaque and calculus) (II, III)
- oral health-related factors (I, II, III)
- effect of oral health promotion intervention related to oral self-care (IV)
- longitudinal changes in periodontal treatment needs (V)

3.2. Hypothesis

Oral self-care among patients with diabetes is not consistent with their increased risk for periodontal diseases. The null hypothesis is that oral self-care and periodontal status cannot be improved by oral health promotion intervention related to motivation to regular dental visits among patients with diabetes.
4. Subjects and methods

4.1. Description of the studies

The present research consists of five studies, which were carried out as indicated in Table 2.

Table 2. Description of the studies in papers I-V.

<table>
<thead>
<tr>
<th></th>
<th>Pre-intervention</th>
<th>Intervention</th>
<th>Post-intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>1998</td>
<td>1999</td>
<td>2001</td>
</tr>
<tr>
<td>Type of study</td>
<td>Survey</td>
<td>Community trial</td>
<td>Community trial</td>
</tr>
<tr>
<td>Main methods</td>
<td>Nation-wide questionnaire</td>
<td>Clinical examination Questionnaire</td>
<td>Clinical examination Questionnaire</td>
</tr>
<tr>
<td>Number of participants</td>
<td>336</td>
<td>120</td>
<td>115</td>
</tr>
<tr>
<td>Paper number</td>
<td>I</td>
<td>II, III</td>
<td>IV, V</td>
</tr>
</tbody>
</table>

4.2. Study population

4.2.1. Approval for the study

The nationwide questionnaire study was carried out in co-operation with the Finnish Diabetes Association, which gave permission to use their register. The longitudinal questionnaire and clinical studies were implemented in Salo, Finland, with the permission of the Ethics Committee of the Salo Regional Hospital.

4.2.2. Nation-wide questionnaire study in 1998

The population of this questionnaire study consisted of 420 members from the register of the Finnish Diabetes Association, which has approximately 42 000 national members (the capital district Helsinki was excluded because of its separate register). Every fifty-fourth person was included in the systematic sampling undertaken among the 22 600 subjects meeting inclusion criteria (age 18-70 years, insulin and/or tablet treatment). Of the 336 participants, the numbers...
of edentulous and dentate subjects were 78 (23%) and 258 (77%), respectively. The edentulous subjects were excluded from the final data analysis.

4.2.3. Longitudinal questionnaire and clinical study in 1999 and 2001

Baseline characteristics of the study populations are presented in Table 3.

4.2.3.1. Study population in 1999

Diabetes nurses interviewed all patients regularly attending the Salo Regional Hospital Diabetes Clinic in south-west Finland between November 1998 and February 1999. The diagnosis of diabetes was originally made by criteria of the World Health Organization (WHO 1985). The total number of patients visiting the clinic annually was about 250, and patients visited at individual intervals, usually from three to four months. There was no selection on the basis of diabetes onset or other systemic diseases. Out of the interviewed patients who filled the inclusion criteria (age 18-70 years, insulin and/or tablet treatment and having own teeth in least one jaw), six did not want to participate and seven refused for various practical reasons. Twelve others, who had initially agreed to participate, could not make the dental appointment. Subjects received an information letter and gave signed consent.

4.2.3.2. Follow-up study population in 2001

In 2001, the subjects were invited to participate in a follow-up examination. Two participants had died, one had moved, one had received full dentures and one refused to participate. The drop-out rate was 4%.

Table 3. Characteristics of the baseline and follow-up study populations.

<table>
<thead>
<tr>
<th></th>
<th>Age (years)</th>
<th>Gender, female/male (%)</th>
<th>Type of DM, 1/2/other (%)</th>
<th>Duration of DM (years)</th>
<th>Complications, none/micro/ macro/both (%)</th>
<th>HbA₁c mean (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline n=120</td>
<td>44.6 ±13.5</td>
<td>43/58 76/22/3</td>
<td>18.2 ±10.7 45/49/1</td>
<td>4/5/9/</td>
<td>none/micro/ macro/both</td>
<td>8.2 ±1.3</td>
</tr>
<tr>
<td>Follow-up n=115</td>
<td>44.9 ±13.5</td>
<td>42/58 75/23/3</td>
<td>20.6 ±10.8 44/50/</td>
<td>4/5/9/</td>
<td>none/micro/ macro/both</td>
<td>8.1 ±1.4</td>
</tr>
</tbody>
</table>

DM = diabetes mellitus
HbA₁c = five HbA₁c values preceding the examination
4.3. Questionnaire studies

4.3.1. Baseline questionnaires

The questionnaire was pre-tested (n=23) in the Diabetes Centre in Tampere, Finland, and contained 29 items. Questions were closed and mostly multiple choice with alternative statements. Grouped into five categories, the questions covered 1) social background, 2) medical history, 3) self-treatment, -prevention and -diagnosis of oral diseases, 4) utilization of dental services and 5) knowledge, values and attitude towards oral health. The questions have been successfully used in earlier Finnish oral health behaviour studies (Murtomaa et al. 1984, 1997, Murtomaa & Metsäniitty 1994). The number of individuals varies between different analyses due to some missing data. The range of missing values varies from 0% to 10.5%.

4.3.1.1. Nation-wide questionnaire study in 1998

The Diabetes Association mailed the questionnaire to prospective participants’ homes. The first questionnaire (n=420) was mailed in September 1998, with a reminder sent in October 1998. The response rate was 80%.

4.3.1.2. Questionnaire study in 1999

Diabetes nurses distributed the forms during the interview at the diabetes clinic, and participants filled them out and brought them back to the clinical periodontal examination.

4.3.2. Follow-up questionnaire in 2001

The self-completed questionnaire contained 22 items, which followed the same format used in our previous studies in 1998 and 1999, and was filled in during the follow-up clinical examination.

4.3.3. Variables

Variables chosen for data analysis were based on the New Century Model of oral health promotion (Inglehart & Tedesco 1995a) and dichotomized as follows:
4.3.3.1. Social background, situational factors
Age was dichotomized as <40 years vs. ≥40 years and gender as female vs. male. Degree of education was categorized either as low, comprising primary, secondary, comprehensive and high school, and technical education, or as high, comprising a college or university degree.

4.3.3.2. Medical history
Diabetes was categorized as type 1 or 2, and those who had some other type or did not know their type were excluded when type of diabetes was examined as an independent variable (I). Diabetes-related variables are presented in more detail in the section “Diabetes assessment”. Behavioural factors included questions about smoking habit. Smoking habit was dichotomized as smoking (originally the alternatives were regular and occasional smoking) and no smoking (originally the alternatives were stopped smoking and no smoking habit).

4.3.3.3. Self-treatment, -prevention and -diagnosis of oral diseases
Oral hygiene habits were dichotomized as follows: brushing at least two times a day vs. more seldom and cleaning interdental space daily vs. more seldom. Self-reported number of missing teeth was dichotomized as some vs. none and used as a past behaviour factor. The question about self-reported condition of oral health was used as a cognitive self-related belief factor and dichotomised as good, corresponding to the original alternatives of good and quite good, vs. not good, corresponding to the original alternatives of average, quite bad and bad. In 2001, one question dealt with an increase in tooth brushing or interdental cleaning frequency during the two-year study period and was dichotomized as no vs. yes.

4.3.3.4. Utilization of dental services
Utilization of dental services was categorized as dental visits at least once a year vs. more seldom. A question about the last dental visit place was dichotomized as private vs. public and used as a past behaviour factor. In 2001, a question was asked about increasing frequency of dental visits during the study period and dichotomized as no vs. yes.

4.3.3.5. Knowledge, values and attitudes towards oral health
Cognitive factors were evaluated with a question about knowledge: “Have you received information about the relationship between diabetes and gum diseases?” (dichotomized as no vs. yes), and with an attitude statement: “I want to keep my natural teeth as long as possible”.

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Affective factors were evaluated with a value statement: “Oral health is not as important as general health”. Alternatives for the statements were as follows: fully agree, somewhat agree, I do not know, somewhat disagree, and fully disagree, but for the analysis fully agree and somewhat agree were combined into agree, fully disagree and somewhat disagree were combined into disagree, and I do not know was classified separately.

4.4. Clinical examination

The clinical examination was performed by the same examiner (AK) in 1999 and 2001 in a clinical setting with an assisting dental nurse. The methods applied both years were similar. The time interval between the two examinations was generally 24 months, but for 10 subjects 25 months, 4 subjects 26 months, one subject 27 months and one subject 28 months.

The following variables were included:

4.4.1. Plaque
The presence of visible plaque on four surfaces of each tooth was assessed after drying with air. This corresponds to criteria for scores 2 and 3 of the Plaque Index System (Silness & Löe 1964). The percentage of surfaces with visible plaque was calculated. In advance, no instructions regarding oral hygiene habits were given.

4.4.2. Calculus
The presence of supra- and subgingival calculus was measured using a World Health Organization (WHO 1984a) probe from all six sites of each tooth. The percentage of surfaces with calculus was calculated. For data analysis, visible plaque and calculus indices were dichotomized as ≤60% vs. >60%, the latter corresponding to a poor clinical level of oral cleanliness for debris and calculus (Spolsky 1996). The same reference was used when frequencies of plaque and calculus indices were analysed.

4.4.3. Community Periodontal Index of Treatment Needs (CPITN)
Periodontal treatment needs were assessed using the Community Periodontal Index of Treatment Needs (CPITN) (WHO 1984a). The recordings were based on the code number observed after examination of all remaining teeth, excluding third molars, in each of the six
segments (sextants) containing at least two functional teeth from six sites of the tooth. The subjects, sextants and teeth were classified according to the highest code number recorded (codes 0-4). For each individual, the number of teeth with CPITN score 3 or 4 was calculated. The number of missing sextants and teeth were recorded separately. The examination was performed using a 2.5 magnification surgical telescope.

CPITN recordings were made using the following code numbers:

Code 0 = healthy periodontal tissue
Code 1 = bleeding after probing
Code 2 = supra- or subgingival calculus and/or overhang(s) of filling(s) or crown(s)
Code 3 = pathological pocket(s) of 4 or 5 mm
Code 4 = pathological pocket(s) of ≥ 6 mm

In 2001, intra-observer reliability was studied in 21 participants with a CPITN score 3 or 4 by re-examination at a 1- to 2-week interval. Only the score of one patient (4.8%) differed from the original one. For the original sextant measurements (n=119) and for the original teeth measurements (n=528), the corresponding rates were 6.7% and 7.2%. Of the total number of teeth (n=528) with CPITN scores of 3 and 4, the kappa value for CPITN recordings per individual tooth was 0.85.

The number of teeth with CPITN score 3 or 4 was calculated and chosen as the dependent variable (V) dichotomized as improved or stable/deteriorated and stable/improved or deteriorated. Changes between CPITN scores 0, 1 and 2 were not recorded. The need for treatment was considered to be decreased/increased when the number of teeth with decreased/increased scores was higher than the number of teeth with increased/stable scores and, in the case of deterioration, the number of teeth with decreased/stable scores.

Missing sextants were dichotomized as 1-5 missing sextants vs. none.

In 2001, history of periodontitis was studied with a variable collected from the examination in 1999 and dichotomized as follows: at least three sextants with code 3 or one sextant with code 4 vs. less than three sextants with code 3 or no sextants with code 4.
4.5. Diabetes-related factors

The diabetes nurses, who had interviewed the patients in the baseline study, collected information about duration and type of diabetes, complications and glycated haemoglobin levels (HbA1c). HbA1c levels were classified as follows: <7.5% as good glycaemic control, 7.5-8.5% as moderate control, 8.6-10.0% as poor control and >10.0% as alarming control in accordance with Development Programme for Prevention and Care of Diabetes in Finland (2000) (II). Although original HbA1c levels were available for the follow-up studies (IV and V) the method of analysis had changed. Therefore, values taken after February 1999 were converted by decreasing them by 13% (this figure was qualified by the senior chemist in Salo Regional Hospital in 2001) to make them compatible with earlier values. Before March 1999, HbA1c values had been assayed using a low pressure liquid chromatographic method (LPLC) and after that with turbidimetric immunoassay (TIA). The normal range is 4.2-6.0%. For data analysis, the variables were dichotomized as follows: DM type 1 vs. type 2, no complications vs. complications, duration of disease \( \leq \) 10 years vs. >10 years and HbA1c value \( \leq \) 8.5% vs. \( \geq \) 8.6%.

Data on visits to the diabetes clinic were collected from patients’ records since 1998. On average, the patients visit the clinic at 3- to 4-month intervals. The interval was considered to be fulfilled, if there was only one exception from the interval. During the study period, data concerning five patients were inadequate.

Five HbA1c values preceding the first examination in 1999 and another five preceding the follow-up examination in 2001 were gathered from patients’ records. For 17 patients, some of the ten HbA1c values were unavailable, with these missing values represented 32% of the total.

4.6. Oral health promotion intervention

In 1999, the examiner informed patients about their periodontal status and about the relationship between periodontal diseases and diabetes in the dental clinic in a standardized manner. For those subjects who did not report brushing twice a day and daily interdental
cleaning, those oral self-care regimens were strongly recommended. Oral self-care instructions did not include any personal hands-on guidance. Participants were also instructed to visit their own dentists according to their personal treatment needs at a 3-, 6- or 12-month intervals. The criteria for recommendation of frequent dental visits were based on individual periodontal status as follows:

1. CPITN 4, sextants with score 4 >1 and calculus >50%: treatment interval 3 months
2. CPITN 4, sextants with score 4 >1 and calculus ≤50%: treatment interval 6 months
3. CPITN 4 and sextants with score 4 =1: treatment interval 6 months
4. CPITN 4 and sextants with score 3 =5-6: treatment interval 6 months
5. CPITN 3, sextants with score 3 =1-4 and calculus >25%: treatment interval 6 months
6. CPITN 3, sextants with score 3 =1-4 and calculus ≤25%: treatment interval 12 months
7. CPITN 2-1: treatment interval 12 months

When cardiovascular complications were present (one subject), a shorter interval than indicated by these criteria was recommended.

All subjects were categorized according to their descending CPITN indices and divided into three intervention groups and a control group, so that every fourth person belonged to each group. The purpose of this sampling was to ensure equal distribution of the index among the four groups. The first group (G1) received a reminder letter and a diabetes nurse reminded them about dental care (n=26); the second group (G2) was reminded about dental care only by a diabetes nurse (n=30); the third group (G3) received only a reminder letter (n=31); and the control group (G4) received no reminders (n=28) (Figure 1). The diabetes nurses working at the Salo Regional Hospital Diabetes Clinic received forms about the recommended treatment intervals, but were not trained for the study purpose. Dental care reminders of subjects in groups G1 and G2 occurred during the regular polyclinic appointments. The nurses registered self-reported dental visits on data forms. Data were missing for three patients belonging to group G2 because they failed to attend the diabetes clinic during the study period. The examiner (AK) formulated the reminder letters on the basis of the recommended treatment interval and a dental assistant added personal details and mailed the letters to groups G1 and G3 every half year or annually. When the recommended treatment interval was three months, the letters were nonetheless mailed every half year. The examiner was blinded to the groupings.
**Figure 3.** Study groups for the oral health promotion intervention.

![Study groups diagram]

**4.7. Statistical analysis**

Pearson chi-squared test was used in bivariate analyses for frequencies (I, II, III).

The Mann-Whitney test was used to analyse associations between periodontal health variables and oral health behaviours as well as between periodontal health variables and the potential predictive factors from the New Century Model of oral health promotion (III).

The Wilcoxon Signed Ranks test was used to analyse changes in visible plaque, calculus and CPITN indices (IV, V).

The *t*-test for paired samples was used to analyse differences between five HbA1c values in 1999 and 2001 (IV).

Analysis of variance was used to evaluate the effects of the background variables on the number of missing teeth (II).

Logistic regression analysis was used to assess the effects of the independent variables on frequent oral health behaviours (I, III), on the probability of having the highest CPITN score of 4 and a CPITN score of 3 or 4 (II), and on the probability of having changes in the number of teeth with CPITN score 3 or 4 (V). Odds ratios (OR) and the corresponding 95% confidence intervals (CI) were calculated.

The level of significance was set at $p<0.05$. Statistical analyses were performed using SPSS for Windows 7.5.
5. Results

5.1. Self-reported oral self-care among adults with diabetes (I, III)

About one-third of patients reported brushing their teeth twice a day or more often, one-quarter daily interdental cleaning and two-thirds having had a dental appointment within a year (Table 4).

Table 4. Oral health behaviours among study populations in questionnaire studies.

<table>
<thead>
<tr>
<th></th>
<th>Nation-wide questionnaire(I) 1998, n=258, (%)</th>
<th>Baseline questionnaire(II) 1999, n=120, (%)</th>
<th>Follow-up questionnaire(IV) 2001, n=115, (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent brushing</td>
<td>38.3</td>
<td>29.2</td>
<td>33.9</td>
</tr>
<tr>
<td>Frequent interdental cleaning</td>
<td>26.7</td>
<td>20.8</td>
<td>28.7</td>
</tr>
<tr>
<td>Frequent dental visits</td>
<td>63.3</td>
<td>69.2</td>
<td>73.0</td>
</tr>
<tr>
<td>No tooth brushing</td>
<td>2.3</td>
<td>2.5</td>
<td>1.7</td>
</tr>
<tr>
<td>No interdental cleaning</td>
<td>25.1</td>
<td>26.7</td>
<td>15.7</td>
</tr>
<tr>
<td>No dental visits</td>
<td>6.3</td>
<td>5.8</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Frequent brushing = brushing twice daily or more often
Frequent interdental cleaning = cleaning at least daily
Frequent dental visits = dental visits within one year
No dental visits = no dental visits within five years

Using oral health behaviours as a dependent variable, logistic regression analysis revealed that for determining frequent tooth brushing female gender was a very significant variable, both in the nation-wide questionnaire study and in the baseline questionnaire, and high education was significant only in the nation-wide questionnaire study. In both studies, age 40 years or over was significantly related to frequent interdental cleaning, and in the nation-wide study to last visiting a private dentist. Logistic regression analysis showed a significant relationship between self-reported good oral condition and frequent dental visits in both studies. Moreover, positive answers to the statements about receiving information concerning the relationship between diabetes and gum diseases and about appreciation of one’s natural teeth and a negative answer to the statement about under valuation of oral health with respect to general health had a positive association with frequent dental visits in the nation-wide study (Tables 5 and 6). Smoking habit was not associated with oral health behaviours. In addition,
no significant difference was found in frequent oral health behaviours between those individuals with poor and those with good metabolic control.

Table 5. Logistic regression analysis for frequent oral health behaviours in the nation-wide questionnaire study in 1998.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Independent variable</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent tooth brushing</td>
<td>Male gender</td>
<td>0.23</td>
<td>0.12 – 0.43</td>
</tr>
<tr>
<td></td>
<td>High education</td>
<td>3.09</td>
<td>1.47 – 6.49</td>
</tr>
<tr>
<td>Frequent interdental cleaning</td>
<td>Age ≥40 years</td>
<td>5.49</td>
<td>1.16 – 25.9</td>
</tr>
<tr>
<td></td>
<td>Public dental care</td>
<td>0.31</td>
<td>0.15 – 0.61</td>
</tr>
<tr>
<td>Frequent dental visits</td>
<td>*Information: yes</td>
<td>2.42</td>
<td>1.29 – 4.56</td>
</tr>
<tr>
<td></td>
<td>†Good oral condition</td>
<td>2.17</td>
<td>1.12 – 4.14</td>
</tr>
<tr>
<td></td>
<td>‡ Statement 1: agree</td>
<td>4.03</td>
<td>1.06 – 12.7</td>
</tr>
<tr>
<td></td>
<td>§ Statement 2: agree</td>
<td>0.31</td>
<td>0.11 – 0.87</td>
</tr>
</tbody>
</table>

*Information: “Have you received information about the relationship between diabetes and gum diseases?”
†Self-reported condition of oral health
‡Statement 1: “I want to keep my natural teeth as long as possible.”
§Statement 2: “Oral health is not as important as general health.”

Table 6. Logistic regression analysis for frequent oral health behaviours in the baseline questionnaire study in 1999.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Independent variable</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent tooth brushing</td>
<td>Male gender</td>
<td>0.23</td>
<td>0.09 – 0.62</td>
</tr>
<tr>
<td>Frequent interdental cleaning</td>
<td>Age ≥40 years</td>
<td>6.60</td>
<td>1.39 – 11.43</td>
</tr>
<tr>
<td>Frequent dental visits</td>
<td>†Good oral condition</td>
<td>6.18</td>
<td>1.11 – 34.50</td>
</tr>
</tbody>
</table>

*Information: “Have you received information about the relationship between diabetes and gum diseases?”
†Self-reported condition of oral health

5.2. Periodontal health among patients with diabetes (II, III)

At baseline, less than one-third of tooth surfaces were covered with visible plaque (28.2%, SD ± 21.8%) and about one-third with calculus (33.5%, SD ± 24.3%). High plaque and calculus indices (>60%) were found in 10% and 15% of subjects, respectively (Table 7). Those with poor metabolic control did not differ from the distribution of plaque and calculus indices shown in Table 7. The proportion of individuals having teeth with a CPITN score of 3 or 4 was 78%. No patients had a CPITN score of 0, and a CPITN score of 3 was the most prevalent (Table 8).
Table 7. Proportion of individuals in three categories of plaque and calculus indices and proportion of individuals having teeth with a CPITN score of 3 or 4 in three different categories.

<table>
<thead>
<tr>
<th>Plaque* and calculus*†</th>
<th>Teeth with CPITN score 3 or 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>43*</td>
<td>47*</td>
</tr>
<tr>
<td>20-60%</td>
<td>10*</td>
</tr>
<tr>
<td>&lt;20%</td>
<td>22</td>
</tr>
<tr>
<td>20-60%</td>
<td>&gt;60%</td>
</tr>
<tr>
<td>0%</td>
<td>0.1-30%</td>
</tr>
<tr>
<td>&gt;60%</td>
<td>30%</td>
</tr>
<tr>
<td>0%</td>
<td>0.1-30%</td>
</tr>
<tr>
<td>&gt;60%</td>
<td>30%</td>
</tr>
</tbody>
</table>

*Percentage of surfaces with visible plaque
†Percentage of surfaces with calculus

Table 8. Number and percentage distribution of CPITN and codes 0-4 / sextants.

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPITN 0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>CPITN 1</td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>CPITN 2</td>
<td>23</td>
<td>19.2</td>
</tr>
<tr>
<td>CPITN 3</td>
<td>66</td>
<td>55.0</td>
</tr>
<tr>
<td>CPITN 4</td>
<td>28</td>
<td>23.3</td>
</tr>
<tr>
<td>Code 0 / sextants</td>
<td>14</td>
<td>2.1</td>
</tr>
<tr>
<td>Code 1 / sextants</td>
<td>126</td>
<td>19.3</td>
</tr>
<tr>
<td>Code 2 / sextants</td>
<td>187</td>
<td>28.6</td>
</tr>
<tr>
<td>Code 3 / sextants</td>
<td>270</td>
<td>41.3</td>
</tr>
<tr>
<td>Code 4 / sextants</td>
<td>57</td>
<td>8.7</td>
</tr>
</tbody>
</table>

When oral health behaviours and periodontal health indicators were assessed, whose individuals who had had frequent dental visits had significantly less calculus. Frequent tooth brushing had almost the same effect on amount of calculus. Those subjects who were younger than 40 years, were female, self-reported good oral health, had high a education and no missing teeth had significantly less plaque and calculus. Age less than 40 years and no missing teeth indicated significantly lower CPITN scores. A low CPITN score was also significantly related to the positive statement about appreciation of oral health relative to general health.

Poor metabolic control and advanced age had a significant positive association with CPITN 3 or 4 in logistic regression analysis (Table 9). This association remained even when plaque and calculus indices were removed from the model. Smoking habit was not significantly related to CPITN 3 or 4.
Table 9. Logistic regression for dependent variable CPITN 3 or 4.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Independent variable</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPITN 3 or 4</td>
<td>Male gender</td>
<td>1.18</td>
<td>0.44 - 3.18</td>
</tr>
<tr>
<td></td>
<td>Age ≥40 years</td>
<td>9.58</td>
<td>2.42 - 37.90</td>
</tr>
<tr>
<td></td>
<td>Type 2 diabetes</td>
<td>0.39</td>
<td>0.09 - 1.65</td>
</tr>
<tr>
<td></td>
<td>Complications</td>
<td>1.45</td>
<td>0.45 - 4.67</td>
</tr>
<tr>
<td></td>
<td>Duration of diabetes &gt;10 years</td>
<td>0.98</td>
<td>0.27 - 3.54</td>
</tr>
<tr>
<td></td>
<td>HbA1c value ≥8.6%</td>
<td>3.08</td>
<td>1.04 - 9.10</td>
</tr>
<tr>
<td></td>
<td>1-5 missing sextants</td>
<td>0.29</td>
<td>0.07 - 1.24</td>
</tr>
<tr>
<td></td>
<td>Visible plaque &gt;60%</td>
<td>0.78</td>
<td>0.12 - 4.88</td>
</tr>
<tr>
<td></td>
<td>Calculus &gt;60%</td>
<td>1.97</td>
<td>0.35 - 10.97</td>
</tr>
</tbody>
</table>

5.3. Oral health promotion intervention (IV)

Characteristics of individuals in different study groups are presented in Table 10.

Table 10. Characteristics of individuals in different study groups in 1999.

<table>
<thead>
<tr>
<th></th>
<th>G1, n=26</th>
<th>G2, n=30</th>
<th>G3, n=31</th>
<th>G4, n=28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>female (%)</td>
<td>46</td>
<td>37</td>
<td>48</td>
<td>36</td>
</tr>
<tr>
<td>Age (mean years)</td>
<td>41</td>
<td>45</td>
<td>49</td>
<td>43</td>
</tr>
<tr>
<td>Education low (%)</td>
<td>62</td>
<td>80</td>
<td>71</td>
<td>64</td>
</tr>
<tr>
<td>Smoking yes (%)</td>
<td>19</td>
<td>33</td>
<td>16</td>
<td>21</td>
</tr>
<tr>
<td>HbA1c (mean)</td>
<td>8.2%</td>
<td>8.2%</td>
<td>8.1%</td>
<td>8.2%</td>
</tr>
<tr>
<td>poor ≥8.6 (%)</td>
<td>31</td>
<td>30</td>
<td>26</td>
<td>32</td>
</tr>
<tr>
<td>Complications yes (%)</td>
<td>50</td>
<td>57</td>
<td>52</td>
<td>6</td>
</tr>
<tr>
<td>Duration of DM (mean years)</td>
<td>20</td>
<td>16</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>≤10 years (%)</td>
<td>27</td>
<td>33</td>
<td>26</td>
<td>25</td>
</tr>
<tr>
<td>Number of teeth (mean)</td>
<td>26</td>
<td>22</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>Visible plaque* (%)</td>
<td>22</td>
<td>30</td>
<td>31</td>
<td>25</td>
</tr>
<tr>
<td>Calculus † (%)</td>
<td>29</td>
<td>40</td>
<td>32</td>
<td>29</td>
</tr>
<tr>
<td>Individuals having teeth with CPITN 3 or 4 (%)</td>
<td>23</td>
<td>36</td>
<td>26</td>
<td>23</td>
</tr>
</tbody>
</table>

*Mean of individual percentage of surfaces with visible plaque
†Mean of individual percentage of surfaces with calculus
G1 = diabetes nurse and letter reminder group
G2 = diabetes nurse reminder group
G3 = letter reminder group
G4 = control group

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When the different study groups were compared regarding self-reported improvement in oral health behaviours, the greatest increases in tooth brushing were in the diabetes nurse and letter reminder (G1; 26.9%) and the letter reminder (G3; 19.4%) groups. The corresponding figure for the control group was 10.7%. For interdental cleaning, the greatest increase was in the same groups (G1; 38.5% and G3; 45.2%), as compared with 28.6% in the control group. The greatest increase in dental visits occurred in the letter reminder (G3; 25.8%) and the diabetes nurse reminder (G2; 16.7%) groups. In the control group (G4), the corresponding figure was 14.3%. The mean of individual percentages of surfaces with visible plaque and calculus decreased most in groups G2 and G3 (Table 11), and the proportion of individuals having teeth with a CPITN score of 3 or 4 increased slightly in the control group (Table 12).

Table 11. Proportion of individuals with a decrease in percentage of surfaces with visible plaque and calculus in different study groups.

<table>
<thead>
<tr>
<th></th>
<th>G1, n=26 (%)</th>
<th>G2, n=30 (%)</th>
<th>G3, n=31 (%)</th>
<th>G4, n=28 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease in visible plaque</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-30%</td>
<td>15.4</td>
<td>30.0</td>
<td>45.2</td>
<td>25.0</td>
</tr>
<tr>
<td>&gt;30%</td>
<td>11.5</td>
<td>16.7</td>
<td>12.9</td>
<td>7.1</td>
</tr>
<tr>
<td>Summary</td>
<td>29.9</td>
<td>46.7</td>
<td>58.1</td>
<td>32.1</td>
</tr>
<tr>
<td>Decrease in calculus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-30 %</td>
<td>26.9</td>
<td>23.3</td>
<td>29.0</td>
<td>14.3</td>
</tr>
<tr>
<td>&gt;30 %</td>
<td>3.8</td>
<td>16.7</td>
<td>3.2</td>
<td>3.6</td>
</tr>
<tr>
<td>Summary</td>
<td>30.7</td>
<td>40.0</td>
<td>32.2</td>
<td>17.9</td>
</tr>
</tbody>
</table>

G1 = diabetes nurse and letter reminder group  
G2 = diabetes nurse reminder group  
G3 = letter reminder group  
G4 = control group
Table 12. Mean of individual percentage of teeth with CPITN score 3 or 4 and proportion of individuals having changes in the number of teeth with CPITN score 3 or 4 in different study groups.

<table>
<thead>
<tr>
<th></th>
<th>CPITN 3 or 4 /1999 (%)</th>
<th>CPITN 3 or 4 /2001 (%)</th>
<th>Decrease (%)</th>
<th>Increase (%)</th>
<th>No change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1, n=26</td>
<td>23.3</td>
<td>22.1</td>
<td>38.5</td>
<td>26.9</td>
<td>34.6</td>
</tr>
<tr>
<td>G2, n=30</td>
<td>36.1</td>
<td>32.3</td>
<td>36.7</td>
<td>36.7</td>
<td>26.7</td>
</tr>
<tr>
<td>G3, n=31</td>
<td>25.9</td>
<td>22.2</td>
<td>48.4</td>
<td>22.6</td>
<td>29.0</td>
</tr>
<tr>
<td>G4, n=28</td>
<td>23.1</td>
<td>23.6</td>
<td>28.6</td>
<td>46.4</td>
<td>25.0</td>
</tr>
</tbody>
</table>

CPITN 3 or 4/1999 = mean of individual percentage of teeth with CPITN score 3 or 4 in 1999
CPITN 3 or 4/2001 = mean of individual percentage of teeth with CPITN score 3 or 4 in 2001
Decrease = proportion of individuals with decrease in number of teeth with CPITN score 3 or 4
Increase = proportion of individuals with increase in number of teeth with CPITN score 3 or 4
No change = proportion of individuals with no change in number of teeth with CPITN score 3 or 4
G1 = diabetes nurse and letter reminder group
G2 = diabetes nurse reminder group
G3 = letter reminder group
G4 = control group

5.4. Changes in periodontal health indicators (IV)

When changes in visible plaque and calculus and CPITN indices were evaluated, drop-outs (n=5) in 2001 were eliminated from 1999 data, as indicated in Table 13.

Table 13. Mean of individual percentage of visible plaque and calculus indices and proportion of subjects with different CPITN scores in 1999 and 2001. All study groups together.

<table>
<thead>
<tr>
<th></th>
<th>Baseline examination n=115 (%)</th>
<th>Follow-up examination n=115 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visible plaque mean and SD</td>
<td>27.4 (22.0)</td>
<td>16.7 (16.8)</td>
</tr>
<tr>
<td>Calculus mean and SD</td>
<td>32.5 (23.1)</td>
<td>26.4 (19.8)</td>
</tr>
<tr>
<td>CPITN 0-2</td>
<td>22.6</td>
<td>20.0</td>
</tr>
<tr>
<td>CPITN 3</td>
<td>55.7</td>
<td>62.6</td>
</tr>
<tr>
<td>CPITN 4</td>
<td>21.7</td>
<td>17.4</td>
</tr>
</tbody>
</table>
When the number of teeth with a CPITN score of 3 or 4 was calculated, the figure had decreased for 44 and increased for 38 subjects, excluding changes between CPITN scores 0, 1 and 2. Individual characteristics are presented in Table 14.

Table 14. Characteristics of individuals with increased, decreased or no change in number of teeth with CPITN score 3 or 4.

<table>
<thead>
<tr>
<th></th>
<th>Decrease, n=44</th>
<th>Increase, n=38</th>
<th>No change,, n=33</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender female (%)</td>
<td>48</td>
<td>26</td>
<td>52</td>
</tr>
<tr>
<td>Age (mean years)</td>
<td>47</td>
<td>44</td>
<td>43</td>
</tr>
<tr>
<td>Education low (%)</td>
<td>70</td>
<td>68</td>
<td>70</td>
</tr>
<tr>
<td>Smoking yes (%)</td>
<td>16</td>
<td>32</td>
<td>21</td>
</tr>
<tr>
<td>HbA1c (mean)</td>
<td>8.3%</td>
<td>8.3%</td>
<td>7.8%</td>
</tr>
<tr>
<td>poor ≥8.6 (%)</td>
<td>34</td>
<td>39</td>
<td>15</td>
</tr>
<tr>
<td>Complications yes (%)</td>
<td>50</td>
<td>58</td>
<td>61</td>
</tr>
<tr>
<td>Duration of DM (mean years)</td>
<td>20</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>≤10 years (%)</td>
<td>30</td>
<td>29</td>
<td>24</td>
</tr>
<tr>
<td>Frequent brushing &lt;2 x day (%)</td>
<td>27</td>
<td>29</td>
<td>36</td>
</tr>
<tr>
<td>Frequent interdental cleaning &lt;1 x day (%)</td>
<td>21</td>
<td>16</td>
<td>27</td>
</tr>
<tr>
<td>Frequent dental visits ≥1 year ago (%)</td>
<td>75</td>
<td>59</td>
<td>82</td>
</tr>
<tr>
<td>Number of teeth (mean)</td>
<td>24</td>
<td>25</td>
<td>23</td>
</tr>
<tr>
<td>Visible plaque∗ (%)</td>
<td>30</td>
<td>28</td>
<td>23</td>
</tr>
<tr>
<td>Calculus† (%)</td>
<td>38</td>
<td>34</td>
<td>24</td>
</tr>
<tr>
<td>Individuals having teeth with CPITN 3 or 4 (%)</td>
<td>4</td>
<td>26</td>
<td>8</td>
</tr>
</tbody>
</table>

Decrease = individuals with decrease in number of teeth with CPITN score 3 or 4
Increase = individuals with increase in number of teeth with CPITN score 3 or 4
No change = individuals with no change in number of teeth with CPITN score 3 or 4

∗Mean of individual percentage of surfaces with visible plaque
†Mean of individual percentage of surfaces with calculus

Because Pearson chi-squared test indicated fewer variables associated with a decrease in number of teeth with a CPITN score 3 or 4 than with an increase, the latter was chosen to be the variable for further analysis. Self-reported antibiotic use during the six months before the 2001 examination was not associated with either an increase or decrease in number of teeth with a CPITN score of 3 or 4 in baseline analysis.
Factors separately associated with an increase in number of teeth with a CPITN score of 3 or 4 included smoking, infrequent dental visits and infrequent interdental cleaning (Table 15). In multivariate logistic regression, when different independent factors were analysed, the importance of dental visits was emphasized.

**Table 15.** Factors separately associated with an increase in number of teeth with CPITN score 3 or 4 (n=38). Changes between scores 0, 1 and 2 are not taken into consideration.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Tooth-based deteriorated CPITN</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 40 years</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 40 years</td>
<td>0.73</td>
<td>0.32 – 1.66</td>
<td></td>
</tr>
<tr>
<td>Gender:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>female</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>2.23</td>
<td>0.99 – 5.22</td>
<td></td>
</tr>
<tr>
<td>Education:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>high</td>
<td>1.30</td>
<td>0.57 – 2.99</td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>smoking</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>no smoking</td>
<td>0.29</td>
<td>0.11 – 0.74</td>
<td></td>
</tr>
<tr>
<td>Dental visits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥1 year ago</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1 year ago</td>
<td>0.40</td>
<td>0.17 – 0.94</td>
<td></td>
</tr>
<tr>
<td>Tooth brushing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤2 x day</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥3 x day</td>
<td>0.86</td>
<td>0.37 – 1.96</td>
<td></td>
</tr>
<tr>
<td>Interdental cleaning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤1 x day</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥1 x day</td>
<td>0.35</td>
<td>0.13 – 0.93</td>
<td></td>
</tr>
<tr>
<td>Calculus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤60%</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;60%</td>
<td>2.18</td>
<td>0.51 – 9.10</td>
<td></td>
</tr>
<tr>
<td>† Sextants with code 3 or 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>1.14</td>
<td>0.52 – 2.48</td>
<td></td>
</tr>
<tr>
<td>‡DM years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤10 years</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;10 years</td>
<td>0.89</td>
<td>0.30 – 2.62</td>
<td></td>
</tr>
<tr>
<td>Complications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>1.15</td>
<td>0.52 – 2.51</td>
<td></td>
</tr>
<tr>
<td>HbA1c value</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤8.5%</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥8.6%</td>
<td>0.84</td>
<td>0.37 – 1.90</td>
<td></td>
</tr>
</tbody>
</table>

†At least three sextants with code 3 or one with code 4
‡Years with diabetes mellitus
5.5. Awareness, values and attitudes

In the nation-wide questionnaire study (I), 38.3% of participants reported that they had not received information about the relationship between periodontal diseases and diabetes. The corresponding rates for the baseline questionnaire study in 1999 and the follow-up questionnaire study in 2001 were 54.2% and 18.3% (Table 16). The majority of subjects (about 90%) reported that they find it important that the diabetes nurse also reminds them about dental care. The proportion of subjects with frequent visits to the diabetes clinic (73.0%) was higher the proportion following the recommended dental treatment interval (42.6%) (IV).

Table 16. Percentage distribution of individuals responding to the cognitive (†) and affective (‡) statements in the questionnaire studies.

<table>
<thead>
<tr>
<th></th>
<th>Nation-wide questionnaire (I), 1998, n=258</th>
<th>Baseline questionnaire (II), 1999, n=120</th>
<th>Follow-up questionnaire (IV), 2001, n=115</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge (†)</td>
<td>no (%) yes (%) I do not know (%)</td>
<td>no (%) yes (%) I do not know (%)</td>
<td>no (%) yes (%) I do not know (%)</td>
</tr>
</tbody>
</table>
| Knowledge = “Have you received information about the relationship between diabetes and gum diseases?”
| Own teeth (†)                | 38 62 0                                  | 46 0                                     | 82 0                                     |
| Own teeth = “I want to keep my natural teeth as long as possible.”
| Motivation (‡)               | 3 92 5                                  | 5 91 4                                  | 3 90 8                                  |
| Motivation = “I find it important that diabetes nurse gives advice about dental care.”
| Oral health (‡)              | 88 10 2                                  | 8 2                                     | 97 2 1                                  |
| Oral health = “Oral health is not as important as general health.”

Responses of different study groups regarding values and attitudes remained fairly consistent throughout the study period. Knowledge about the relationship between diabetes and gum diseases, by contrast, improved. In the diabetes nurse and letter reminder group (G1), the proposition of those stating that they had received information increased from 42% in 1999 to 88% in 2001. The corresponding figure for the diabetes nurse reminder group (G2) was from 43% to 73%, for the letter reminder group (G3) from 52% to 90% and the control group (G4) from 39% to 75%. All individuals received the same information about the relationship between diabetes and periodontal diseases during the clinical examination in 1999, and diabetes nurses gave no further information about the subject.
When individuals with changes in periodontal treatment needs were compared, awareness and appreciation of oral health was lowest among those in whom the number of teeth with CPITN score 3 or 4 had increased (Table 17).

**Table 17.** Percentage distribution of individuals responding to the cognitive (†) and affective (‡) statements according to increased, decreased or no change in number of teeth with CPITN score 3 or 4.

<table>
<thead>
<tr>
<th></th>
<th>Decreased number of teeth with CPITN score 3 or 4, n=44</th>
<th>Increased number of teeth with CPITN score 3 or 4, n=38</th>
<th>No change in number of teeth with CPITN score 3 or 4, n=33</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>no (%) yes (%) I do not know (%)</td>
<td>no (%) yes (%) I do not know (%)</td>
<td>no (%) yes (%) I do not know (%)</td>
</tr>
<tr>
<td>Knowledge (†)</td>
<td>55 45 0</td>
<td>61 39 0</td>
<td>52 48 0</td>
</tr>
<tr>
<td>Own teeth (†)</td>
<td>9 84 7</td>
<td>3 95 3</td>
<td>0 97 3</td>
</tr>
<tr>
<td>Motivation (‡)</td>
<td>5 91 5</td>
<td>0 95 5</td>
<td>9 85 6</td>
</tr>
<tr>
<td>Oral health (‡)</td>
<td>91 7 2</td>
<td>86 14 0</td>
<td>91 6 3</td>
</tr>
</tbody>
</table>

Knowledge = “Have you received information about the relationship between diabetes and gum diseases?”
Own teeth = “I want to keep my natural teeth as long as possible.”
Motivation = “Find it important that diabetes nurse gives advice about dental care.”
Oral health = “Oral health is not as important as general health.”
6. Discussion

6.1. Discussion of methodological aspects

6.1.1. Sampling methods

In the longitudinal intervention study, the diabetes nurses distributed an information letter about the study and interviewed patients during their regular policlinic visits to the Salo Regional Hospital Diabetes Clinic. The interviews were performed within four months, which is the recommended time interval (3-4 months) between regular diabetes control check-ups at the clinic. Thus, every patient at the clinic theoretically had an opportunity to participate in the study. The personal interviews may have activated patients to participate more than a passive invitation letter would have; this approach allowed a comprehensive sample to be gathered. Nevertheless, individuals who are health-orientated and regularly visit the diabetes clinic may also have been more willing to participate in the study; and thus, the results may be an over-estimation of oral self-care among patients with diabetes.

The patient sample must also be examined from two other perspectives. First, the patients were selected from a hospital clinic frequented by patients with more advanced diabetes. However, compared with a Finnish nation-wide study (Valle 1999) in which glycaemic control was poor in almost 50% of the patients with diabetes, the corresponding figure in the present study was only 38%. This indicates that the results are likely an under-estimation with respect to diabetes state. Second, subjects with type 1 diabetes are over-represented (76%); the number of people with type 1 diabetes in Finland is 30 000 (17%) out of a total of 180 000 diagnosed diabetes cases (Development Programme for Prevention and Care of Diabetes in Finland 2000). Type of diabetes has, however, not been shown to be a predictive factor of periodontitis (Tervonen & Oliver 1993), with both type 1 (Thorstensson & Hugoson 1993, Firalti 1997) and type 2 (Shlossman et al. 1990, Emrich et al. 1991, Collin et al. 1998, Sandberg et al. 2000) diabetes being risk factors for periodontal disease. Moreover, the existing health care system in Finland provides patients with diabetes the same opportunities as those available at the Salo Regional Hospital Diabetes Clinic, i.e. for regular diabetes control either in the hospital or at public health care centre clinics by appointment.
6.1.2. Questionnaires

The baseline questionnaire was pre-tested at the Diabetes Centre, in Tampere, on patients with diabetes and revised accordingly. The items in the questionnaire have been successfully used in earlier studies (Murtomaa & Ainamo 1977, Murtomaa 1979, Murtomaa et al. 1984, 1997, Murtomaa & Metsäniitty 1994), which allows for comparison of results. The items in the post-intervention questionnaire followed the same format as those in the preceding questionnaire studies.

The items in the questionnaires are in accordance with the guidelines presented by Eskola (1971); clear and grammatically simple questions were placed at the beginning of the form, and the respondent’s interest was maintained by a logical sequence of items. The questions were closed and multiple choice with alternative statements to facilitate respondents finding suitable answers; this may have improved response and data quality (Bennett & Ritchie 1975). In addition, answers to closed questions tend to be more reliable and consistent over time than answers to open questions (Fink 1995).

Sjöström et al. (1999) concluded in their study of dental attendance that the validity of questionnaire studies is decreased by non-response and incorrect answers, the latter being responsible for approximately one-third of total bias. In the present study, the completed questionnaire forms were verified during clinical examination to ensure that they were duly completed by patients.

Respondents’ answers in a questionnaire study on oral health behaviours and related background variables may be affected by social desirability bias and be more optimistic than their actual behaviour. To diminish this effect, the instructions at the top of the questionnaire advised participants to answer according to their first impulse when hesitating between alternatives. The response rate to the nation-wide questionnaire study with one reminder was 80%, which is relatively high. In mailed questionnaire surveys, a 60-70% response rate is typical (Sjöström et al. 1999).
6.1.3. Clinical examinations

Unlike several diabetes studies which have provided information about periodontal status among patients with diabetes, in the present study, oral self-care and periodontal treatment needs were examined to provide a foundation for oral health promotion among individuals with diabetes.

The Community Periodontal Index of Treatment Needs (CPITN) was primarily designed to assess treatment needs rather than periodontal status (Germo 1994). It has been recommended for use in evaluation of long-term results of preventive and treatment efforts (Barmes & Leous 1986, Ainamo et al. 1987). The CPITN index does not, however, measure attachment loss, recession or bone loss, and when disease is found using this index, a full periodontal examination is necessary (Croxson 1998b). According to current concepts of periodontal disease, the majority of periodontal pockets in most patients are disease-inactive, and interventions may have little or no effect on pocket depth (Page & Morrison 1994). While some doubts have been cast to the sensitivity of the CPITN index to measure outcome of preventive or therapeutic interventions (Holmgren 1994, Page & Morrison 1994), Gjermo (1994) suggested that the CPITN can be used to evaluate results of treatment against described goals.

In this study, the CPITN index, based on the highest CPITN code for the mouth, proved to be insensitive to change as an outcome measure, a result supported by Lennon et al. (1992). Therefore, it is likely that the insensitivity of the CPITN index may have had a negative impact on results of the effects of periodontal treatment or oral health promotion. The distributions of CPITN scores may vary widely on a mouth, sextant and tooth basis, and CPITN scores frequently differ from those indicated by periodontal components, bleeding and calculus (Lewis et al. 1994). Using the percentage of subjects with periodontal pockets is reported to over-estimate the prevalence of deep pockets compared with using sextants (Beningeri et al. 2000). In the present study, the full-mouth recordings for the CPITN were used, and probing was done from six sites of the tooth making the study more precise according to Beningeri et al. (2000). When each tooth with CPITN score 3 or 4 was calculated separately, changes in periodontal treatment needs were detected. Consistent with Lewis et al. (1994), these modifications of the CPITN index are admitted to be time-consuming and
impractical for monitoring patients in general practice, but for study purposes these modifications provided information unavailable when using the highest CPITN code for the mouth.

6.1.4. Design of oral health promotion intervention

This oral health promotion study was designed as a community-based investigation to provide data of real-life significance. A community (also known as pragmatic) trial reflects variations between patients that occur in everyday clinical practice. The sample in a community trial should represent the patients to whom the study results will be applied, and thus, a homogeneous study population is not required as in an explanatory trial (Roland & Torgerson 1998). In addition, because community-based trials measure effectiveness of treatment produced in routine clinical practice, health care professional and patient biases should not be viewed as detrimental, as they would in an explanatory trial (Roland & Torgerson 1998). In a pragmatic trial, the definition of treatments is flexible and usually complex and the approach aims at decision-making, not trying to understand differences between treatments (Schwartz & Lellouch 1967).

6.2. Discussion of results

Even though edentulous subjects were excluded from the final data analysis in the present study, it is noteworthy that edentulousness among participants in the nation-wide questionnaire study seems high (23%) compared with the recently published "Health 2000" nation-wide report (Aromaa & Koskinen 2002), where the rate of edentulous individuals was 13% among 30-to 85-year-old subjects. While edentulousness can be considered to be a rough measurement of oral diseases and oral self-care, the evaluation of reasons for edentulousness among adults with diabetes was not the focus of this study.

6.2.1. Oral health behaviours and associated factors

The rate of those claiming to brush their teeth more often than once a day was quite low, both in the nation-wide (NWQS; 38%) and in the baseline questionnaire studies (BLQS; 29%), and
lower than that in a recent study among Finnish adults with diabetes (Syrrjälä et al. 1999), where at least twice-a-day brushing was reported by 50% of those surveyed. Murtomaa & Metsäniitty (1994) found that the rate of those claiming to brush their teeth more often than once a day was 61%, and in Helakorpi et al. (2000) only 38% of Finnish men and 54% of women reported brushing more often than once a day. In Finland, the twice-a-day brushing recommendation by the Finnish Dental Association appears to be met by a minority. The proportion of subjects who reported cleaning interdental surfaces daily was also low (NWQS; 27% and BLQS; 21%) but higher than in an earlier Finnish diabetes study (15%) (Syrrjälä et al. 1999).

The rate of participants reporting having attended a dental appointment within the previous year was quite high (NWQS; 62% and BLQS; 69%). In a nationwide study (Helakorpi et al. 2000), 58% of men and 65% of women reported having a dental appointment within the past year. A large proportion of patients received emergency treatment (NWQS; 19% and BLQS; 23%) at the last visit. This is consistent with Thorstensson et al. (1989), who found that patients with diabetes required more emergency dental care (13%) than their non-diabetic controls (4%). For many people, especially such disadvantaged groups as the chronically ill (Petersen & Holst 1995), regular screening health care visits are unusual (Blinkhorn 1993), and this is a considerable obstacle to the improvement of oral health (Steele et al. 1996). Individuals with diabetes do not seem to be an exception.

In logistic regression analysis of situational factors, female gender, proved to be a strong predictor of brushing frequency in both questionnaire studies, in line with other dental health behaviour studies (Ronis et al. 1996, Sakki et al. 1996). High education was also a predictor of frequent brushing in the nation-wide questionnaire study. A cognitive statement of self-reported good condition of oral health was a common significant determinant to frequent dental visits in both questionnaire studies. In the nation-wide study, an interesting variable, information about the relation between diabetes and periodontal diseases, was a significant cognitive determinant to frequent dental visits. This modifiable determinant speaks for the important role of knowledge in oral health promotion (Inglehart & Tedesco 1995a). The rate of those who reported that they had not received information about the relationship between periodontal diseases and diabetes was quite high in both studies (NWQS; 38.3% and BLQS; 54.2%), supporting general knowledge about periodontal diseases being poor among the adult
population in Finland (Murto\-maa et al. 1997). Motivation is a critical affective factor in explaining oral health care behaviour (Inglehart & Tedesco 1995a). Its relevance was understood in this study population; in all questionnaires the majority found it important that diabetes nurses, as part of the counselling process, take an active role in reminding patients about dental care.

Löe (2000) has emphasized the importance of active removal of plaque in dental and periodontal health. Barnold et al. (1998) concluded that current oral hygiene measures are aimed at supragingival plaque control and stressed the role of subgingival plaque control and periodontal risk factors in management of periodontal disease. In view of the present study results, there is considerable room for improvement in oral self-care among patients with diabetes in Finland.

6.2.2. Periodontal health indicators and associated factors

Compared with the goals for periodontal health in European populations by the year 2000 (Frandsen 1984), the CPITN recordings in the present study seem high. The rate of individual CPITN 4 scores (23%) in 1999 was much higher than in Ahlberg et al. (1996), where CPITN 4 scores varied from 6% to 11% among Finnish male industrial workers. Bacic et al. (1988), who used CPITN to measure the periodontal treatment needs of patients with diabetes in Yugoslavia, found CPITN scores of 4 in 51% of patients with diabetes and 18% of controls. In a nation-wide study (Vehkalahti & Paunio 1994) among Finnish adults 30 years and older, the proportion of pathological pockets (77%) was almost identical to our findings (78%). In the recently published “Health 2000” nation-wide report (Aromaa & Koskinen 2002), the proportion of those with periodontal disease, defined as at least one deepened pocket ≥4mm, was 65% among 30-to 85-year-old participants compared with 78% in the present study in 1999 among 18-to 70-year-olds.

The majority of earlier diabetes studies have measured periodontal disease rather than treatment needs, and this should be borne in mind when results are compared. The percentage of sextants with CPITN 4 was highest in subjects aged 40-49 years. In this same age group, Hugoson et al. (1989) found more extensive alveolar bone loss in patients with long-duration insulin-dependent diabetes than with short-duration diabetes or in patients without diabetes.
The age group 40-49 years had the longest duration of disease, which indicates that age at disease onset may be a major risk factor for future periodontal destruction (Thorstensson & Hugoson 1993). In the present study, not much of a difference was present in mean duration of disease between age groups, except in the youngest, which had a shorter duration of disease.

In logistic regression, poor metabolic control was the only diabetes-related factor significantly associated with pathological pockets in baseline statistical analysis. This result is consistent with other diabetes studies (Tervonen & Oliver 1993, Collin et al. 1998, Tsai et al. 2002), although methodologies used in measuring glycated haemoglobin may differ between the studies, and thus, comparing results may be unreliable. In the present study, analysis of HbA1c values changed in February 1999, and HbA1c values after that had to be converted to make them compatible with earlier values, possibly decreasing the reliability of this variable.

Other diabetes complications were found to be neither significantly associated with pathological pockets nor increased periodontal treatment needs. In contrast, Bacic et al. (1988) reported an association between CPITN score 4 and advanced retinopathy. Karjalainen et al. (1994) also found that the percentage of ≥4 mm deep pockets (corresponding to CPITN scores 3 and 4) at sites with subgingival calculus was significantly higher among those with advanced organ complications than among patients without complications. Apparently, a more detailed examination and classification of other diabetic complications is needed than was performed in the present study when examining the association between complications and periodontal status.

Variables, such as age 40 years or less, high education, self-reported good condition of oral health and no missing teeth, which were significantly associated with less plaque and less calculus, can not be directly modified. An affective statement concerning the importance of oral health relative to general health was significantly associated with a low CPITN score and is actually the only variable which can be affected by oral health promotion.

Results of the baseline questionnaire and clinical examination study corroborate the belief that a low correlation exists between oral health habits reported and the results of clinical measurements of these habits, with the exception of frequent dental visits and reduced amount
of calculus. Consistent with Lang et al. (1994), no statistically significant differences in plaque and calculus indices or CPITN scores were found between those with frequent and those with less frequent brushing habits. The frequency of interdental cleaning was low and the thoroughness of this habit is suspect since no beneficial effect on periodontal health indicators was found. In Lang et al. (1994, 1995), when attention was paid to the quality of oral health practices, a positive association was found between oral health care behaviours and periodontal health, indicating the importance of guidance in oral hygiene practices. Oral cleanliness was stressed in the management of periodontal diseases in a UK population because over two-thirds of those with self-reported regular brushing still had visible plaque deposits (Morris et al. 2001).

6.2.3. Oral health promotion

The benefits of good oral self-care in preventing dental diseases are well known, but implementation on the individual level requires continuous motivation and guidance (Croxson & Purdell-Lewis 1994). Moreover, Inglehart & Tedesco (1995a) presented that oral health care practices are habitual tasks that need to be well established.

The individuals studied were regular with their visits (73%) to the diabetes clinic but not that precise with the recommended dental treatment interval (43%). This indicates that patients could be more easily reached in diabetes clinics regarding oral health promotion. Cooperation among heath care professionals has been supported by several diabetes studies (Tervonen & Oliver 1993, Karjalainen et al. 1994, Kneckt et al. 2000, Sandberg et al. 2000). According to Tervonen & Oliver (1993) and Karjalainen et al. (1994) patients with poor metabolic control, regardless of their high risk for periodontal diseases, are irregular with dental visits.

Diabetes nurses and dental professionals carried out an intervention to increase use of dental services among patients with diabetes. Diabetes nurses are a professional group very influential among Finnish patients with diabetes, who they are in contact with through regular appointments. For the purposes of the present study, the diabetes nurses were not trained on the importance of oral health, but training these professionals would presumably further
benefit individuals with diabetes. Moreover, when oral health promotion is part of existing health care services, only minimal additional funding is required.

In Finland, patients with diabetes receive some dental care benefits. Adults with diabetes are entitled to state-subsidized public dental care, the extent of which is contingent on the resources of municipalities. In addition, when patients with type 1 diabetes have a physician’s referral for treatment of oral infections, they are eligible for the National Health Scheme, which partly reimburses the use of private dental services. The results of the nation-wide and the baseline questionnaire studies show that this benefit has not been fully utilized, indicating a lack of information both on the medical and dental side. The impact of an amendment to the National Health Scheme, which came into effect on the first of December 2002 allowing partial reimbursement to all Finnish citizens, remains to be seen. The importance of consistent oral health care behaviour and good metabolic control in oral health have been stressed in the national guidelines for care of type 1 diabetes (Suomen Diabetesliitto 2000), but oral health in type 2 diabetes is not included in the revised guidebook (Suomen Diabetesliitto 2001).

The descriptive results of the present intervention study which were related to motivation to frequent dental visits indicated that the smallest decrease in the amount of calculus was in the control group. This implies that motivating individuals make frequent dental visits might be effective in promoting periodontal health. While some changes in the number of teeth with a high CPITN score could be detected, the differences between study and control group might have been more apparent with a more sensitive outcome measure. A considerable increase occurred in the study population’s awareness of the relationship between diabetes and periodontal diseases. Improving the awareness of increased risk for periodontal diseases in individuals with diabetes is thus a prime educational area (Moore et al. 2000, Sandberg et al. 2001). Sandberg et al. (2001) found that 85% of their subjects had never received information about the relationship between diabetes and oral health. Most subjects with diabetes appear to be unaware of oral health complications (Moore et al. 2000) or of their own oral health problems (Jones et al. 1992). The increased awareness among the present study subjects had a positive effect on oral self-care.

Kay & Locker concluded (1998) that while oral health promotion improves the level of knowledge, the impact on behaviour or clinical indices of the disease is unclear or only a
short-term clinical effect is achieved (Kay & Locker 1996, Watt et al. 2001). However, the present results suggest that periodontal treatment needs could be reduced with a minimal contribution to oral self-care. Health promotion in diabetes care and in oral health care share the same principles of patient empowerment: knowledge, behavioural skills and self-responsibility (Anderson 1995, Schou & Locker 1997), which could further facilitate cooperation for the benefit of patients with diabetes. Taken together, health care professionals have an ethical obligation to provide information about diseases and their prevention, irrespective of what the population does with that knowledge (Kay & Locker 1996).

6.2.4. Changes in periodontal health indicators

Increased periodontal treatment needs were studied in greater detail, because more variables explained increase than decrease in periodontal treatment needs. This approach was also considered more useful from the perspective of oral health promotion. In this context, there was no intend to understand the underlying factors related to oral self-care behaviour.

When common periodontal risk factors were studied in a bivariate analysis, smoking proved to be a risk factor for increased periodontal treatment needs. Smoking has been suggested to affect the host defence system (Kinane & Chestnutt 2000). In Bridges et al. (1996), the risk for periodontal disease was significantly higher for smokers with diabetes than for any other group (smoking and no diabetes; non-smoking and diabetes; non-smoking and no diabetes), indicating the combined detrimental effect of smoking and diabetes. Moore et al. (1999) found that smoking increased the risk for excessive periodontal disease about 10-fold among patients with type 1 diabetes. Moreover, smokers have a less favourable response to both nonsurgical and surgical periodontal therapies than non-smokers (Grossi et al. 1996).

The importance of regular interdental cleaning in maintaining periodontal health was evident when increased periodontal treatment needs (scores 3 and 4) were studied. A Norwegian study examining deterioration of the Periodontal Treatment Need System (PTNS) index also demonstrated that lack of interdental cleaning and low educational level were the main factors associated with an increased number of quadrants with deep periodontal pockets (≥5mm) in a longitudinal 15-year study (Hansen et al. 1995).
Infrequent dental visits also proved to be significantly associated with an increase in periodontal treatment needs. However, in their cross-sectional study, Mullally & Linden (1994) found no difference in clinical attachment loss between irregular and regular dental attenders, although the difference in mean percentage of plaque, calculus and bleeding on probing was significant and the number of smokers was double among irregular attenders. The opposite results were reported by Morris et al. (2001), who found that those visiting the dentist within the last year were only half as likely to have moderate pockets as those who had not visited the dentist in the last five years (11% compared with 20%). In any case, the importance of regular dental visits in prevention, treatment and maintenance care of periodontal diseases among patients with diabetes is evident because the local factors of plaque and calculus are required for the disease to occur (Salvi et al. 1997a).

While diabetic state can not be cured, diabetes mellitus can be considered to be a modifiable risk indicator because the risk for periodontal disease is increased with poor glycaemic control (Seppälä & Ainamo 1994, Collin et al. 1998) and other organ complications (Bacic et al. 1988, Karjalainen et al. 1994). The risk for severe periodontitis in well-controlled patients with diabetes, especially those without calculus and with excellent dental care and oral hygiene, is no greater than in patients without diabetes (Oliver & Tervonen 1993). In this study, diabetes-related risk factors did not prove to be significant in explaining deterioration of the individual tooth-based CPITN index. This could partly be explained by fairly good metabolic control among the study population.

The analysis used in the present study suggested that no smoking and good oral self-care are essential in maintaining and promoting periodontal health among people with diabetes. According to the common risk factor approach health, promotion should not be disease-specific but aimed at reducing risk factors (Sheiham & Watt 2000). In light of the present results, encouraging cessation of smoking and regular health care as well as emphasizing oral hygiene as a part of daily hygiene and grooming behaviour could improve both systemic and periodontal health.
7. Conclusions and recommendations

Based on the parameters investigated, the oral self-care behaviours of adults with diabetes are not consistent with their increased risk for periodontal diseases; i.e. this patient group practises poorer oral self-care than is required. Moreover, the results indicate extensive periodontal treatment needs among the study population. Although numerous and complex factors are involved in periodontal diseases, regular oral self-care seems to play a central role in preventing and treating these diseases, especially among patients at high risk such as individuals with diabetes. Special action should therefore be directed at improving their oral self-care and periodontal health.

The variety of factors partly explaining oral self-care in adults with diabetes in the present study indicates the complexity of human health behaviour. Besides the commonly found determinants of frequent oral health behaviours, such as female gender and high education, the results also highlight the importance of awareness and appreciation of oral health as part of general health.

The results give guidelines as to where oral health promotion should be directed. Participants were regular with their visits to the diabetes clinic but less careful about adhering to the recommended dental treatment intervals, which supports the approach that educational oral health promotion needs to be targeted not only at patients with diabetes but also at health care professionals. Diabetes nurses are a professional group that has regular contact with and a strong influence on Finnish patients with diabetes. For the purposes of this study, diabetes nurses were not trained about the importance of oral health, but training of these professionals would presumably further benefit individuals with diabetes. In addition, the majority of subjects were interested in receiving motivation on dental care from diabetes nurses. Promotion of oral health can be seen as a multi-professional task. All health care professionals have an ethical obligation to inform patients about their possibilities for better health, including oral health.

When the effectiveness of oral health promotion was evaluated, positive effects were found on oral health behaviours and periodontal health indicators. Positive changes in amount of
calculus and number of teeth with CPITN score 3 or 4 in intervention groups compared to the control group indicated that it is possible to further promote oral health among individuals with diabetes by enhancing regular oral health behaviours.

Healthy life-styles choices, such as cessation of cigarette smoking and regular oral self-care, are modifiable determinants of periodontal treatment needs. The common risk factor approach could be applied to alleviate multiple risks in oral health. Because diabetes and periodontal disease share a special two-way relationship, collaboration and consultation between all health care professionals involved in diabetes care is necessary.

While the factors affecting periodontal health are numerous and many are still insufficiently understood, the results of the present community trial indicate that oral self-care promotion is needed and is quite effective among subjects with diabetes. Consistent with the principles of patient empowerment, individuals with diabetes together with health care professionals share the responsibility for maintaining comprehensive oral health, an integral part of general health. This principle has not yet been fully realized, and therefore all actions directed towards improving this collaboration should be supported for the benefit of individuals with diabetes as well as the whole health care system.
8. Acknowledgements

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Helsinki, April 2003

Aija Karikoski
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10. Appendices

10.1. Questionnaire for the baseline studies

1) What is your gender?
   1. female
   2. male

2) How old are you?
   1. less than 20 years
   2. 20-29 years
   3. 30-39 years
   4. 40-49 years
   5. 50-59 years
   6. 60-69 years
   7. more than 70 years

3) What is the highest education that you have achieved?
   1. low, secondary or comprehensive school
   2. high school and/or forms of technical education
   3. college degree
   4. lower university degree
   5. university degree

4) Do you smoke?
   1. regularly (almost every day )
   2. every now and then (e.g. during an evening out)
   3. I had smoked for_______ years but stopped
   4. I do not smoke

5) What year were you diagnosed with diabetes?  19____

6) What type of diabetes do you have?
   1. insulin-dependent diabetes mellitus
   2. non-insulin-dependent diabetes mellitus
   3. some other type
   4. I do not know

7) How would you describe the balance of your diabetes AT THIS MOMENT?
   1. good
   2. fair
   3. tolerable
   4. bad

8) Has a long-term blood glucose level (HbA1c-level), been assessed for you?
   1. no
   2. I do not know
   3. yes, when? Month____, year 19____.
      Value? HbA1c____%
9) Do you have complications due to diabetes? Please answer all six questions.

<table>
<thead>
<tr>
<th>Question</th>
<th>NO</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. numbness in your feet</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2. regular albuminuria</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>3. retinopathy</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>4. neuropathy</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>5. nephropathy</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>6. coronary disease or infarct of the heart</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

10) When was your LAST dental appointment?
1. less than 1 year ago
2. 1-2 years ago
3. 3-5 years ago
4. more than 5 years ago
5. I do not know

11) What was your LAST treatment place?
1. private dentist
2. health care center
3. something else, what? _________________

12) What was the MAIN reason for your LAST dental treatment? (Choose only one alternative.)
1. pain or some other emergency treatment
2. normal check-up
3. preparing or fixing a denture
4. something else, what? _________________
5. I do not remember

13) If you have not had dental treatment for two years, what is the reason? (You may choose several alternatives.)
1. dental care is unpleasant
2. dental care is too expensive
3. I have not had any problems with my teeth/dentures
4. it is difficult to make an appointment because of my work
5. I have not received a call though I am in the recall system
6. some other reason, what? _______________

14) Do you have any of the following symptoms AT THIS MOMENT? (You may choose several alternatives.)
1. pain in the jaw (temporomandibular joint) or difficulties in opening your mouth
2. a broken tooth or filling
3. sensitivity when you bite your teeth together
4. dry mouth
5. unpleasant taste
6. bad-smelling breath
7. painful tongue or mouth
8. dry, painful or chapped lips
9. burning mouth
10. bleeding gums
11. painful or sensitive gums
12. a loose denture
13. calculus
14. sensitive teeth
15. some other symptom, what? ____________________
16. I do not have any symptoms ____________________

15) How would you describe the condition of your mouth and teeth?
   1. good
   2. quite good
   3. average
   4. quite bad
   5. bad
   6. I do not know

16) Have you lost any permanent teeth?
   1. none
   2. some teeth from one jaw
   3. all teeth from one jaw
   4. all teeth from both jaws

17) How much information have you received about dental care and oral diseases?
   1. I have received sufficient information
   2. I have received some information but not enough
   3. I have not received information, move to question number 19
   4. I do not know, move to question number 19

18) Where have you received the above-mentioned information? (You may choose several alternatives.)
   1. the diabetes nurse
   2. the doctor
   3. the dentist or dental nurses
   4. the diabetes journal
   5. somewhere else, where? ______________

19) Have you ever received a physician’s referral to dental care?
   1. yes
   2. no
   3. I do not know

20) Have you received any information about the influence of gum disease and diabetes?
   1. no
   2. yes, from where?
      a. the diabetes nurse
      b. the doctor
      c. the dentist or dental nurses
      d. the diabetes journal
      e. somewhere else, where? ______________

21) Do you think you have any gum disease AT THIS MOMENT? If not, have you had gum disease and when was the last time? (Choose only one alternative.)
   1. I have gum disease now
   2. I do not have gum disease now, nor have I had gum disease earlier
   3. I had gum disease earlier this year
   4. I had gum disease more than one year ago
   5. I had gum disease two or more years ago
   6. I do not know

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22) Have your gums been bleeding RECENTLY? Have your gums ever bled before?
   1. my gums have bled recently
   2. my gums have not bled recently or in the past
   3. my gums have bled this year
   4. my gums have bled more than one year ago
   5. my gums have bled two or more years ago
   6. I do not know

23) How often do you brush your teeth?
   1. almost every day
   2. once a day
   3. more often than once a day
   4. I do not brush my teeth

24) What do you use for cleaning the space between the teeth?
   1. dental floss
   2. toothpick
   3. interdental brush
   4. nothing

25) How often do you clean the interdental space?
   1. almost every day
   2. once a day
   3. more often than once a day
   4. never

26) If you notice bleeding when cleaning your teeth, what do you do?
   1. I have never noticed bleeding from my gums
   2. I stop cleaning the area that is bleeding
   3. I clean the bleeding area very carefully
   4. I contact my dentist
   5. I do not pay attention to bleeding gums
   6. I do something else, what?_________________

27) During the LAST dental visit my next appointment was recommended to be scheduled
   1. in three months
   2. in six months
   3. in one year
   4. some other time, when?_________________
   5. no suitable interval between dental visits was recommended

28) Some statements are presented. Indicate your opinion by ticking the box RIGHT if you agree and the box WRONG if you disagree. If you do not know, tick the box I DO NOT KNOW.

   1. During brushing bleeding gums are normal.
   2. The tooth is attached to the bone with very thin fibres.
   3. The symptoms of gum disease are swelling and red colour.
4. Pure oral health can be injurious to general health.

5. Calculus can also be found under the gum line.

6. Advanced gum disease means an infection as big as the size of your palm.

7. Calculus is caused by bacterial debris on the teeth.

8. Mouthwash and antibiotics are the most effective means to release and cure gum diseases.

9. Even when cured, gum diseases require regular cleaning of the teeth.
29) Next, you will find some statements on dental care. You should circle the one alternative nearest to your own opinion for each statement from the five alternatives provided. There is no best response. Your own opinion is the key issue and is most important.

<table>
<thead>
<tr>
<th>Statement</th>
<th>FULLY AGREE</th>
<th>SOMEWHAT AGREE</th>
<th>I DO NOT KNOW</th>
<th>SOMEWHAT DISAGREE</th>
<th>FULLY DISAGREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curing gum diseases is not as important as filling cavities.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>High costs are the main reason for not visiting a dentist.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Oral health is not as important as general health.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Dental clinic personnel do not provide enough information.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Since early childhood, I have suffered from dental problems which I can not influence</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I want to keep my natural teeth as long as possible.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Forgetting and lack of time are the main reasons for not taking care of my teeth.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>In my opinion, beautiful teeth are more important than healthy gums.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I find it very important that the diabetes nurse remind patients to take better care of their teeth.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Furthermore, I would like to mention…. ____________________________________________________

Thank you for your participation.
10.2. Questionnaire for the follow-up study

1) What is the highest education that you have achieved?
   1. low, secondary or comprehensive school
   2. high school and/or forms of technical education
   3. college degree
   4. lower university degree
   5. university degree

2) Do you smoke?
   1. regularly (almost every day )
   2. every now and then (e.g. during an evening out)
   3. I had smoked for______ years but stopped
   4. I do not smoke

3) Have you taken antibiotics during the last six months?
   1. yes, I have
   2. no, I have not
   3. I do not know

4) When was your LAST dental appointment?
   1. less than 1 year ago
   2. 1-2 years ago
   3. 3-5 years ago
   4. more than 5 years ago
   5. I do not know

5) How often do you have dental treatment?
   1. every three months
   2. every six months
   3. once a year
   4. other, how often?__________________

6) What was your LAST treatment place?
   1. private dentist
   2. health care center
   3. something else, what?__________________

7) What was the MAIN reason for your LAST dental treatment? (Choose only one alternative.)
   1. pain or some other emergency treatment
   2. normal check-up
   3. preparing or fixing a denture
   4. something else, what?__________________
   5. I do not remember

8) If you have not had dental treatment for two years, what is the reason? (You may choose several
alternatives.)
   1. dental care is unpleasant
   2. dental care is too expensive
   3. I have not had any problems with my teeth /dentures
   4. it is difficult to make an appointment because of my work
   5. I have not received a call though I am in the recall system
   6. some other reason, what?__________________
9) How would you describe the condition of your mouth and teeth?
   1. good
   2. quite good
   3. average
   4. quite bad
   5. bad
   6. I do not know

10) Have you ever received a physician’s referral to dental care?
   1. yes
   2. no
   3. I do not know

11) Have you received any information about the influence of gum diseases and diabetes?
   1. no
   2. yes, from where?
      a. the diabetes nurse
      b. the doctor
      c. the dentist or dental nurses
      d. the diabetes journal
      e. somewhere else, where? ______________

12) How often do you brush your teeth?
   1. almost every day
   2. once a day
   3. more often than once a day
   4. I do not brush my teeth

13) What do you use for cleaning the space between the teeth (interdental space)?
   1. dental floss
   2. toothpick
   3. interdental brush
   4. nothing

14) How often do you clean the interdental space?
   1. almost every day
   2. once a day
   3. more often than once a day
   4. never

15) Have your gums been bleeding RECENTLY? Have your gums ever bled before? Choose one of the following alternatives:
   1. my gums have bled recently
   2. my gums have bled in the past
   3. my gums have not bled recently or in the past
   4. I do not know

16) Has your dentist/oral hygienist provided any training for brushing your teeth during the past two years?
   1. yes
   2. no
   3. I do not know
17) Has your dentist/oral hygienist provided any training for interdental cleaning during the past two years?
   1. yes
   2. no
   3. I do not know

18) Have you increased brushing of your teeth during the past two years?
   1. yes
   2. no
   3. I do not know

19) Have you increased interdental cleaning during the past two years?
   1. yes
   2. no
   3. I do not know

20) Have you increased your dental visits during the past two years?
   1. yes
   2. no
   3. I do not know

21) Do you think you have any gum disease AT THIS MOMENT? If not, have you had gum disease
    before and when was the last time? (Choose only one alternative.)
    1. I have gum disease now
    2. I have had gum disease earlier
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In my opinion, oral health is not as important as the other physical health.

I want to keep my natural teeth as long as possible.

I find it very important that the diabetes nurse remind patients to take better care of their teeth

Furthermore, I would like to mention….__________________________________________________

Thank you for your participation.