Long-term change in dental prevention and check-up intervals in public dental service in Helsinki, Finland

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Academic dissertation

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Helsinki 2003
"It is not the healthy who need a doctor, but the sick" (Luke 5:31)

To Elsa, Helvi, Kalle, Riitta, Riina and Tiina
Abstract


The aim of the present study was to track changes in dental state from 1976 to 1999, in Helsinki, Finland, and to evaluate dental prevention measures and the success with which they have been targeted at high-risk groups by Helsinki City Health Department. The study design was longitudinal, dental prevention being evaluated on the basis of five cross-sectional and one follow-up study. Data on dental state and treatments were collected from patient records and from official automatic data processing files.

During the first 10 years, from 1976-1986 there was a substantial decrease in caries occurrence. In 1986, no focusing on risk patients was found. In 1989-91, the percentage of dental prevention in the treatment mix was directly proportional to a decrease in caries prevalence.

In 1999, a positive change was observed in the targeting of caries prevention to 0- to 18-year-old patients. The patients in orthodontic care were receiving more caries prevention. The proposed check-up intervals corresponded to the dental state of children. The dentists’ age and gender had no impact on the time spent for repeated caries prevention. Young adults’ check-up intervals appeared to function optimally. On the other hand, the feasibility of the DT and CPITN indices as administrative measures of treatment needs in young adults seemed to be minor.

On the whole, the targeting of dental prevention has improved since 1976 and 1986. However recommendations are made for 1) additional training in calibration and usage of a computer-aided program to aid dentists in providing more accurate dental prevention, 2) economic incentives and 3) an administratively more practical dental index. In addition, the cost-effectiveness of the methods used in Helsinki should be studied and compared to methods used elsewhere.

Key words:
check-up intervals, dental indices, dental prevention, dentists’ characteristics, orthodontic care, public dental service, risk strategies, targeting

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Abbreviations

ADP        automatic data processing
CI         number of incipient caries lesions
CPITN      Community Periodontal Index of Treatment Needs
DMFS       number of decayed, missing, filled permanent tooth surfaces
dmfs       number of decayed, missing, filled deciduous tooth surfaces
DMFT/DMF   number of decayed, missing, filled permanent teeth
dmft/dmf   number of decayed, missing, filled deciduous teeth
DS         number of decayed tooth surfaces
DSa        number of decayed permanent approximal surfaces
DT         number of decayed teeth
DT+dt      total number of decayed permanent + deciduous teeth
FS         number of filled tooth surfaces
FT         number of filled teeth
HCHD       Helsinki City Health Department
MT         number of missing teeth
REP        repeated dental prevention. REP is performed at further visits after the first check-up visit. See page 37.
List of original publications

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


V  Helminen SKJ, Vehkalahti MM. Do check-up intervals correspond to caries indices in the free public dental service in Helsinki, Finland? Community Dental Health 2002;19:166-172.

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ORIGINAL PUBLICATIONS
1 Introduction

A large body of research published in the 1980s indicated a rapid decline of dental caries among children and adolescents during the previous two decades, especially in most western industrialised countries. In countries like Finland, this decline could be seen best in subsidised public dental service, where the coverage among 0- to 18-year-olds approaches 100%. Opinions were voiced that the measures used in dental prevention since the 1970s were inadequate two decades later. The Primary Health Act of 1972 and detailed nationwide instructions of the National Board of Health formed a systematic framework for prevention-orientated public dental service. In Finland all public dental clinics were required to use similar standardised patient charts. Both the public and private dental sector record dental treatments using one system of codes maintained by the Social Insurance Institution.

In the beginning of the 1990s, the public dental clinics of the Helsinki City Health Department (HCHD) provided dental prevention programmes in accordance with the administrative instructions given in 1978 and renewed in 1985. Since 1997, HCHD has used the Effica® online software (by TietoEnator Corporation) for patient and administrative data. All public dental clinics in Helsinki use the same network. Patient charts and appointments are displayed on screen. Patient data are recorded and automatically transmitted to the administrative part of the program. The program calculates the DMFT and CPITN indices from dentists’ original clinical finding data. Here, the usability of these dental indices will be evaluated from the administrative and prevention-orientated point of view.

For human resource planning it is also important to know which factors are involved in the differences in the outcome of dental service. The present study, covering 23 years, aims to evaluate whether it is the dental diseases or dental practices that have changed and, moreover, what factors explain the improvement in dental prevention. The dentists’ characteristics and the treatment mix are used in evaluating the dental prevention measures that have been taken for patients in various risk categories. One important target group includes the patients in orthodontic care, due to their increased risk for caries and periodontal diseases.

Children and adolescents have dominated as target populations for studies of dental prevention, whereas studies of the caries risk among young adults are very scarce. Therefore, dental indices and their impact on targeting dental prevention, periodontal, and filling therapy were evaluated among young adults as well.
The questions investigated in this study are:

- Have dental prevention practices in relation to dental health changed from 1976 to 1999?

- Is dental prevention given to those who need it most?

- Do check-up intervals correspond to dental indices?

- Is dental prevention, including check-up intervals, provided independent of dentists’ characteristics?

The general approach to the present study is administrative. It aims to evaluate the dental prevention in HCHD longitudinally, starting with the caries data from 1976 to 1986 and observing the trends in caries decline and resources used in dental prevention in the late 1990s.
2 Review of the literature

2.1 Trends in oral health and dental prevention

2.1.1 Trends in oral health

The improvement in the oral health of children and adults in industrialised countries during the last few decades has been widely reported (Renson et al., 1985; Marthaler et al., 1996; Sundberg, 1996; von der Fehr and Haugejorden, 1997; Hugoson et al., 1998; 2000a; 2000b; Oliver et al., 1998; Kelly et al., 2000; Carvalho et al., 2001; Aromaa and Koskinen, 2002; WHO, 2003) and has been described as "dramatic", "marked", and "substantial" (Nadanovsky and Sheiham, 1995; Brown and Lazar, 1998a; Burt, 1998; Winston and Bhaskar, 1998; Featherstone, 2000). Age-specific analyses from 1966 to 1983 in Norway showed that the caries decline among the 6- to 17-year-olds started at different points of time in various age-groups: for the 8- to 11- and the 17-year-olds in the late sixties, and for the remaining age-groups after 1971 (Birkeland et al., 2000). In Helsinki, the caries decline among children and adolescents was sharp from 1976 to 1986 (Vehkalahti et al., 1990), but very little further reduction has taken place since then (Helsinki City Health Department, 1993a; 1994; Varsio and Vehkalahti, 1996; Varsio et al., 1999b; Vehkalahti et al., 1997).

Since the 1960s, the progression of caries lesions from the enamel has become slower in subjects with either high and low caries intensity, with many lesions remaining in the enamel (Ekanayake and Sheiham, 1987). Incipient enamel lesions in 16-year-old children constituted 80% of the total number of carious lesions in the county of Bohuslän, Sweden, in 1990 (Moberg Sköld et al., 1995). Although the reduction in the mean values of DMFT at the population level gives the impression that caries is no longer a major public health problem, this impression is false (Bowen, 1991; O’Mullane, 1995).

In the era of high prevalence, caries were described using DMFT indices for age-groups. Nowadays, these indices include an increasing number of caries-free subjects and, on the other hand, only a few high-caries subjects. As this skewed distribution of caries means a high proportion of lesions concentrated in relatively few subjects (Milén et al., 1988; Burt, 1998), therefore, mean DMFT and DT+dt indices should not be used as a data basis when updating preventive strategies (Fejerskov, 1995; Vehkalahti et al., 1997). Instead, attention should be paid to population distributions within these DMFT and DT+dt indices (Varsio, 1999; Bratthall, 2000). In Australia, the DMFT index for 12-year-olds was normally distributed in 1977, the mode being DMFT=4, but in 1993, the distribution was uni-modal, with the mode being DMFT=0 (Spencer, 1997). In two Finnish towns a strongly
skewed distribution of DMFS was seen in 1992-1998, the highest quartile of the
12-year-olds accounting for 79%, and of 15-year-olds for 67% of all DMFS (Seppä et al.,
2000b). In 1993, 8% of Helsinki 5-year-olds accounted for 76% of all DT+dt in that
age-group, and correspondingly for 15-year-olds, 10% accounted for 55% of all decayed
teeth (Vehkalahti et al. 1997).

2.1.2 Trends in dental prevention

After detecting the role of fluorides in caries prevention, fluoride was first added to
piped water, starting in 1945 in Grand Rapids, Michigan, and from the early 1970s to
toothpaste, leading to substantial caries decline (Winston and Bhaskar, 1998; Marthaler,
2002). The use of fluoride toothpaste was the only clear and positive common denominator
in the reports of 52 dental experts who were questioned about the impact of various
possible caries preventive factors on the decline of caries in children and adolescents
(Bratthall et al., 1996). In addition, improvement in dental health during the past 30
years has been related to improvements in social, economic and environmental factors (Watt
and Sheiham, 1999). Due to the multifactorial origin of caries, it seems that conclusive
scientific evidence for the reasons behind caries decline will be hard to present (Renson
et al., 1985).

Dental prevention measures were established at a time when caries was a common public
health problem (Burt, 1998; Schwarz, 1998). In the present era of low and stable
occurrence, dental caries and periodontal diseases cannot be prevented totally, but they
can be controlled (Fejerskov, 1995; Horowitz, 1995). For dental prevention, several
in-office measures with clinically proven effectiveness have been available: use of
fluorides, sealing of fissures, use of xylitol and chlorhexidine, and professional tooth
cleaning, scaling, and root planing (Luoma et al., 1978; Axelsson and Lindhe, 1981;
Isokangas, 1987; Axelsson et al., 1991; Spets-Happonen et al., 1991; Tenovuo et al., 1992;
Seppä et al., 1994; Page and Beck, 1997; Petersson et al., 1998, Pitts, 2002). From among
these, clinicians and dental administrators select the appropriate methods for each target
population, leading, for example in Denmark, Iceland, Norway, and Sweden, to a wide
variety of measures taken to improve dental health, but resulting in similar caries
deciles (Wang et al., 1998b). A systematic review of 1435 papers considered the efficacy
of in-office preventive interventions, such as fluorides, chlorhexidine, sealants and
their combinations, for high caries risk patients, but finally included only 22 studies
with sufficient data (Bader et al., 2001). For fluoride varnishes, the strength of the
evidence was judged to be fair but for all other methods insufficient, indicating a need
for stronger evidence rather than for the verification of the inefficacy of other
preventive methods. Another systematic review of reviews by Rozier (2001) covering the
period from 1980 to 2000 revealed good evidence for the effectiveness of fluoride gels and
varnishes, chlorhexidine, and sealants as regards caries prevention in the permanent teeth
of children and adolescents. In Sweden, a systematic review of caries-preventive methods
extracted from the Medline database from 1966 to 2001 gave strong scientific evidence only
for daily use of fluoride toothpaste in children and adolescents (SBU, 2002).

Since the 1990s, researchers have become increasingly critical of the preventive methods and their positive effects in public health services. Even the impact of dental services on the incidence of caries in children and adolescents has been questioned (Nadanovsky and Sheiham, 1995; Sheiham, 1997), as well as that of oral health education programmes and interventions (O’Mullane, 1995; Kay and Locker, 1996).

Criticism has tended to be focussed on the following three areas:

- ineffective fluoride mouthrinsing programmes are still being conducted in some schools (Kallestål and Holm, 1994; Wang et al., 1998b),

- dental health education interventions have no discernible effect on caries incidence, but a small, positive and temporary effect on plaque accumulation (Kay and Locker, 1996), and

- the outcome in children’s dental care, as measured by caries experience and numbers of treated patients, is equivalent to or even better than European dentist-based services when provided by dental therapists in Australia (Riordan, 1997).

Suggestions for improvement include:

- reconfirmation of the purpose of caries prevention (Schwarz, 1998), and

- a clear oral health policy, including prevention-based health care reform and reimbursement (Choo et al., 2001).

Lately, the term "preservative dentistry" has gained in popularity, thus taking into account the modern management of caries as an infectious disease. Preservative dentistry tries to avoid or delay operative intervention as long as possible (Anusavice, 1995; 1998; Featherstone, 2000). Although new innovations, such as the use of xylitol and antibacterial chemotherapeutic agents, can improve oral hygiene, they also have their limitations. Despite the fact that its clinical efficacy is still under discussion (Scheie and Fejerskov, 1998; SBU, 2002), the use of xylitol to prevent caries saves dental resources (Mäkinen, 1998; Kovari, 2002) but needs motivated patients.
2.2 Dental prevention approaches

2.2.1 A population strategy

A population strategy in dental prevention envisions preventive measures for an entire target group or population and is feasible when the prevalence of dental diseases in the population is high (Sheiham and Joffe, 1991). A population strategy attempts to control the causes of the incidence in order to lower the mean level of risk factors in that population (Rose, 1985).

In Finland, the Primary Health Act (Laki 66/1972) emphasises universal prevention in all fields of health, including dental prevention. The Act required the National Board of Health to present a systematic framework for national public health policy with five-year goals and strategies including detailed instructions for dental health promotion in public dental clinics (National Board of Health, 1972). Ever since, this has been the uniform official basis for the population strategy in the dental prevention programme of public dental service in Finland.

Since 1972, dental care has been provided in Finland free of charge to all children and adolescents up to 17 years of age. In practice, adults have only limited access to public dental service in larger cities such as Helsinki, due to lacking resources. There is clear disagreement with the population strategy but the emphasis on children and adolescents in dental prevention can be seen as a "directed population strategy" (Sheiham and Joffe, 1991), which is flexible application of a population strategy.

Water fluoridation has been the most effective population-based caries prevention measure designed to reach all inhabitants. In Finland, the national plan for primary health care for 1976-80 included a requirement for the communes to provide the inhabitants with sufficient intake of fluorides. A proposal for water fluoridation was made in 1981 based on a working group report (National Board of Health, 1981), but the local politicians in Helsinki opposed it. In countries with low caries rates the relative effectiveness of fluoridated water has diminished (Seppä, 2001). In Kuopio, Finland, no increase in permanent and primary teeth caries was noticed three years after discontinuation of water fluoridation in 1992 (Seppä et al., 1998; 2000a), when for the first time the beneficial effect of water fluoridation was not shown. In Ireland, where fluoridated water supplies cover 70% of the population, children in families from the lower social class have benefited from water fluoridation: in a sample of Irish 12-year-olds no difference in caries experience was found in children from low and high social classes (Bolin et al., 1997). Recently, water fluoridation has been introduced in the USA in Los Angeles, San Diego and San Antonio (Marthaler, 2002). Further components of a population strategy are...
dental health education through mass media and the comprehensive use of fluoride toothpaste (Burt, 1998).

In Finland, applying a population strategy has been questioned because of the skewed caries distribution (Varsio, 1999; Raitio, 2002). It has been argued that since there are even signs of an increase in caries prevalence, it is important that population-based health education measures continue (Seppä, 2001).

2.2.2 A high-risk strategy

A high-risk strategy seeks to protect susceptible individuals, whereas a population strategy seeks to control the causes of incidence of diseases (Rose, 1985). In dental prevention, this means that the individuals at high risk of dental diseases must first be identified in order to design preventive measures for them.

Following the rapid decline in caries occurrence, a strong polarisation in caries occurrence has been observed among child and youth populations (Spencer, 1997; Vehkalahti et al., 1997; Burt, 1998). A high-risk strategy has been promoted in countries where caries is strongly polarised (Seppä, 2001). However, high-risk individuals nowadays have much lower DMF scores than the average scores a generation ago (Eriksen, 1998).

Recently, a strategy for high-risk groups was evaluated in real-life conditions in a 12-year-old Finnish population with a low overall caries frequency in an intensive preventive trial aimed at children with a high risk of caries. After three years, practically no additional benefits from such a strategy were observed (Hausen et al., 2000). Drop-out rates of 24% to 29% of the high-risk patients may have had some impact on the results. However, a population strategy, which in this case was basic prevention for all children, might have produced results that were similar to those achieved by a high-risk group strategy. In another Finnish study, basic prevention appeared to be the most cost-effective approach in an intensive caries prevention programme for 14-year-old patients at high-risk of having caries (Raitio et al., 2001).

The implementation of a strategy for high-risk groups in the public dental service clinics in Västerbotten, Sweden, seemed to be less than satisfactory: the chance to get more than 15 minutes of preventive time during the four years between 13 and 17 years of age was only 1.35 times higher in the highly caries active participants (Kallestål and Holm, 1994). Neither this study nor that of Hausen et al. (2000) was able to show positive results in implementing dental prevention strategies in real-life conditions.

In contrast, encouraging findings have been reported from Australia, where a prevention programme aimed at a group of 12- to 13-year-olds with a high risk of caries received a weekly fluoride mouthrinse, an annual application of fissure sealants and an annual oral hygiene education programme for three years (Morgan et al., 1998). The preventive dental
programme implemented resulted in significant improvements in an environment of reduced caries. There are similar findings from risk-based caries prevention programmes for two- to five-year-old children in Finland, who obviously benefited from targeted supplemental caries prevention measures (Pienihäkkinen and Jokela, 2002).

### 2.2.3 A combined population and high-risk strategy

Adoption of a high-risk strategy should not exclude the application of a population strategy and *vice versa*. In appropriate circumstances both strategies should be used together (Sheiham and Joffe, 1991; Fejerskov, 1995; Burt, 1998). In Sweden, preventive measures in public dental clinics were taken on the basis of a high-risk strategy by 49% of the clinics, while 50% of the clinics preferred a combination of high-risk and population strategies (Sundberg et al., 1996), which is in line with a suggestion that major shifts from a population strategy to a high-risk approach should be implemented with caution (Hausen et al., 2000).

The advantages and disadvantages of the high-risk and the population strategies have been properly discussed by Sheiham and Joffe (1991). Among the advantages of the high-risk strategy they include appropriate preventive dental interventions for high-risk subjects so that non-risk subjects do not have to undergo treatment. By targeting those most in need, resources are saved. Among the disadvantages were the likelihood that costs would need to be borne by those at high risk and that the cost-benefit ratio still might be unfavourable. As regards the population strategy, Sheiham and Joffe list three advantages: the whole population will benefit, reinforcement will be unnecessary after the acceptance of a norm (e.g. fluoridated toothpaste), and effective basic dental prevention diminishes the need of intensified prevention. As disadvantages of the population strategy they identify the lengthy periods of time needed to change social norms (e.g. use of products rich in sugar) and the possible adverse impact of its implementation (e.g. unemployment in sugar industries).

A strategy of six-month dental examinations was adopted in the United Kingdom in 1970s, and dentists were paid for them by the National Health Service. This policy was strongly criticised by Sheiham (1977). More recently, criticism has also been directed against the six-month recall intervals for low-risk populations (Frame et al., 2000).

### 2.2.4 Risk assessment for caries and periodontal diseases

In dental epidemiology, risk means the probability that an individual will develop dental disease, e.g., carious lesion or periodontal disease, in a certain period (Hausen et al., 1994). The risk of dental disease can be assessed by knowing and analysing all related factors, behavioural or biological (Newman, 1998). There is a difference between risk assessment and prediction, as explained by Hausen (1997): "risk assessment is used by the
clinicians to know what happens to their patients with different risk factors and prediction is used by researchers who are trying to predict future disease development”.

In the era of high occurrence of dental disease it was not necessary to identify high-risk patients, because almost every subject was potentially at high risk. Nowadays the high number of children and adolescents with no experience of dental caries and the skewed caries distribution have led to the reassessment of the coverage and targeting of dental prevention. Due to the very low occurrence of caries among children and adolescents in Finland, the concept "risk group" has been suggested instead of "high risk group" for subjects showing one or more new caries lesions per year (Alanen et al., 1994).

Each age-group - children, adolescents, and adults - has its own set of risk factors (Powell, 1998b), but these have appeared to be unsuccessful in predicting caries, leaving the scientific basis for caries risk assessment weak (Tinanoff, 1995). Since caries activity (the rate of caries progress in teeth) may be impossible to predict accurately in a population with a low disease prevalence (Messer, 2000), risk assessment requires improvement in predictors of dental diseases in individuals (Sheiham and Joffe, 1991; Graves et al., 1992). For example, in the University of North Carolina caries risk assessment study, 20-25% of 7- and 11-year-old patients with the highest caries increment were classified as high-risk cases. However, when the risk assessment was based on a 3-year DMFS increment analysis, approximately 40% of these high-risk children were found to be misclassified (Graves et al., 1992). Due to the multifactorial aetiology of caries, no single test is able to take all of the principal factors into consideration: host, microflora, diet and time. Instead, risk should be assessed by analysing and integrating several causative factors (Reich et al., 1999).

In real-life conditions dentists have to consider future caries activity without salivary or bacterial tests. Based on their own intuition and guided by their clinical experience, Australian dentists and dental therapists assigned 5- to 15-year-old children to risk groups (Saemundsson et al., 1997). About 13% were assigned to the high-risk, 60% to the moderate risk and 27% to the low-risk group. A similar study was done in Finland on the ability of dentists in the public dental service to identify, without salivary tests, children who would develop caries within a year after the assessment (Isokangas et al., 1993). On average, clinicians were able to show a high degree of proficiency in predicting caries by using clinical and sociodemographic information and measures routinely available at clinical examinations. However, a later study in Finland showed that on average, neither dentists nor hygienists in the public health service had reached an acceptable level in predicting caries, although the dentists were slightly better predictors than oral hygienists (Alanen et al., 1994). In all three studies the clinicians based their risk assessments mainly on children’s past caries experience, as was also shown in two additional Finnish studies by Vehkalahti et al. (1996) and Varsio and Vehkalahti (1997).

Past caries experience has been widely confirmed as the best predictor of future caries in children (Disney et al., 1992; An, 1993; Raitio et al., 1996a; Powell, 1998a; Jälevik et
al., 1999; Messer, 2000; van Palenstein Helderman et al., 2001). In a 3-year study in Finland, 60% of the 13-to 15-year-olds with no carious teeth (DT=0) at initial examination developed no caries, and half of those who initially had DT=2 developed at least three new carious teeth (Utriainen et al., 1998). Baseline caries experience has proven to be at least as powerful as salivary tests in predicting caries increment (Alaluusua, 1993).

Risk assessment for periodontal diseases seems to be "in its infancy", but there are data demonstrating the strong role of A. actinomycetemcomitans in the aetiology of juvenile periodontitis (Page and Beck, 1997). Patient’s age has been reported as the risk indicator most strongly associated with attachment loss in 25- to 74-year-olds, the other important risk indicators being smoking, diabetes mellitus, and the presence of subgingival P. gingivalis and B. forsythus (Grossi et al., 1994). In practice, the risk of having molars with furcation lesions is greatest among smokers (Axelsson et al., 1998). Bleeding on probing is a weak predictor for attachment loss, but presumably indicates an enhanced risk of future periodontal disease, and on the other hand patients with advanced periodontitis have an increased risk of attachment loss in the future (Page and Beck, 1997).

Especially in adults, both the periodontal and caries risk must be considered for every patient by evaluating at least the past changes in periodontal and caries state. Risk markers can be "loss of more than one mm of attachment at more than one interproximal tooth surface during the preceding 6-year period and/or development of more than one caries lesion during the course of any of the 6 preceding 12-month periods", according to a 15-year study of Swedish adults (Axelsson et al., 1991).

### 2.3 Dental prevention in relation to prevalence of dental disease

#### 2.3.1 Dental prevention in relation to time period and scientific knowledge

Preventive methods widely used in the Nordic countries were recently studied in conditions with high caries prevalence and without any previous caries-preventive programme. The Danish Nexø method (Carvalho et al., 1991; Thylstrup et al., 1997) proved its effectiveness in 2.5-year preventive programmes for 3-, 6-, and 11-year-olds in Moscow (Ekstrand et al., 2000). The programme included health education of children and their parents and teachers about caries disease, training in toothbrushing, professional plaque removal, applications of fluoride and sealant applications according to individual needs, but its cost-effectiveness was not analysed. It can be assumed that similar results could not have been achieved in areas of low caries occurrence, e.g. in Finland.

Professional dental prevention should be based on scientific evidence and should reflect the actual needs of the patients. Some dental prevention measures consumed resources needlessly, as was concluded in a retrospective study in Kuopio, Finland, where fluoride varnish and sealant applications were found to be superfluous during the fluoridation of piped water (Seppä et al., 1998; 2000b). In Denmark, Iceland, Norway and Sweden, during
1995 and 1996, oral hygiene education was the most frequently provided method of dental prevention, followed by dietary advice and information on the use of fluorides (Källestål et al., 1999). In choosing preventive methods, most public health dentists in Denmark and Norway referred to institutional directives or their chief dental officers, Icelandic dentists said they used their basic education, and their Swedish colleagues reported that they picked up ideas and methods from attending courses and meetings. For most dental auxiliaries in these four countries, the sources of information about preventive methods were either courses or institutional directives from chief dental officers.

In the early 1990s in Finland, chief dental officers in public sector reported that the source of information on caries preventive methods was for 40% continuing education courses, for 27% internal innovation meetings, for 15% meetings with chief dental officers, for 8% domestic and for 2% international dental journals. The main method of implementing new preventive practices was for 76% of the chief dental officers a meeting with all employees, for 7% the use of outside lecturers or sending employees to outside education, for 7% education for themselves, and for 3% briefly giving instructions (Kärkkäinen, 1997). The importance of continuing education was seen in Texas, USA, where dentists attending frequently professional meetings delivered more preventive procedures (Chen, 1990).

2.3.2 Costs and targeting of dental prevention

The decrease in the occurrence of dental diseases has been reflected as an increase of the costs per saved tooth or surface (Fejeskov, 1995). It has been asked whether caries prevalence has become "so low that we are wasting a lot of time and money on prevention" (Burt, 1998). The costs should be kept in mind because dental diseases are among the most expensive disease entities (Rugg-Gunn, 2001). The purpose of dental prevention is to produce health gains, not to save money, but the latter will also be achieved if the coverage and targeting of dental prevention are adequate (Schwarz, 1998). Without careful targeting, traditional preventive methods, such as fluoride rinsing for school classes, professionally applied fluorides, and intensive chair-side dental health education, are no longer cost-effective (Sheiham, 1997; Sheiham and Watt, 2000; Watt et al., 2001), as they used to be in the decades of high caries levels (Schwarz, 1998; Seppä, 2001).

To avoid wasting resources, dental prevention needs careful consideration as to when, for whom and by which personnel the preventive measures are carried out (Vehmanen, 1993; Burt, 1998). Combining various caries prevention approaches has criticised (American Dental Association, 1995). The common use of some preventive measures, such as fluoride rinsing, has been stopped in low caries incidence conditions because such methods are no longer adequate and cost-effective (Ripa, 1991).

Targeting in preventive dentistry means controlling dental diseases in a cost-effective manner and concentrating the preventive resources on the patients who need them most
As the dental health of children and adolescents has markedly improved, the need for targeted prevention has increased (Saemundsson et al., 1997). Generally, the targeting of dental prevention has not been appropriate in Finland (An, 1993; Vehmanen, 1993; Kärkkäinen, 1997; Varsio, 1999; Raitio et al., 2001) because the children most in need may be the hardest ones to reach in a community. However, targeting seems to have been effective in "geographic pockets", i.e., in low socio-economic areas with high caries levels in a generally low-caries area (Burt, 1998).

Targeting of dental prevention seems still to be an exception, even in the Nordic countries. In Denmark, Iceland, Norway, and Sweden, 25% to 98% of dentists offered similar types of preventive service to all children (Wang et al., 1998b). In western Sweden, the preventive measures given to adolescents were suboptimal, with hardly any variation based on the number of approximal carious lesions (Jälevik et al., 1999). In Finland in the early 1990s, preventive treatment in public dental service in Kuopio and Jyväskylä seemed insufficient and stereotyped (Kärkkäinen et al., 2001), and in Pori a programme designed to provide individual oral health education to adolescents at risk was inadequate (Laiho et al., 1991). In Helsinki, caries prevention for 6-, 13-, and 15-year-olds was inadequately targeted in the early 1990s, the patient’s DT+dt index having no remarkable influence on the intensity or variety of preventive treatments given, and among the six-year-old high-caries children fewer preventive treatments were given to non-cooperative patients than to cooperative ones (Varsio and Vehkalahti, 1996; 1997; Varsio et al., 1999a; 1999b). From 1989 to 1997, a slight increase in oral hygiene instructions for high-risk groups was observed in Finland, but at the same time a slight decrease in sugar advice (Honkala et al., 2002).

### 2.4 Share of dental prevention in service mix

#### 2.4.1 Share of preventive procedures of all dental treatments

In Finland, provision of free check-ups with preventive treatments for children and adolescents is a cornerstone of the public dental services based on the Primary Health Act (Laki 66/1972). In nine public sector units the share of preventive treatments in 1998 varied from 2% to 30%, dentists providing 21% of all preventive treatments for 0- to 18-year-olds, dental assistants 14% and oral hygienists 65% (Läärä et al., 2000; Mattelmäki, 2001).

Free public dental services are available to almost 100% of those under 19 years. Thereafter, the private sector plays a more important role: in 1999 the Social Insurance Institution subsidised dental care to almost 150,000 patients aged 19- to 36-years (Social Insurance Institution, 2002). The share of dental prevention was 6% of all dental treatments subsidised, filling therapy 43%, examinations 16% and periodontics 5%. In Helsinki the corresponding figures were almost the same.
Generally, the share of prevention in the service mix has seen a remarkable increase. From 1959 to 1990 in the USA, the percentage of patients receiving "prophylaxis" doubled to 39% and the percentage of patients receiving "fluoride treatment" increased ten-fold to 10% (Brown and Lazar, 1998b). Among private practitioners in the USA in 1990, prophylaxis was the second most common dental procedure after oral examination (Brown and Lazar, 1998a). In Minnesota, 26% of private dental services for 1- to 60-year-old patients were devoted to hygiene/prevention (Shuman and Davidson, 1994). In Michigan, examinations and preventive services for insured patients increased from one to one and half procedures per user per year from 1980 to 1995 (Eklund et al., 1997). In the USA in 1987 and 1996, preventive measures were the most common procedures, accounting for 30% of all dental procedures (Manski et al., 1999; Manski and Moeller, 2002). Finnish private practitioners, meanwhile, were reported to have undervalued preventive treatments in 1986, the share of prevention being near zero (Telivuo and Murtomaa, 1988).

In the United Kingdom, 58% of the dentate adults reported in 1998 receiving "scale and polish" at the most recent visit to the dentist (Kelly et al., 2000). In Japan, when private general dentists recorded all services provided during three consecutive days in 1995, the share of preventive and periodontal procedures was 15% (Kawamura et al., 1998).

The trend is clear: the share of diagnostic and preventive services is expected to grow and that of intensive treatments, such as crowns and bridges, to diminish. In his projection to 2030, Eklund (1999) stated that, "the population in 2030 and beyond will need far less intensive dental treatment than is currently the norm. Diagnostic and preventive services will dominate, in the way that restorative services have in the recent past".

### 2.4.2 Time spent performing preventive procedures

In Denmark, Norway, and Sweden dental prevention takes 18% to 50% of the dentist’s total time in dental care for children and adolescents (Wang et al., 1998b). Auxiliaries in Norway spent 44% of their working time for dental prevention and in Sweden up to 62%. Dentists used 12 to 25 minutes per child per year on prevention while auxiliaries spent 23 to 41 minutes. In Gothenburg, Sweden, dentists used 8-18% of their treatment time for preventive therapy in several age categories from 3 to 70 and over (Swedberg, 1995b). Of the total time used for prevention, dentists’ share was 55%, oral hygienists’ 26% and dental assistants’ 19%. Prophylactic procedures took 4% to 10% of the total treatment time in the low-caries groups in 3- to 19-year-olds and 2% to 4% in the high-caries groups (Swedberg, 1995a). In the USA, the average time "independent general practitioners” spent performing preventive procedures increased from 9.4% in 1981 to 12.4% in 1993 (Brown and Lazar, 1998a). A shift from restorative dental care to diagnostic and preventive care can be seen over the past two decades.
In 1992, HCHD monitored dental treatment time by type and item of treatments. Their data show that dental prevention was the second most common item of dental treatment, accounting for 17% of the total treatment time of all dental clinics, while examination was the most common at 20% (Hulkkonen, 1993). Dentists used 14% and oral hygienists 42% of their total clinical hours for dental prevention. On the average one preventive procedure took 12 minutes.

Only a few studies have dealt with the time spent on dental prevention in adults. In 1987 and 1988, the national dental associations in Canada, Denmark, Finland, France, Hong Kong, Japan, the Netherlands, New Zealand, and Sweden carried out a "Practice-profile-time study" (Backer et al., 1990). A random sample of general dental practitioners revealed that the percentage of time spent during two consecutive working days on preventive activities was 12%, being the smallest in Finland (3%) and the greatest in Canada (20%). A Finnish two-year study on subsidised dental care provided for male industrial workers by their employer showed an increase in the time spent for diagnostic and preventive procedures from one-third to one-half of all treatment time (Ahlberg et al., 1997).

2.4.3 Market price of preventive procedures

The gross income to dental practices from insured patients in Michigan was analysed by Eklund et al. (1998). The per-patient inflation-adjusted income from preventive services increased between 1980 and 1995 for all ages. At the same time, per-patient income from restorative and prosthodontic services declined. In 1995, the age cohort of patients aged 19-34 years provided lower per-patient practice incomes compared with that in 1980. Brown and Lazar (1998a), found that among private practitioners in the USA the average real fee for topical application of fluoride for an adult decreased from 1975 to 1995 by 19.5% to $20, and that the real fee for other forms of prophylaxis increased by 15.8% to $45.

2.5 Dental indices and check-up intervals in an administrative framework

2.5.1 Usability of dental indices as administrative tools

Dental indices describing caries and periodontal diseases are used to assess treatment needs on the population level. The World Health Organization has been active in developing dental indices, and the Finnish National Board of Health has adapted them for national purposes since 1974. The DMFT index was originally developed to describe the cumulative caries experience of the permanent teeth of children (Klein et al., 1938). The index consists of the number of decayed (DT), missing (MT) and filled (FT) teeth in permanent teeth, and for primary teeth the lower case (dmft) is used. Correspondingly, the DMFS/dmfs indices are defined by surface. DMFT and DMFS can be used so that DT refers to the number
of teeth with caries lesions and DS the number of decayed surfaces (National Board of Health, 1985). The DT+dt index indicates the sum of new dentinal lesions in permanent and in deciduous teeth (Helsinki City Health Department, 1985).

DMFT, DMFS, and DT have their weaknesses: e.g., the severity of the carious lesions is not fully described and the indices by no means describe the functional state or aesthetics of the teeth (Gift, 1996; Saemundsson et al., 1997; Spencer; 1997). The DMFT index and its components have been criticised in particular. In low-caries populations, the M component currently plays no role, because in adolescents there are practically no extractions due to caries. Due to the substantial number of missing teeth, the M component for older adults is problematic because the reason for their extraction is not known (Lawrence et al., 1996).

For adults, the D component also presents problems. When two thirds of teeth in adults are treated for reasons other than caries, the filling therapy has weak impact on caries indices in an adult population (Clarkson et al., 2000). The main reason for the restorative treatment in 17- to 29-year-olds is primary caries, whereas in patients who are aged 30 or older, secondary caries and fractures of the tooth or restoration with no impact on indices dominate as reasons for restorations (Forss and Widström, 2001; Palotie and Vehkalahti, 2002).

For reasons discussed above, the "Significant Caries Index" (SiC Index) was introduced by Bratthall (2000). The SiC index describes the mean DMFT for the third of the population with the highest DMFT scores and is suggested to be used to target dental prevention to those in need. The SiC index carries the same problems, being based on the use of the DMFT index.

The CPITN index was designed for rapid and practical assessment of periodontal treatment needs in population surveys and for initial screening of patients receiving regular dental care (Ainamo et al., 1982). The index classifies each sextant into five treatment need categories (code 0-4) and classification per patient is made according to the highest score. In practice, CPITN needs to be complemented by more precise records for the position of the findings: subgingival calculus, position of the gingival margin, pocket depths, and the level of alveolar bone. Several periodontal indices have been published, but due to the recommendation of National Board of Health (1984) the CPITN index has been in use in Finnish public dental service since 1984.

**2.5.2 Dental indices in actual practice**

Although the findings of each clinical dental examination are carefully recorded, they often seem to be ignored. Only 59% of all patient’s dental records were properly filled out in Sweden in 1992 (Rasmusson et al., 1994). In Vantaa, Finland, the CPITN index was
found in 93% and the index of incipient lesions in 16% of the public records (Helminen SE et al., 1998). For caries risk assessment the evaluation of various clinical indices by an experienced clinician is adequate (Reich et al., 1999).

Dental indices should be used in planning patient care but this was not the case as shown by a comparison of DMFT indices and the amount of time used for preventive care among children in Denmark, Iceland, Norway and Sweden 1995-96 (Wang et al., 1998b). In HCHD in 1992, the DT+dt and DMFT indices also showed no association with dental prevention given to high-caries patients (Varsio, 1999). In Kuopio and Jyväskylä, Finland, in 1990-1992, the caries indices dt, DT, and DSa had some influence on children’s dental prevention, but the CPITN index had virtually no impact on the amount of oral hygiene instructions (Kärkkäinen, 1997).

2.5.3 Dental indices and check-up intervals

The terms "check-up interval", "examination interval", and "recall interval" refers to the period between two consecutive dental examinations. The term "current recall interval" describes the period since the previous examination until the current examination, and the term "proposed recall interval" the period from completion of the current course of treatment until the next scheduled examination (Wang et al., 1998a). The lengthening of check-up intervals would reduce treatment and examination times for low-caries children by 15% (Wang et al., 1992; Wang et al., 1998a; Lahti et al., 2001). Wang and Holst (1995), however, underlined that "the philosophy behind individualized recall intervals is to maintain equality in oral health, not in resource allocation".

The law of School Dental Care (Laki 297/1956) required that the school dental service in Finland set annual check-up intervals. At that time this was an adequate practice due to the high caries occurrence. This practice continued until 1972 and the Finnish public dentists received part of their salary for examinations made on a per-patient, once-a-year basis. This may have worked against the lengthening of check-up intervals with decreasing caries, despite the instructions by the National Board of Health (1985) that check-up intervals should be based on the individual needs of each patient.

Check-up intervals should reflect patient’s risk level, often described by dental indices: the higher the risk the shorter the check-up interval. However, no association was found between the length of the interval and the DT value of 12- and 18-year-olds in 1990 in Norway (Wang, 1994b), nor between the length of the interval and the DMFT index scores for 12- and 15-year-olds in Kuopio and Jyväskylä, Finland (Kärkkäinen et al., 2001). According to a Finnish expert group, check-up intervals for children and adolescents with no elevated caries risk could well be extended to 1.5 to 2 years without jeopardising their oral health (Eerola et al., 1998). For reasons of caution, caries risk patients have not been included in studies where recall intervals have been extended (Wang et al., 1992; Wang and Riordan, 1995).
2.6 Dental prevention in relation to dentists’ characteristics

The dentist’s ability to differentiate patients according to risk and to individualise check-up intervals is of great importance to individual subjects and to the use of resources. Clinicians with long clinical experience tended to show slightly higher sensitivity figures in a study evaluating their ability to identify caries risk subjects (Isokangas et al., 1993). On the other hand, dentist age seems to be negatively related to the quality of the patient records, showing that older dentists are less likely to observe the rules (Rasmusson et al., 1994).

The gender of dentists has been associated with the prevention provided. In Finland, female dentists, both public and private, were more likely to pay attention to caries prevention than were male dentists, nearly all the preventive measures being used more frequently by female private dentists than by males (Kärkkäinen, 1997). However, in an earlier study on Finnish private and public dentists, no difference between genders in the incidence of performing preventive measures was found, as 94% of males and 96% of females had carried out prevention during the last year (Murtoamä et al., 1990). Male dentists working for the public dental service in Vantaa, Finland, made more frequent use of active preventive treatments, such as motivation and instructions, whereas passive measures, such as topical fluoride applications, were used more frequently by females (Helminen SE, 2000).
3 Aim of the study

3.1 General aim of the study

The general aim was to describe preventive dental treatment in relation to dental health in Helsinki City Health Department during the period 1976-1999. The main concern was to determine whether preventive treatment was being given to subjects most in need and whether the check-up intervals were reflecting subjects’ levels of dental health.

3.2 Specific aims

The specific aims were:

- to evaluate dental prevention given in relation to dental indices and orthodontic treatments, and
- to evaluate dental prevention given by health district and on the basis of dentists’ characteristics.

3.3 Hypotheses

The hypotheses were as follows:

- The targeting of high-risk patients for repeated dental prevention by the public dental service in Helsinki has improved since 1976.

- In 1999, the use of resources for dental prevention in public dental service is related to patients’ oral health: the better it is, the fewer the resources required.

- Dental prevention is independent of dentists’ characteristics.
4 Subjects and methods

4.1 Description of public dental services in Finland and in Helsinki

4.1.1 Public dental services in Finland

In Finland, partly or totally tax-paid, public dental services have been provided by municipalities from the beginning of the twentieth century on a voluntary basis and since 1957 based on the law of School Dental Care (Laki 297/1956), which directed parents to bring their children to annual dental examinations. Since 1972, public dental services have been provided by municipalities according to the Primary Health Act (Laki 66/1972). All children under the age of 17 were gradually entitled to comprehensive dental care free of charge and there was no obligation for examination. From 1979-2001 the upper age limit for free dental care services was 19 years, but 18 years from 2002 on. The municipalities are responsible for providing dental services for all their inhabitants, with certain privileges being given to some special groups, such as students, pregnant women, seamen living elsewhere, patients receiving radiotherapy, and war veterans. After reaching the age limit of free dental care services, adults have to pay charges, which, however, are highly subsidised by the municipalities.

In most rural municipalities public dental services are available to the entire population, but in urban areas public services have been available principally to children and adolescents. If adults received these services, it was mainly young adults. Municipalities providing public dental services to all their inhabitants covered 31% of the population of Finland in 1997 (Widström et al., 1998) and 28% at the beginning of 2002 (Widström et al., 2002). Half of the dental services in Finland are provided by privately practising dentists, mainly to adults. The upper age limit for eligibility to receive a subsidy from the Social Insurance Institution for private dental care services was 43 years (except for war veterans) in 1999, but since December 2002, all inhabitants are entitled to subsidised dental care, private or public. Orthodontics and prosthetics provided by private practice are not covered by the subsidy. Statistical data on private dental care are available for the subsidised services only and include the number of visits, patients and various treatments but not the indices of oral health state. In 1997, the total cost of dental care in Finland was FIM 3232 million (€543 million). The gross expenditure for public dental service was 44% of the total, i.e. FIM 1409 million (€237 million), private dental care FIM 1534 million (€258 million), prosthetic costs FIM 245 million (€41 million) and students’ dental care services FIM 44 million (€7 million) (Widström, 2001).
Among children and adolescents the coverage of free dental care services is 95-100%. In 1996, 57% of all dental visits to the public dental service were made by those under 19 years of age (Widström and Hiiri, 1998). The share of 0- to 18-year-old patients visiting the public dental service was 56% in 1997 and 53% in 2000 (Widström and Erkinantti, 1999; 2002). Since 1972, national plans for public health care have gradually expanded the availability of public dental services to include new young adult age-groups every year. National five-year plans for primary health care are no longer as rigidly binding as they were earlier. This has either enlarged or reduced public dental services, according to varying economic conditions and political power structures in municipalities.

Dental prevention measures in the Finnish public dental service include oral hygiene instructions, dietary counselling, advice regarding use of fluorides or chlorhexidine solutions at home, fissure sealing, cleaning of teeth and topical application of fluoride by dental professionals. In addition to including dental prevention, free comprehensive dental care offers individualized check-up intervals, filling therapy, periodontics, oral surgery and orthodontics. Orthodontics is a notable part of children’s and adolescents’ dental care: their every fourth visit and 14% of all visits in the public dental service relate to orthodontics (Pietilä et al., 1994).

In 1972, the National Board of Health published instructions for dental prevention and in 1985, guidelines for comprehensive oral health care including the length of check-up intervals based on the individual needs of the patients (National Board of health, 1972; 1985). Since 1995 public dentists have been paid extra compensation for the year when a patient’s clinical dental examination has been skipped, according to his/her individualised recall interval, as planned.

Since the passage of the School Dental Care Act, gathering data on oral health and dental care has been strongly emphasised in the public dental service. Official statistics on public dental services were collected annually 1957-1979 and every third year 1982-1991 and were published by the National Board of Health. Until now, public dental clinics have used the same standardised patient charts containing information on medical and dental history, oral health findings in detail, and all treatments by visit and by procedure, the treatment codes being the same in for both public and private dental care. In the last five years, a major shift to electronic patient files has taken place. Such files include the same detailed information as the earlier paper-based recordings, but five different commercial applications are in use.

### 4.1.2 Public dental services in Helsinki

Helsinki, the capital of Finland with 560,000 inhabitants, has kept the upper age limit for free public dental service somewhat higher than that suggested as the national limit. From 1976 on, public dental service in Helsinki was free of charge to 0- to 16-year-olds,
from 1986 to 0- to 19-year-olds, from 1993 to those under 19 years and since 2002 to 0- to 17-year-olds. Comprehensive dental care in Helsinki always includes regular check-ups and radiographs, dental prevention and operative treatments as needed. Dental prevention includes oral hygiene instructions, dietary counselling, salivary tests, topical application of fluorides and sealing of fissures at the discretion of the dentist. Orthodontic treatment has been given moderately at public expense to those most in need of it. In Helsinki, piped water currently contains less than 0.1 mg/l fluoride.

In 1985, HCHD implemented instructions on preventive treatments in public dental clinics. The purpose was to update instructions issued by the National Board of Health in 1972, which included fluoride rinsing at school and at home. In 1993, these instructions were re-evaluated and new instructions were issued, including recommendations on individualised recall intervals for children, adolescents, young adults, expectant mothers and elderly people and on the restricted use of fissure sealants, topical application of fluorides and other preventive methods.

In HCHD the number of patients has increased from 78,000 per year in 1979 to 123,000 in 1999, the number of public dental clinics from 46 to 56, of dentists from 97 to 169, and of dental assistants and other auxiliaries from 200 to 280. The pressure from legislation to offer public dental services to all inhabitants was one reason to reallocate dental care services at the beginning of the 1990s, when HCHD was divided into seven independent administrative units. They are responsible for providing dental services according to a uniform health care policy that is ultimately determined by the City Council. To encourage the dental personnel to achieve better health outcomes, HCHD has adopted a reward for each health district that meets the fixed goal. The annual reward is paid to every dental employee in the district.

In the past few decades, the public dental service has faced varying economic conditions in Helsinki, the worst being the economic recession in the late 1980s and early 1990s, which led to the restriction of dental services. Since the late 1990s, young adults have been obliged to be on a waiting list, and adults have had access to comprehensive dental care only if they have serious general health disorders.

An education index that describes the relative rate of the population having only a basic education has been used (Study III) in HCHD as a demographic variable to express the difference in the children’s background. In 1997, HCHD installed online Effica® (by TietoEnator Corporation) software for handling patient files and administrative data.

### 4.2 Subjects and data collection

The share and successful targeting of dental prevention in HCHD was evaluated longitudinally on the basis of five cross-sectional studies and one follow-up study. The outline of Studies I-VI is presented in Table 1.
Table 1. Subjects, sampling methods and data sources in Studies I-VI

<table>
<thead>
<tr>
<th>Study and time of data collection</th>
<th>N</th>
<th>Age groups</th>
<th>Sampling method</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study I (1976 and 1986) and Study II (1986)</td>
<td>396</td>
<td>representing all 15-year-old patients in 1976</td>
<td>Systematic sampling from patient files</td>
<td>Patient records (paper charts)</td>
</tr>
<tr>
<td>Study III (1989-91)</td>
<td>16,000</td>
<td>all 8-, 10-, 12- and 13-year-olds</td>
<td>Population study, no sampling</td>
<td>Annual official statistics</td>
</tr>
<tr>
<td>Study IV (1999) and Study V (1999)</td>
<td>48,040</td>
<td>all 0- to 18-year-olds</td>
<td>Population study, no sampling</td>
<td>ADP files by subject</td>
</tr>
<tr>
<td>Study VI (1999)</td>
<td>25,657</td>
<td>all 19- to 36-year-olds</td>
<td>Population study, no sampling</td>
<td>ADP files by subject</td>
</tr>
</tbody>
</table>

Studies I and II

The cross-sectional data were collected from each subject’s personal oral health records from two samples that represented all 15-year-olds using the public dental service in Helsinki in 1976 (n=4,300) and in 1986 (n=3,700). For sampling in 1976, every tenth patient chart was picked, yielding 396 cases. In 1986, a random selection of 400 subjects was made from the official register of Helsinki inhabitants. According to the subject’s name, date of birth and postal address, their oral health records were requested from the public dental clinics. The final sample consisted of 367 patient records because 33 subjects did not visit a public dental clinic in 1986.

Data on dental state and treatments were collected from the patient records, recorded on data collection forms and then stored in electronic databases. For both years, the data included the dental state by surface and tooth, DMFT and DT indices, treatments given and number of visits. In addition, the CPITN and CI indices and the current check-up intervals were included in 1986.
Study III

The data (1989) were collected from the administrative statistics on treatments given to 98,161 patients as recorded in 160 various codes. The data were aggregated at the level of the seven oral health care districts in Helsinki. Six service categories were used: examination, prevention, fillings and endodontics, periodontics, orthodontics and others. Each code was priced according to the 1989 mean tariff of the Finnish Dental Association. The sum of these prices, separately for each service category, was calculated to determine the market price of all chair-side dental services. The education index (HCHD, 1990) was used to determine the percentage of low-educated adults in each district. The increment in the DMFT index from 1989 to 1991 in the age-groups of 8-, 10-, 12- and 13-year-olds, totalling 16,000 subjects, was calculated separately for each district by age-group.

Studies IV-VI

The data for Studies IV-VI were collected from the official automatic data processing files of HCHD comprising records for all patients, visits and dental treatments in 1999. Since the ADP files are for administrative purposes only, the information was first converted into the form required for this analysis, i.e., a normal data matrix. This was first done on the basis of visits, but thereafter the data were further aggregated by taking a patient and later a dentist as the observation unit.

The data included all 0- to 18- and 19- to 36-year-old patients receiving comprehensive dental care with a full dental examination in 1999, excluding those patients whose dentist had performed fewer than 50 check-ups in the corresponding age-groups. The final data included 48,040 in the younger and 25,657 in the older cohort. Data were incomplete for 230 cases in the younger age-group.

The patient data came from the automatic data processing files, recorded by visit. These data include the date, the identity of the patient and the staff member who provided the treatment, dental indices and all treatments by individual code. DMFT/dmft and DT+ dt indices were used to categorise the younger cohort into four oral health state groups, while DT and CPITN indices were combined to categorise the patients in the older cohort into seven oral health state groups. The four codes for dental prevention and repeated dental prevention (REP) in 1999 were recorded based on the actual time used, divided into two categories: short (at 10 minutes and 10-15 minutes; estimated time 12 minutes), and long (at 20 minutes and over 20 minutes; estimated time 25 minutes). Fissure sealing has its own individual code based on sealants per jaw half. Periodontal treatments are recorded in seven separate real-time codes, here summarised into two, short (estimated time 12 minutes) and long (25 minutes). Fillings are recorded into eight separate codes,
here categorised into three groups: one-surface fillings (estimated time 20 minutes),
two-surface fillings (35 minutes), and fillings involving more than two-surfaces (50
minutes).

On the basis of the 140 dentists’ identification codes, dental authorities provided the
dentists’ characteristics, such as gender, year of birth and year of graduation, to be
added to the data for this research. Patient-based data were aggregated by dentist in
order to evaluate the relationship between dentists’ characteristics and dental prevention
and check-up intervals. Aggregations of check-up intervals were made separately for
no-caries and high-caries patients.

4.3 Definitions and terms used

4.3.1 Risk assessments (I, II, IV-VI)

In Study I, the risk assessment was based on the quintiles in the distribution of the DMFT
index. The subjects belonging to the highest and the lowest quintile were defined as the
high-risk and the low-risk group, respectively.

In Study II, the risk assessment was made on the basis of three indices:

1)  number of DT = 0, 1-2 or ≥3;
2)  number of incipient caries lesions on axial surfaces (CI) = 0, 1-2 or ≥3;
3)  CPITN index = 0 or ≥1.

In Studies IV and V, the patient’s dental state was categorised into four groups:

\[
\begin{align*}
    \text{NC} &= \text{no caries} \quad \text{(DMFT/dmft}=0 \text{ and DT+dt}=0), \\
    \text{PC} &= \text{past caries} \quad \text{(DMFT/dmft}>0 \text{ but DT+dt}=0), \\
    \text{LC} &= \text{low caries} \quad \text{(DMFT/dmft}>0 \text{ and DT+dt}=1-2), \text{ and} \\
    \text{HC} &= \text{high caries} \quad \text{(DMFT/dmft}>0 \text{ and DT+dt}≥3).
\end{align*}
\]
In Study VI, the patient’s oral health was assessed by combining the CPITN and DT indices and categorising the combination into one of the following seven groups:

- **Low-risk** (LR) \( CPITN=0-1, DT=0, \)
- **Low periodontal + some caries risk** (LPSC) \( CPITN=0-1, DT>0, \)
- **Calculus + low caries risk** (CLC) \( CPITN=2, DT=0, \)
- **Calculus + moderate caries risk** (CMC) \( CPITN=2, DT=1-2, \)
- **Calculus + high caries risk** (CHC) \( CPITN=2, DT \geq 3, \)
- **High periodontal + low caries risk** (HPLC) \( CPITN=3-4, DT=0, \)
- **High periodontal + some caries risk** (HPSC) \( CPITN=3-4, DT>0 \)

### 4.3.2 Dental prevention (I-VI)

In Studies I-VI, the term **dental prevention** covers both caries and periodontal prevention but not prevention of malocclusions, trauma, oral cancer or other oral diseases.

In Studies I-III, dental prevention included such recorded preventive treatments as oral hygiene instructions, dietary counselling, advice regarding the use of fluorides at home, and topical application of fluoride.

In Studies IV-VI, **repeated dental prevention** includes all caries and periodontal preventive measures after the **basic dental prevention** performed at the check-up visit. Repeated dental prevention is performed at further visits according to each dentist’s decision and carried out by dentists, oral hygienists or dental assistants.
4.3.3 Criteria for adequacy of dental treatment (II, IV-VI)

The criteria for the adequacy of dental treatments were defined as follows.

**Adequate preventive treatment (II):**

- for all adolescents: one application of topical fluoride during treatment and oral hygiene instructions if needed, and
- for patients at high risk of caries: repeated application of topical fluoride and advice regarding use of fluoride at home, detailed oral hygiene instructions and dietary advice.

**Adequacy of targeting of dental prevention** (II, IV-VI) was judged on the basis of dental risk assessment. Those at a high risk of dental diseases were supposed to receive repeated dental prevention and those at a low risk were not supposed to.

**Adequacy of coverage of dental prevention** (II, IV-VI): everyone at high risk of dental disease was supposed to receive REP.

**Adequacy of check-up intervals (II, V-VI):**

In Study II, the check-up interval was the period from the previous clinical dental examination to the current one. In Studies V and VI, the check-up interval was defined as the period from the current check-up to the next one as proposed by the dentist. The check-up interval was judged to be adequate if its length corresponded to the health of the teeth.

4.3.4 Dentists’ differentiation ability (V)

A dentist’s differentiation ability describes the effectiveness of his/her decisions in proposing check-up intervals for high- and low-risk patients. The ability was judged as strong when the mean difference in the check-up intervals of these cases was longer than eight months, moderate when it was four to eight months, and weak when it was shorter than four months (Study V).
4.3.5 Share and targeting (I-VI)

The term share means here a part of a whole. The share of prevention in the whole service mix can be explained in terms of a percentage.

**Targeting:** Prevention should be given (targeted) to those who need it most.

4.4 Assessment of preventive practices and use of resources

Assessments of preventive practices and use of resources were based on comparisons of preventive treatments based on dental indices or dental risk groups, check-up intervals proposed and the time spent on dental prevention. Coverage of preventive practices was measured by the percentage of patients in various dental risk categories receiving preventive treatments. Targeting of prevention and REP was similarly measured as the percentage of patients in various dental risk groups receiving preventive treatments.

4.5 Statistical evaluation

The statistical significance of differences between the compared groups was evaluated by t-test, ANOVA, and chi square test, at the 5% significance level. Pearson’s correlation coefficient was used to show associations between selected variables describing oral health services, background of the population, and dental health. A linear regression model was used to analyse the differences in outcomes between the seven districts in HCHD and to explain the variation in the check-up intervals between dentists. The proportions of prevention, check-ups, and orthodontics in the treatment mix were used as independent variables in regression models.
5 Results

5.1 Changes in dental state from 1976 to 1999 (I-IV)

The mean DMFT index of all 15-year-old patients decreased from 12.1 in 1976 to 2.9 in 1999, and the percentage of caries-free patients (DMFT=0) increased from 1% to 26% (Table 2). The high-risk patients’ mean DMFT decreased by 45% by 1986 and 63% by 1999. In 1999, the mean DMFT value for the 35-year-old high-risk patients was almost the same as that of the 15-year-old high-risk patients in 1976. Regardless of patient age, the mean DT values in the high-risk groups remained almost the same over the 23-year period.

Table 2. Changes in dental caries state in selected age groups in HCHD from 1976 to 1999.

<table>
<thead>
<tr>
<th>Year &amp; Study</th>
<th>Age (years)</th>
<th>Caries free (%)</th>
<th>All sampled</th>
<th>High-risk-group</th>
<th>Definition for high-risk group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>DMFT Mean (SD)</td>
<td>DT Mean (SD)</td>
<td>DMFT Mean (SD)</td>
</tr>
<tr>
<td>1976 I</td>
<td>15</td>
<td>1%</td>
<td>12.1 (5.1)</td>
<td>3.0 (3.0)</td>
<td>19.5 (2.3)</td>
</tr>
<tr>
<td>1986 I</td>
<td>15</td>
<td>10%</td>
<td>5.1 (3.8)</td>
<td>1.4 (2.1)</td>
<td>10.8 (3.1)</td>
</tr>
<tr>
<td>1989 III</td>
<td>12</td>
<td>n.a.</td>
<td>1.8 (n.a.)</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>1999 V</td>
<td>12</td>
<td>47%</td>
<td>1.3 (1.8)</td>
<td>0.5 (1.1)</td>
<td>4.5 (2.6)</td>
</tr>
<tr>
<td>1999 15Ⅵ</td>
<td>15Ⅵ</td>
<td>26%</td>
<td>2.9 (3.0)</td>
<td>1.0 (1.7)</td>
<td>7.2 (3.4)</td>
</tr>
<tr>
<td>1999 25Ⅵ</td>
<td>25Ⅵ</td>
<td>5%</td>
<td>9.1 (5.8)</td>
<td>2.0 (2.7)</td>
<td>13.1 (5.3)</td>
</tr>
<tr>
<td>1999 35Ⅵ</td>
<td>35Ⅵ</td>
<td>2%</td>
<td>16.4 (6.0)</td>
<td>1.3 (2.0)</td>
<td>19.1 (5.4)</td>
</tr>
</tbody>
</table>

* = previously unpublished  
n.a. = not available

The decrease in caries occurrence was reflected in the fact that in 1976, 53% of all fillings were made in molars and 21% in incisors, compared to 67% and 8% in 1986 (p<0.001).
5.2 Changes in dental prevention from 1976 to 1999 by dental state (II, IV, VI)

5.2.1 Changes in repeated dental prevention practices (II, IV, VI)

From 1976 to 1986, the number of fluoride applications given to low-risk and high-risk patients remained unchanged, but in 1986, topical application of fluoride on a twice-a-year basis was more frequent (p<0.05) in the high-risk than in the low-risk group (Table 3). In 1999, repeated dental prevention (REP) was given to 25% of 0- to 18-year-old patients, the coverage being the greatest for 6- to 15-year-olds, 29%. REP treatments were given more frequently to high-risk than low-risk patients.

Table 3. Repeated dental prevention (REP) given by caries state, patient age and orthodontics in HCHD from 1986 to 1999.

<table>
<thead>
<tr>
<th>Year &amp; Study</th>
<th>Age (years)</th>
<th>REP given to % of patients</th>
<th>P-value Low-risk group vs. High-risk group</th>
<th>Definition for high-risk cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986 II</td>
<td>15</td>
<td>5%#</td>
<td>3%#</td>
<td>12%#</td>
</tr>
<tr>
<td>1999 IV</td>
<td>6-15 ORT§</td>
<td>33%x</td>
<td>28%</td>
<td>49%</td>
</tr>
<tr>
<td>1999 IV</td>
<td>6-15 NORT§</td>
<td>28%x</td>
<td>23%</td>
<td>38%</td>
</tr>
<tr>
<td>1999 IV</td>
<td>0-18</td>
<td>25%</td>
<td>19%</td>
<td>36%</td>
</tr>
<tr>
<td>1999 VI</td>
<td>19-36</td>
<td>20%</td>
<td>10%</td>
<td>23%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

# = REP measure: topical application of fluoride at least twice a year
§ = previously unpublished

As for 19- to 36-year-olds in 1999, REP was given at least once to 17% and more than once to 3%, 80% receiving none. The highest coverage of REP was in the "high-periodontal + low caries risk" group (39%), and the lowest in the "low-risk" group (10%) (Table 4).
Table 4. Repeated dental prevention (REP) percentage of 19- to 36-year-old patients by current caries and periodontal state in HCHD in 1999.

<table>
<thead>
<tr>
<th>REP given</th>
<th>19- to 36-year-olds by oral health</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LR CPITN=0-1 DT=0</td>
</tr>
<tr>
<td>Once</td>
<td>9%</td>
</tr>
<tr>
<td>More than once</td>
<td>1%</td>
</tr>
</tbody>
</table>

LR= Low-risk group  
HPLC= High periodontal + low caries-risk group  
HPSC= High periodontal + some caries-risk group

Statistical evaluation by chi square test. Differences by patient categories: p<0.001.

5.2.2 Time used for dental prevention (IV, VI)

The average time used for all 0- to 18-year-olds for REP was 4.9 (SD 3.3) minutes and 19.5 (SD 14.1) minutes for 0- to 18-year-olds. As for 6- to 15-year-olds, 23% received orthodontic treatment in 1999. The time used for REP for 6- to 15-year-olds in the high-caries group with orthodontic treatment was longer than for those in the high-risk group without orthodontic treatment, and a similar strategy was seen in the no-caries group (Figure 1).

Figure 1. Mean time (minutes) for repeated dental prevention in extreme (low-risk and high-risk) caries categories of 6- to 15-year-old orthodontic (ORT) and non-orthodontic (NORT) patients in HCHD in 1999.
In 1999, time used for REP for 19- to 36-year-olds was slightly reflected in the periodontal and current caries state, as shown for their extreme (low-risk and high-risk) dental risk categories in Table 5. The average time used for REP was 3.6 (9.0) minutes for all 19- to 36-year-olds and 14.9 (5.4) minutes for those receiving REP.

**Table 5.** Mean time (minutes) for repeated dental prevention (REP) in extreme (low-risk and high-risk) dental risk categories of 19-to 36-year-olds in HCHD in 1999.

<table>
<thead>
<tr>
<th>Risk categories</th>
<th>Categories of dental indices</th>
<th>Mean time for REP (minutes) (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-risk group</td>
<td>CPITN=0-1 DT=0</td>
<td>1.8 (6.3)</td>
</tr>
<tr>
<td>High periodontal + low caries risk group</td>
<td>CPITN=3-4 DT=0</td>
<td>6.7 (11.1)</td>
</tr>
<tr>
<td>High periodontal + some caries risk group</td>
<td>CPITN=3-4 DT&gt;0</td>
<td>6.7 (10.5)</td>
</tr>
</tbody>
</table>

Statistical evaluation by ANOVA: differences between risk categories: p<0.0001.

The time used for REP was clearly shorter for patients receiving no filling therapy than for those receiving fillings (2.7 (8.6) vs. 4.2 (9.2) minutes). The p-value for differences in time for REP by the DT index (DT=0, 1-2 or ≥3) was p=0.001 for patient groups receiving filling therapy and p=0.002 for patients with no filling therapy.

In high-risk groups, the mean time used for periodontics was 3 to 4 times that used for REP, time used for filling therapy being the longest in all categories except in the high-periodontal + low caries-risk group (Figure 2).
Figure 2. Mean time (minutes) used for repeated dental prevention, periodontics and filling therapy for 19- to 36-year-old patients by oral health indices in various combinations in HCHD in 1999.

LR = CPITN=0-1, DT=0;  CHC = CPITN=2, DT≥3;
LPSC = CPITN=0-1, DT>0;  HPLC = CPITN=3-4, DT=0;
CLC = CPITN=2, DT=0;  HPSC = CPITN=3-4, DT>0.
CMC = CPITN=2, DT=1-2;
5.2.3 Changes in dental prevention by dental indices (II, IV)

A slight tendency to target oral hygiene instructions was found in 1976 when patients in the high-risk group received on average 0.8 such procedures and the low-risk patients 0.4, compared to 0.6 and 0.5 for the respective groups in 1986. No targeting of application of topical fluorides to high-risk group was seen in either 1976 or 1986. In 1986, dental prevention for high-risk patients (DT≥3 or CI≥3) was inadequate: fluoride treatment was given to 57% of them - for 45% once and for 12% twice - oral hygiene instructions were given to approximately 50% and dietary counselling very seldom (Table 6).


<table>
<thead>
<tr>
<th>Treatment given</th>
<th>DT=0 vs. DT≥3 % vs. %</th>
<th>CI=0 vs. CI≥3 % vs. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral hygiene instruction</td>
<td>34 vs. 51 *</td>
<td>33 vs. 45 NS</td>
</tr>
<tr>
<td>Dietary advice</td>
<td>1 vs. 6 *</td>
<td>1 vs. 5 *</td>
</tr>
<tr>
<td>Topical application of fluoride once/</td>
<td>58 vs. 45 */ 3 vs. 12 *</td>
<td>51 vs. 50 NS/ 4 vs. 10 *</td>
</tr>
<tr>
<td>twice</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Statistical evaluation by chi square test. Difference by DT or CI: *p<0.05, others NS.

In 1999, REP was given to 36% of 0- to 18-year-old high-risk patients - to 25% once and to 11% more than once. From 1986 to 1999, the coverage of REP given to 0- to 18-year-old high-risk patients increased from 12% to 36%, indicating an obvious improvement in targeting of dental prevention efforts to that group. During the same period, the corresponding change for low-risk cases was from 3% to 19%, indicating deterioration in targeting high-risk cases.
5.3 Changes in check-up intervals in relation to caries indices (II, V, VI)

In 1986, the average interval between check-ups for 15-year-olds was 13.7 months. Only small differences in check-up intervals were found by DMFT, DT and CI indices and the number of fillings made during the preceding treatment (Figure 3).

![Figure 3](image-url)  

**Figure 3.** Distribution of check-up intervals in relation to extremes (low-risk and high-risk) of caries indices and number of fillings made during the preceding treatment for 15-year-old patients in HCHD in 1986.
From 1986 to 1999 the mean check-up interval of 15-year-olds increased by 2.8 months. In all age-groups the mean interval was quite similar: ~ 17 months in 1999 (Table 7). In 1999, the proposed check-up interval was less than six months for 2%, 7 to 12 months for 34%, 13 to 18 months for 24% and more than 18 months for 40% of patients. In the high-caries groups, the mean check-up interval varied from 10.9 months for 0- to 5-year-olds to 13.2 for 16- to 18-year-olds, the average being 12.2 months. For the no-caries groups, the mean interval for 6- to 15-year-olds varied from 17.3 months to 20.6 months for 16- to 18-year-olds.

Table 7. Mean check-up intervals for all patients and by risk of caries in HCHD in 1986 and 1999.

<table>
<thead>
<tr>
<th>Year &amp; Study</th>
<th>Age (years)</th>
<th>Mean check-up interval (months)</th>
<th>Definition for high-risk</th>
<th>Type of check-up Intervalxx</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>Low-risk patients</td>
<td>High-risk patients</td>
</tr>
<tr>
<td>1986 II</td>
<td>15</td>
<td>13.7</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>1999</td>
<td>15x</td>
<td>16.5</td>
<td>18.2</td>
<td>12.8</td>
</tr>
<tr>
<td>1999 V</td>
<td>0-18</td>
<td>16.4</td>
<td>17.8</td>
<td>12.2</td>
</tr>
<tr>
<td>1999</td>
<td>25x</td>
<td>17.5</td>
<td>20.2</td>
<td>14.0</td>
</tr>
<tr>
<td>1999</td>
<td>35x</td>
<td>17.8</td>
<td>19.2</td>
<td>14.4</td>
</tr>
<tr>
<td>1999 VI</td>
<td>19-36</td>
<td>17.8</td>
<td>20.0</td>
<td>15.1</td>
</tr>
</tbody>
</table>

n.a. = not available
x = previously unpublished
xx = Proposed = by dentist; Realised = the period from the previous clinical examination to the current one

Among 19- to 36-year-olds, the mean proposed check-up interval was the shortest for the "high periodontal + some caries risk" patients (15.1 months) and the longest for the "low-risk" patients (20.0 months) (Table 8).
Table 8. Mean check-up intervals (months) proposed for 19- to 36-year-old patients according to oral health indices in HCHD in 1999.

<table>
<thead>
<tr>
<th>Oral health categories</th>
<th>Proposed check-up intervals (months) (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-risk group (LR) (CPITN=0-1, DT=0)</td>
<td>20.0 (5.6)</td>
</tr>
<tr>
<td>Low periodontal + some caries risk group (LPSC) (CPITN=0-1, DT&gt;0)</td>
<td>16.5 (5.1)</td>
</tr>
<tr>
<td>Calculus + low caries risk group (CLC) (CPITN=2, DT=0)</td>
<td>19.8 (5.6)</td>
</tr>
<tr>
<td>Calculus + moderate caries risk group (CMC) (CPITN=2, DT=1-2)</td>
<td>18.0 (5.1)</td>
</tr>
<tr>
<td>Calculus + high caries risk group (CHC) (CPITN=2, DT&gt;2)</td>
<td>15.2 (4.4)</td>
</tr>
<tr>
<td>High periodontal + low caries risk group (HPLC) (CPITN=3-4, DT=0)</td>
<td>17.0 (5.7)</td>
</tr>
<tr>
<td>High periodontal + some caries risk group (HPSC) (CPITN=3-4, DT&gt;0)</td>
<td>15.1 (4.8)</td>
</tr>
</tbody>
</table>

Statistical evaluation by ANOVA. Difference by dental categories: p<0.0001.

5.4 Role of administrative units and dentists in prevention (III-V)

The share of prevention in the treatment mix was 25% in HCHD in 1989, ranging by administrative units (districts) from 20% to 33% (III). When used as the independent variable in a regression model, this accounted for 53% of the variation in the outcome by district, defined as the increase in the DMFT index over 2 years (p<0.01). The greater the share of prevention, the smaller the two-year increase in the mean DMFT. The differences in the outcome did not reflect differences in the educational structures of the population between districts. The combined share of dental prevention and check-ups in the treatment mix explained 74% of the variation in the DMFT increment by district.

The average time used by each dentist for repeated dental prevention for all 0- to 18-year-olds in 1999 was 4.9 minutes with no difference on the basis of the dentist’s gender or age. The range of the average time in each patient group was wider for female than for male dentists (Table 9).

The average time used by each dentist for REP for no-caries patients best explained (R²=0.28) the average time used for high-caries patients’ REP, as shown in a linear regression model (IV).
Table 9. Mean and range of time used by dentists for repeated caries prevention in 0- to 18-year-old patients in HCHD in 1999.

<table>
<thead>
<tr>
<th>Patient group</th>
<th>Repeated caries prevention (minutes) per patient by dentist</th>
<th>Range of average time used for repeated caries prevention by dentist gendera (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Range for female dentists</td>
</tr>
<tr>
<td>No-caries group</td>
<td>3.6 (3.1)</td>
<td>0.2-15.4</td>
</tr>
<tr>
<td>High-caries group</td>
<td>8.1 (6.2)</td>
<td>0.0-31.8</td>
</tr>
</tbody>
</table>

a = data by gender, previously unpublished

Male dentists proposed check-up intervals of 7 to 12 months more often than the females did (37 % vs. 33%, p<0.001). Variation in the dentist’s practice as regards proposing check-up intervals for 0- to 18-year-old no-caries patients was best explained by their practice for high-caries patients: the longer the one, the longer the other (Table 10) (V).

Table 10. Factors explaining variation in dentists’ mean check-up intervals among 0- to 18-year-old low-caries patients in HCHD in 1999.

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Regression coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of all check-ups</td>
<td>0.002 *</td>
</tr>
<tr>
<td>Mean DT+dt of all patients</td>
<td>1.948 *</td>
</tr>
<tr>
<td>Check-up intervals for high-caries patients</td>
<td>0.389 ***</td>
</tr>
</tbody>
</table>

* = p<0.05,     *** = p<0.001,     $R^2 = 0.155$
6 Discussion

6.1 Main results in general

The first hypothesis was supported by the findings in the present study: the targeting of repeated dental prevention in the public dental service in HCHD has improved since 1976. Also the second and third hypotheses hold true: patients’ oral health state had an impact on dental prevention, on check-up intervals in particular, and on the use of resources for dental prevention. The results did not depend on the dentists’ characteristics. The role of dentists in dental prevention and in the individual check-up intervals they proposed was varying: some had excellent ability to differentiate dental risk categories (Study V, Figure 3).

The improvement in the targeting of caries prevention to high-risk cases was the most positive finding. While no focusing on patients at high risk of caries was seen in 1976, in 1999 targeting of dental prevention measure corresponded with the dental state of the 0- to 18-year-old children and adolescents: the worse dental health, the higher the coverage of prevention and the more time used for prevention. This indicates a clear improvement even from 1992, when these practices in HCHD were still similar for high-caries and cavity-free six-year-olds (Varsio et al., 1999b), but a slight tendency to target them for 13-year-olds appeared (Varsio and Vehkalahti, 1996). Among young adults in 1999, the present results indicate a slight tendency, too, to target dental prevention according to the patients’ risk of caries and periodontal diseases. In particular, their proposed check-up intervals were well targeted, being shorter the worse the oral health of the patients was.

Studies I and II provided baselines for re-evaluation of dental prevention in Helsinki. Both studies were carried out at a time when dental health in children and adolescents had already shown significant improvement (Vehkalahti et al., 1990). This improvement can be seen in Figure 4 where 15-year-olds in Helsinki in 1976 had fourfold higher mean DMFT value than 15-year-olds in 1999.
The studies revealed that slightly fewer preventive measures were taken in 1986 than 10 years earlier. Focusing on risk patients was still insufficient, preventive treatments were being stereotyped and patients’ individual needs were being ignored. Similar findings of undervaluation of prevention in the late 1980s and early 1990s are reported among Finnish private practicing dentists (Telivuo and Murtomaa, 1988) and in the public sector in two towns in Finland (Kärkkäinen, 1997).

Individual check-up intervals had been implemented in the Helsinki public dental service in 1993, as a part of the high-risk strategy (Helsinki City Health Department, 1993b). Check-up intervals proposed in 1999 were better tailored to meet individual needs than were the actual intervals in 1986.

The time lag from innovation to adoption of new practices in public dental services seems to be long: in Norway, the lapse was 30 years for professional topical application of fluoride in the dental offices (Haugejorden, 1988). As late as 1981-82 topical fluoride applications were given only to every fifth child under school age in Finland, and one-third of the schoolchildren did not get any kind of fluoride treatment in the health centres during the year studied (Milen et al., 1986). In the United States fluoride varnishes were introduced as late as in the 1990s, decades later than in Europe (Fiset and Grembowski, 1997). After reimbursing dentists for providing fluoride varnish, its regular use among general dentists in Washington state increased from 32% in 1995 to 44% in 1997, but still the majority had not yet adopted the new technique (Fiset et al., 2000).
6.1.1 Changes in caries prevention from 1976 to 1999

The number of all preventive treatments remained unchanged between 1976 and 1986, indicating that more attention should be paid both to the coverage and targeting of preventive treatments according to the dental health of patients. A clear improvement in targeting of dental prevention had occurred during these 23- and 13-year periods up to 1999. The coverage of caries prevention was still insufficient in 1999: 64% of the 0- to 18-year-old high-caries patients did not get REP, but every fifth no-caries patient received it. The increase of the percentage of caries prevention given to the no-caries adolescents from 1986 to 1999 is considered a negative finding, indicating stereotyped, non-targeted dental prevention.

6.1.2 Changes in dental prevention in relation to dental health of children and adolescents from 1976 to 1999

Over the 23 years, a dramatic decrease in the caries prevalence was seen. However, caries prevalence may be underestimated in these data since incipient lesions are not included although they account for 80% of the total number of lesions, no matter whether the prevalence is low or high (Moberg Sköld et al., 1995).

For paediatric dentistry, the "interceptive caries treatment" approach has been suggested for early caries lesions, namely treatment with non-invasive or minimal surgical methods (Raadal, 2002). In contrast to the high caries prevalence era in the 1970s, it should nowadays be possible to target dental prevention and resources in order to better reach those at highest risk. Oral hygienists or assistants can perform the interceptive treatments, and relatively simple collection of risk factor data can be delegated to oral hygienists (Benn et al., 1999). In the present study, the treatments given by auxiliary personnel were included, but clinical dental examinations were performed only by dentists.

6.1.3 Changes in dental prevention in relation to orthodontics and periodontal therapy

Orthodontic appliances may increase caries risk (Batoni et al., 2001). In the present study, the higher percentage and better targeting of caries prevention to orthodontic patients indicates that dentists at HCHD took the increased risk into account. On the other hand, the greater number of visits needed for orthodontics may result in more caries prevention.

In 1999, 6% of young adults in HCHD clinics had deepened periodontal pockets. This is in line with findings in American adults over the age of 18, where severe periodontal pockets (≥6 mm) were found in fewer than 5% (Oliver et al., 1998). Probing depth has a high diagnostic predictive value for periodontal attachment loss (Claffey et al., 1990).
A slight tendency to target dental prevention in relation to the periodontal state was seen in young adults in 1999, when the CPITN index scores correlated with the REP. The highest coverage of REP was in the high periodontal + low caries-risk group and the lowest in the low-risk group. However, dentists at HCHD have not fully accepted the role of the CPITN index in clinical use, since 22% to 32% of patients in the high periodontal risk groups were left without periodontal therapy. The prevalence of deepened periodontal pockets in young adults is so low that the resources in HCHD would allow more intensified dental prevention measures. Young adults (aged 19-36) have to pay fees for all dental treatments and may therefore refuse periodontal therapy and dental prevention but accept filling therapy, probably because they perceive this treatment as more necessary and concrete.

The coverage of the most intensive REP (more than once) in 1999 was wider for young adult patients in need of periodontal therapy than for those not in need of it. Patients with a high CPITN value received more REP than those with a high caries index value. CPITN seemed to be more important than DT in leading to REP. These results show that REP was insufficient but in line with delivered periodontal therapy.

6.1.4 Dental prevention in relation to dentists’ characteristics

Evaluation of the outcome of dental services in the seven health districts revealed that emphasising dental prevention might level the effect of socio-economic background factors generally related to an increased risk of caries (III). Since the role of dentists as leaders of the dental team appeared to be important, dental prevention was evaluated in the later studies (IV, V) in relation to the dentists’ characteristics, as also suggested by Kärkkäinen (1997).

Decisions on the frequency of and the type of measures used for caries prevention have been reported to some extent to relate to the dentists’ characteristics, especially to gender (Helminen SE, et al., 1999). In the present study, however, no clear difference in the mean values of average time used by patient for REP existed based on dentist’s gender or age. Variations appeared both in the differentiation ability and the performance of dental prevention. Decisions on check-up intervals seemed to be more dependent on dentist-related factors, such as their practice profile, than on factors related to the patient’s dental status. The dentists’ age or year of graduation had no impact on whether they gave longer check-up intervals to no-caries patients. This is in disagreement with results of Rasmusson et al. (1994), who stated that "the older the dentist the lower his/her readiness to follow rules".

The alternative systems of providing dental care can have an influence on the dental care provided, too. In Denmark, the public system provided preventive dental services to adolescents more frequently than the private system, despite the fact that the economic
barriers were eliminated (Christensen et al., 2002). In the present study (IV, V) the influence of patient charges was eliminated, as all treatments for 0- to 18-year-olds are free. Thus the results describe the willingness of the dentists to provide preventive treatments to children and adolescents without economic barriers.

6.1.5 Share of dental prevention in treatment mix

A positive result is that dental prevention was worthwhile (III): the greater the share of prevention in the treatment mix of a health district of HCHD, the smaller the increase in the average DMFT index. Emphasis on dental prevention can thus also lead to positive outcomes in poor social, family, and educational structure conditions related to a greater number of high-caries risk children (Tala, 1983; Petersen and Torres, 1999), although the usability of these social class variables in caries risk groups can differ in various situations (Schou and Wight, 1994; Grindeljord et al., 2001; Vanobbergen et al., 2001). In Sweden, where public dental service is free of charge for all until their 19th birthday, the prevention has not been able to alter the socio-economic effect on caries in adolescents (Källestål and Wall, 2002).

The mix of preventive treatment remained unchanged but the number of all restorative treatments diminished from 1976 to 1986 (I). The similar and infrequent use of preventive treatments for both high-risk and low-risk patients indicates that dentists may have been unable to see the importance of targeting dental prevention during the decades of a rapid caries decline. The diminishing need for restorative treatment should have released resources to focus caries prevention measures on high-risk patients, but this did not happen. Although each high-risk patient requires much of a dentist’s time, low-risk patients are the majority of the population (Frame et al., 2000). Thus, the optimal use of resources requires that low-risk patients do not receive excessive dental prevention. Explanation for the misuse of preventive treatments in the 1980s may be the fact that as long as the health outcome was satisfactory, the quality of public dental services was not evaluated by dental authorities.

The remarkable role of the share of dental prevention in the treatment mix can be seen in its market price (III). In the present study the emphasis was on the administrative level of dental prevention, partly on dental check-ups in connection with individual check-up intervals and partly on filling therapy in connection with caries indices. Thus, studying these main fields in the dental treatment mix made it possible to assess the quality of public dental services. From the administrative point of view, the public dental service should devote most of its attention and resources not only on improved health, but also on resource consumption trends.

The average time used for REP per patient was 4.9 minutes for all 0- to 18-year-old patients and 3.6 minutes for 19- to 36-year-olds (IV, VI). The older the patients the less REP they received. The overall amount of REP seems to be on a rather low level. The
current codes for prevention do not make it possible to evaluate how much and what type of prevention was performed during the first examination visit. The low level of REP could hardly have resulted solely from under-recording, although it has been stated that dentists are not eager to record small non-remunerated preventive treatments (Läärä et al., 2000). Economic incentives have been effective in changing dental practices, as was seen in Finland in the 1990s, when higher compensation for composite fillings led to a rapid reduction of amalgam fillings (Forss and Widström, 2001).

It has been claimed that "the enthusiasm for preventive measures has probably also decreased both among the patients and the dental personnel" (Hugoson et al., 1995). It has even been debated how probable the worsening of the caries status might be, should the share of dental prevention given be reduced (Läärä et al., 2000). It was seen in the present study that some "preventive overkill" is invested in patients who do not need it, whereas the patients with real dental risk are neglected, or at least they do not receive enough preventive treatment.

6.1.6 Changes in check-up intervals in relation to dental indices

In 1986 in Helsinki, no difference in the length of check-up intervals of 15-year-olds by caries indices was found (II), similarly as in 1992 for 6-, 13-, and 15-year-olds (Varsio and Vehkalahti, 1996; 1997; Varsio et al. 1999b). Length of the check-up intervals correlate with the DT scores either of 12- and 18-year-old Norwegian children in 1990 (Wang, 1994b) or children in Jyväskylä and Kuopio, Finland, in 1990-1992 and in 1993-1995 (Kärkkäinen et al., 2001). In 1999, however, in all age-groups in Helsinki from 0 to 18, the mean proposed check-up interval was the shorter, the higher the caries index (V).

Since 1986, the average interval of adolescents’ check-ups in Helsinki has obviously increased: from 13.7 months in 1986 (II) to 18.6 months in 1999 (V). This increase can be considered satisfactory and is clearly larger than about 10% from 1990 to 1993 in Norway (Wang and Holst, 1995). It is estimated that lengthening of check-up intervals from 12 to 20 months reduces the total time for child dental care by 20% (Wang et al., 1998a). In HCHD the 5-month increase indicates a substantial release of resources from examination for other purposes, as was envisioned in the re-evaluation project in 1993 (Helsinki City Health Department, 1993b).

In 1999, the mean check-up interval of 17.8 months for 0- to 18-year-olds in the no-caries group was in good accord with the Finnish national recommendation of 1.5 - 2 years (Eerola et al., 1998) and the Norwegian recommendation of 1.5 years (Wang, 1994a). For adults in Finland this interval was recently suggested to be 1.5 to 2 years (Jokela, 1998).

In 1999, the check-up intervals for young adults were in line with DT and CPITN indices: the shorter the intervals were proposed to be, the worse the oral health (VI). Dentists’ proposals of check-up intervals seems to function optimally in young adults in accordance
with regulations in 1999, i.e., six years after the re-evaluation of public dental services in HCHD in 1993. It seems that the dentists in HCHD know their own ability to identify risk subjects. Knowing their own ability is the premise that they can define the correct individual examination intervals (Alanen et al., 1994). It should, however, be kept in mind that "a recall system may require a model that predicts the development of one carious lesion and there is much work to be done in the area of risk assessment" (Powell, 1998b).

In young adults, the mean length of the proposed check-up interval of 15 to 20 months is in line with a study of suitable intervals of preventive maintenance treatment of periodontal conditions, where "18 months was selected as the longest interval that could be considered without introducing an ethical concern" (Rosen et al., 1999). The fact that the DT and CPITN indices were reflected in the individually proposed check-up intervals indicates a positive development compared to 1986. The improvement took place between 1992 and 1999, after the re-evaluation project by HCHD in 1993, since check-up interval studies in HCHD in 1992 (Varsio and Vehkalahti, 1996; 1997) showed no improvement compared to 1986 in targeting of check-up intervals.

### 6.1.7 Usability of dental indices and other administrative tools

DMFT and DT indices were useful in describing the decline in dental caries of 15-year-old patients and of those in the high-risk and low-risk groups in 1976 and 1986 (I, II). The CPITN index scores were recorded on 99% of patient charts studied in 1986 (II). The recording of the CPITN index did not correlate with performed periodontal treatment and was done without a clear understanding of the purpose of the index. Neither the DMFT, DT, and CI score nor caries predictive value of the number of fillings during the preceding course of treatment as suggested by Downer (1978) had any effective association with check-up intervals in Study II.

Problems remain in the administrative use of dental indices. In spite of the result that the indices reflected REP and individual check-up intervals, the DT index did not reflect accurately filling therapy. Based on replacement of fillings, 13% of all fillings were made for DT=0 patients (VI). The DMFT value is irreversible, but the subject’s caries incidence may have already slowed markedly or ceased. Dentists should use not only the current disease status but also the past dental diseases in making decisions. During a 5-year study of adults 25 years or older in England, two thirds of the teeth treated were treated for reasons other than caries, indicating the inadequacy of the DMFT index as a measure of caries experience in adults (Clarkson et al., 2000). "CPITN index does not provide an assessment of past periodontal disease experience" (Ainamo et al., 1982). Therefore several consecutive CPITN scores are needed to assess the development of the overall periodontal status. In the present study the feasibility of dental indices varied widely. The proposed check-up intervals best reflected dental indices, especially in young adults.
Neither the M nor the F component of DMF describes the prevalent caries in an individual, although the DMFT is commonly used as a measure of caries occurrence. A number of additional weaknesses in DMFT data are described by Spencer (1997): "DMF index data under-estimate the prevalence of caries today and over-estimate temporal change; have limitations in segmenting the population in the most useful ways for targeting as part of policy development; and lack discrimination between individuals with different caries activity". He suggests new outcome measures for caries: caries severity grading, variants of prevalence, extent and severity and their combination into case definitions, and weighting of the components of the DMF index.

Outcome measures are being called for (Lawrence et al., 1996; Spencer, 1997) to improve current clinical and administrative decision-making. A combination of clinical indices was used in Kuopio, Finland, at the beginning of the 1980s. It was noticed that initial caries scores added little to the predictive power of the DS and FS scores (Seppä and Hausen, 1988). Including initial caries scores in caries predictors may increase the predictive power of DT scores in current low caries situation. Secondary caries scores can be used in middle-aged individuals who are at high risk of developing caries (Hugoson et al., 2000b). In the present study the feasibility of using dental indices on allocation of resources varied, with the CPITN index being a better reflection of the treatment time finally used for treatments. The DT index may be more useful in proposing check-up intervals than in allocating resources, as a substantial percentage of filling therapy occurs due to renewing fillings for reasons other than caries.

Although the Effica® online software by TietoEnator Corporation, now in use in HCHD, helps dentist remember all the details of dental care, instructions for working with various dental risk groups were in 1999 not installed into the programme. This computer-aided program can help the dentist to schedule preventive treatments for those in need. Although some may fear that the control of decision-making is being taken away from the profession by a computer (Benn et al., 1999), introducing computer-aided instructions would be a useful way to strengthen the decision-making.

The education index (HCHD, 1990) used in Study III has its limitations because socioeconomic conditions vary in the individual health districts. Even in districts in which the education index was below average, the emphasis on prevention led to better-than-average outcome. Education index, which describes the relative rate of population having only a basic education expresses the difference in the patients’ background by district. As the seven health districts are quite large and may contain wide variations in socio-economic condition, one must be careful with conclusions. However, the average figures presented here show the important role being played by preventive care in patients’ dental health, although large individual variations may occur.
6.2 Subjects and methods

6.2.1 Data and data collection

The Finnish public dental service has accumulated a good deal of experience in collecting data since 1957. Comparing and evaluating data should thus be possible without misunderstandings. Data collected from public health records "are not decisively inferior to those obtained from examinations by trained and calibrated examiners" (Hausen et al., 2001). Data collection from patient records is far less costly and time consuming than organising clinical examinations, and this "can be recommended - at least for administrative purposes".

Random sampling (I and II), aggregated data (III) and data on the total target population (IV-VI) were used in the present study. The quality of service was assessed in Study II on the basis of the paper records for 15-year-old adolescents in Helsinki in 1986. The latest records of clinical findings were in agreement with earlier records in the vast majority of the patient charts. The most common mistakes in recording were marking a previously filled tooth as intact and an extracted tooth as present. Dental status by surface and CPITN index was recorded in practice in all charts, whereas occlusion (Angle classification and overbite) was recorded on only in one fifth of the charts. The CPITN index in Vantaa (neighbouring town of Helsinki) was recorded only slightly less frequently for young adult patients (Helminen SE et al., 1998).

Studies IV-VI utilised clinical patient data recorded on automatic data processing files in an online network under non-experimental conditions. One advantage of automatic data processing files over paper charts is that the code of the performer is clear. This online data source for 74,000 patients does, however, not include the personal entries of dental personnel.

6.2.2 Representativeness of the data

The two first studies (I and II) were restricted to 15-year-olds because there was enough variation in the occurrence of dental diseases in this age-group for the evaluation of the dental prevention measures taken for different risk groups. At that time, check-ups were organised for entire school classes, with 92% of the pupils participating, thus giving a reliable picture of the dental status and its impact on the treatments given. Both samples were representative of all 15-year-old patients in Helsinki in those years.

In Study III, the seven health districts providing dental care services in HCHD were the basic units, and data were very representative in describing all treatments given to all patients. It has been suggested that socio-economic characteristics are better predictors of the health in a population when measured by area rather than by subject or household
In the present study (III), the seven independent areas were used as basic units for the evaluation of preventive practices, in line with the suggestion of Locker (1993).

All dentists who performed at least 50 check-ups for the age-groups in question in 1999 were included in Studies IV-VI. This was to guarantee that no confounding factors could have been introduced into the data by including temporary dentists with only a few patients. Studies I-V were restricted to free-of-charge patients so as to reveal the dentists’ practices without introducing any confounding economic constraints.

This method, where dentists entered the information on dental status and treatments into a computer file and the computer programme then produced dental indices, is probably more reliable than using index values marked by hand in dental records (Hausen et al., 2001). The large number of patients and dentists virtually guarantees that all information needed has been recorded, provided that the dentists have been instructed adequately. The results of the present study well describe the selected patient groups in HCHD and can be applied to real-life conditions.

6.2.3 Validity of methods

The study was designed to include baseline data (1976) and data from the end of the 1990s, thus describing a 23-year change in the prevention practice in HCHD. The methods for collecting dental data differ from each other, as Manski and Moeller (2002) stated: "Self-reporting of data may be less accurate than collection by observation or by dental record abstraction, potentially limiting the usefulness of these data". In the present studies, the dentists did not know that their practices would be evaluated afterwards, which diminishes the bias.

The adequacy and appropriateness of dental prevention were evaluated based on records of the first full examination check-up visit and visits thereafter during treatment. The patient chart must accurately describe the care performed. The recording must be so clear that any colleague can understand what decisions were made and, if necessary, continue the dental care as planned. All decision-making in these studies occurred in real-life clinical conditions. There may, however, be some confounding factors because the clinician may have obtained information about several background factors during the clinical examination and all data were not recorded (Isokangas et al., 1993).

The sample in all six studies was large enough to evaluate the changes in dental prevention measures and check-up intervals over the 23-year period. In 1999, sampling could have been used, but the new ADP system made it possible to use the total target group in the three last studies (IV-VI) despite the large quantities of subjects in them, about 74,000 in total. The seven health districts vary from each other socioeconomically.
Since the early 1990s, the personnel resources in HCHD have been allocated according to the need for dental services in each district. When data for a total calendar year were used, seasonal variation was controlled for. The validity of the measurements was further increased by using generally accepted concepts and methods.
7 Conclusions

1. A positive change occurred in the targeting of caries prevention in HCHD from 1976 to 1999. Orthodontic patients received more caries prevention than other patients. The dentists seemed to be well aware of the increased risk of caries due to orthodontic appliances. An alarming finding was that one-fifth of the 0 to 18-year-old patients with no caries experience received repeated caries prevention, indicating an overuse of resources.

2. Check-up intervals corresponded to the patients’ dental state: the healthier the teeth, the longer the mean check-up intervals proposed. The mean check-up intervals of children and adolescents have lengthened markedly since 1986 and in young adults they can be considered to be on an optimal level today. The desirable change has been minor in high-risk patients, their check-up intervals having been reduced only slightly. Dentists should follow the changes in caries incidence more closely, implement preventive treatments and propose check-up intervals according to the risk.

3. Currently, the dental prevention covers patients in the highest risk for dental diseases rather accurately, but it is still inadequate.

4. In 1999 a slight tendency to target dental prevention was seen in young adults according to their risk of caries and periodontal diseases. In particular this was seen in individual check-up intervals. An overuse of resources was seen in no-current-caries patients, one-fifth of them receiving repeated dental prevention.

5. There was remarkable variation in the dentists’ differentiation ability in the extremes (low-risk and high-risk) of patients’ dental state and in the performance of preventive practices. This revealed the need of encouraging dentists to differentiate between patients.

6. The impact of the CPITN index on dental prevention for young adults seemed to be stronger than that of the DT index. The usability of the DT and CPITN indices as measures of treatment needs of caries and periodontal diseases in young adults seemed to be minor. An administratively and clinically more practical dental index to describe the need of filling therapy is called for in the dental community.
The six studies produced the information needed for evaluating dental prevention measures and the success with which they have been targeted at high-risk groups in public dental service in HCHD. The population of Helsinki accounts for about 10% of the Finnish public dental service. Since the preventive practices are quite similar in Finland generally, the present results from 1999 can be considered to give a reasonable picture of the preventive practices in Finland in the late 1990s.
8 Recommendations

Based on the results of the present study, the following recommendations are made:

1. Dentists should be encouraged to strictly differentiate patients with various treatment needs and risks of dental diseases.

2. More training in calibration of treatment decisions should be provided for dentists to improve the adequate allocation and use of dental resources.

3. Computer-aided programmes should be used to guide dentists in providing more accurate dental prevention.

4. Economic incentives should be used to improve dentists’ targeting of dental prevention.

5. Dental prevention guidelines for young adults are called for.

6. The dental community needs an administratively more practical dental index to describe treatment needs in young adults.

7. Outcomes of dental services in relation to the treatment mix should be regularly monitored.

8. Prospective research is needed on these recommendations when implemented in public dental service.
9 Summary

At the outset of the present study (1976), a rapid decline in caries occurrence was taking place in Finland. There were many opinions as to the reasons for the decline, above all, the apparent success of the dental prevention measures. From an administrative point of view, interest was expressed in determining whether time and money were being wasted in prevention when dental diseases were on such a low level. In any case, dental prevention could not to be continued in the changing circumstances as before.

The aim of the present study was to evaluate changes in the adequacy and appropriateness, share and targeting of dental prevention in Helsinki City Health Department (HCHD) from 1976 to 1999.

From 1976 to 1986, a substantial decrease was seen in caries occurrence and in the mean number of dental visits and fillings. It was found that slightly fewer preventive measures were being carried out in 1986 than 10 years earlier, and no focusing on risk patients was seen. When assessing the quality of public dental services on the basis of patient records in 1986, preventive treatment was considered insufficient for those at a high risk of developing caries, 40% of them having not received fluoride treatment. No intensification in the high-risk group strategy implemented in HCHD in 1985 was found by the end of the 10-year research period (1976-86).

An encouraging finding was that those health districts in HCHD which were placing the greatest stress on preventive work in 1989-91 achieved better dental health results. The increase in numbers of DMF teeth was smaller in the districts where prevention dominated in the treatment mix. This positive outcome indicates that dental prevention is worthwhile.

New instructions for dental prevention were adopted in HCHD in 1993, based mainly on the results of the three first studies (I-III). They included well-grounded suggestions on the use and targeting of preventive methods.

This study shows that by 1999 the targeting of caries prevention to 0- to 18-year-old patients at high risk had improved. Orthodontic patients were receiving more caries prevention than others. An overuse of preventive resources was found, as one-fifth of children without caries experience were still receiving caries prevention. The proposed check-up intervals corresponded to the dental state of children and adolescents. Dentists’ age and gender had no impact on the time used for repeated caries prevention.

A slight targeting of dental prevention was seen in young adults, in particular in their check-up intervals, which seemed to function optimally. However, over- and under-use of preventive resources still existed.
The feasibility of the DT and CPITN indices as administrative measures of treatment needs of caries and periodontal diseases in young adults seemed to be minor. An administratively and clinically more practical dental index to describe treatment needs in young adults is called for in the dental community.

The present six studies provided necessary information about preventive practices in public dental service and for resource planning in it. They describe preventive practices used in Helsinki but do not compare these with methods used in other countries that might be more cost-effective. The coverage and targeting of dental prevention in HCHD have improved since 1976 and 1986. Recommendations are made here for more training in calibration to improve the allocation of dental resources, for usage of a computer-aided programme guiding dentists to more accurate dental prevention, and for economic incentives to improve targeting of dental prevention. More research is needed on evaluating current basic prevention and dental prevention for young adults and elderly adults now receiving public dental services as new customers. In the current circumstances, which recently underwent a major change, as all population became entitled to subsidised public dental service in 2002, outcomes of public dental service in relation to dental prevention and their share in the treatment mix should be monitored regularly.
10 Tiivistelmä

Tämän tutkimussarjan alussa karieksen esiintyvyys vähensi voimakkaasti Suomessa. Sen syistä on esitetty erilaisia näkemyksiä, mutta noudatettu hammaslääketieteellinen ehkäisy näyttää olleen onnistunutta. Suun terveydenhuollon hallinnossa ryhdyttiin pohtimaan, tuhlataanko ehkäisevään hoitoon aikaa ja rahaa, koska hammassairauksien esiintyvyys oli jo saavuttanut varsin matalan tason. Arveltiin, että hammaslääketieteellisiä ehkäisyohjelmia ei enää ollut tarkoituksenmukaista jatkaa kuten ennen.


Rohkaiseva havainto oli se, että ne Helsingin terveysviraston hammas-huollon suurpiirit, jotka panostivat eniten ehkäisevään hammas-hoitoon vuosina 1989-91 saavuttivat parhaat terveydelliset tulokset. DMF-hampainden määrä lisääntyi vähemmän niissä suurpiireissä, joissa ehkäisy oli vallitsevampaa. Mitä suurempi ehkäisyyn osuus oli, sitä positiivisempi oli tuotos eli hammassairaudet vähenevät. Tämä osoitti, että ehkäisy kannattaa myös alhaisen kariesesiintyvyysen vallitessa.


DT- ja CPITN-indeksien käyttökelpoisuus hallinnollisiin tarpeiisiin osoittautui nuorilla aikuisilla vähäiseksi. Hammaslääketieteellisen yhteisön tulisikin kehittää uusi, hallinnollisesti ja kliinisesti käyttökelpoisempi indeksi osoittamaan nuorten aikuisten hoidon tarvetta.


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Seppo K. J. Helminen
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