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REGISTER STUDY ON DENTAL TREATMENT IN FINLAND

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DOCTORAL DISSERTATION

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To my family and friends

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LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following original articles referred to in the text by the Roman numerals I-IV:

I Linden J, Widström E, Sinkkonen J. Children and adolescents´ dental treatment in 2001–2013 in the Finnish Public Dental Service. BMC Oral Health. 2019;19:131. https://doi.org/10.1186/s12903-019-0828-z

II Linden J, Widström E, Sinkkonen J. Adults' dental treatment in 2001–2013 in the Finnish Public Dental Service. BMC Oral Health 2020;20:121. https://doi.org/10.1186/s12903-020-01091-w

III Linden J, Josefsson K, Widström E. Frequency of visits and examinations in the Public Dental Service in Finland – a retrospective analysis, 2001–2013. BMC Oral Health. 2017;17:138. https://doi.org/10.1186/s12903-017-0436-8

IV Widström E, Linden J, Tiira H, Seppälä TT, Ekqvist M. Treatment provided in the Public Dental Service in Finland in 2009. Community Dent Health. 2015;32:60–4.

THESIS AT A GLANCE

Paper	Objective	Method	Main findings/conclusion
Children and adolescents´ dental treatment in 2001–2013 in the Finnish Public Dental Service	To survey the treatment needs and treatment measures provided for children and adolescents and changes in these in the Finnish Public Dental Service (PDS) during 2001–2013.	Data on children, their oral health and treatment in 2001–2013 were collected retrospectively from databases of five PDS-units covering 320,000 inhabitants. The numbers of visitors, those in need of periodontal or caries treatment and their treatment were calculated for three age groups. Trend analyses were performed to study changes.	Children's oral health had improved and restorative treatment decreased, but the total number of treatment measures increased. Healthy children received frequent examinations and preventive treatment measures. Targeting treatment according to needs was not satisfactory.
Adults' dental treatment in 2001–2013 in Finnish Public Dental Service	To survey the treatment needs and treatment measures provided for adult patients and changes in these in the Finnish PDS during 2001–2013.	Data on adults, their oral health and treatment during 2001–2013 were collected retrospectively from five PDS-units. The numbers of visitors, those in need of periodontal or caries treatment were calculated for three age groups. Treatment provided was also calculated in 13 treatment categories. Trend analyses were performed to study changes.	Adults' dental treatment concentrates on treatment of caries. Periodontal treatment is insufficient and prosthetic treatment is almost totally neglected. The unmet needs may be due to tradition, inadequate treatment processes or a lack of resources or failed salary incentives.
Frequency of visits and examinations in the Public Dental Service in Finland – a retrospective analysis, 2001–2013	To investigate longitudinally examination and visiting patterns in the Finnish PDS and to relate these to patients' treatment needs and international recommendations on examination intervals.	Data on patients, their visits and oral health during 2001–2013 were collected retrospectively from five PDS-units. Each individual's examination and visiting intervals were counted. Multilevel modelling was used to study probabilities of being examined or in need of treatment and differences in examination and visiting intervals between groups and over time.	Young patients had mostly annual or biannual examinations, in line with recommendations. The examination intervals of working aged adults were considerably longer, and more of them needed treatment. The share of elderly among visitors remained low.
Treatment provided in the public dental Service in Finland in 2009	To analyse treatment measures provided in the PDS and to discuss the therapy given against treatment needs, as expressed in the latest national clinical epidemiological studies.	Data on all treatment measures were collected from the municipal 166 Public Dental Service (PDS) databases. Patients were grouped by age (<18, 18-64, 65+) and the treatment measures by 12 main categories.	Children had plenty of examinations and preventive measures. Examinations and restorative treatment made up most of the care provided for adults and periodontics and prosthetics were minor treatment areas, indicating that treatment given to adults was not fully in line with their needs.

ABSTRACT

This register study evaluated treatment measures, dental visiting patterns and examination intervals and changes in them among visitors to the Public Dental Service (PDS) in Finland. In the longitudinal studies I-III, data on patients and their dental visits in 2001–2013 were collected retrospectively from five municipal PDS-units with 320,000 inhabitants and using the same patient database system. For each year, the numbers of visitors, those examined and those in need of periodontal or caries treatment (CPI >2 and D + d > 0) were calculated separately for three age groups (<18, 18-64, 65+ years). Each individual's examination and visiting intervals were counted. Treatment provided was classified into 13 main areas: examinations, preventive care, periodontics, restorative care, endodontics, treatment of TMD, orthodontics, prosthetics, anesthesia, emergencies, radiology, oral surgery and other treatment.

The statistical methods used comprised of trend analyses and multilevel modelling. In the cross-sectional study IV, data on all treatment measures provided in the public sector were collected from all the municipal PDS units' databases. The study contained data on 1 700 758 visitors in the PDS.

The longitudinal studies I-III showed that about 40,000 children and adolescents visited the PDS units each year and 2,488,805 treatment measures were provided for them during the study period (Study I). The proportion of persons in need of treatment decreased from 44.4% in 2001 to 33.2% in 2013. Examinations (24.7%), orthodontics (20.1%), preventive measures (15.0%) and restorative treatment (14.3%) made up 74% of all treatment measures. During the 13 years, statistically significant increasing trends were found for examinations, anesthesia and the total number of treatment measures, and a decreasing trend ($p < 0.01$) for restorative treatment.

The annual number of adult patients increased from 37,377 in 2001 to 67,834 in 2013 and during that time they had altogether 4,099,050 treatment measures (Study II). Restorative treatment (23.6%), examinations (16.1%), radiographs (12.9%), anesthesia (12.7%) and emergency treatments (8.5%) made up 73.8% of all treatment measures during the study period. Periodontal (7.8%) and preventive treatments (3.9%) were not common and prosthetics was extremely uncommon (0.9%). Significant increasing trends were found for radiographs ($p < 0.01$), anesthesia ($p = 0.01$) and total number of treatments ($p = 0.01$) and a decreasing trend in preventive care ($p=0.01$).

Compared with adults, the young were three times less likely to require treatment (OR = 0.31). An increasing trend was detected in examination intervals; among the young and the elderly, the change was from one year to eighteen months and among the working aged from one year and three months to two years two months.

On national level, the 1.7 million public sector visitors had 8.9 million treatment measures in 2009 (Study IV). The working aged were provided by 1,457 restorative treatment, 1,142 examinations, 455 periodontal, 193 preventive and 327 surgical treatment measures per 1000 patients.

Although children's and adolescents' oral health continued to improve, and restorative treatment decreased, the total number of treatment measures increased. They had frequent examinations and high numbers of orthodontic and preventive treatment measures. Adult care concentrated strongly on restorative treatment at the expense of periodontal and prosthetic treatment and prevention. This oral care patch mode in the PDS was in notable contrast to the care pattern of the young.

Summary in Finnish, tiivistelmä

Tässä rekisteritutkimuksessa arvioitiin julkisessa suun terveydenhuollossa käyneiden potilaiden saamaa hoitoa sekä käynti- ja tutkimusvälejä ja niiden muutoksia.
Pitkittäistutkimuksen 2001-2013 (julkaisut I-III) aineisto potilaista, heidän suun terveydenhuollon käynneistään ja saamastaan hoidosta kerättiin takautuvasti viiden terveyskeskuksen potilastietojärjestelmistä. Kunkin vuoden kävijämäärät, tutkitut sekä hoidon tarpeessa olevat (CPI >2 ja D + d > 0) laskettiin kolmessa ikäryhmässä (<18, 18-64, 65+). Kunkin potilaan tutkimus- ja käyntivälit laskettiin. Hoito ryhmiteltiin 13 kategoriaan: tutkimukset, ennaltaehkäisevä hoito, parodontologia, korjaava hoito, endodontia, purentafysiologia, oikomishoito, protetiikka, anestesia, kiireellinen hoito, radiologia, suukirurgia ja muut toimenpiteet.
Tilastollisina menetelminä käytettiin trendianalyysiä ja monitasoanalyysiä. Poikkileikkaustutkimuksessa (julkaisu IV) kerättiin tiedot kaikista julkisen sektorin hoitotoimenpiteistä koko maan terveyskeskusten potilastietojärjestelmistä.
Pitkittäistutkimus osoitti, että tutkimusterveyskeskuksissa kävi vuosittain noin 40 000 lasta ja nuorta vuosittain ja heille tehtiin tutkimusjakson aikana 2,5 milj hoitotoimenpidettä (julkaisu I). Hoidon tarpeessa olevien osuus väheni 44,4 %:sta vuonna 2001 33,2 %:iin vuonna 2013. Tutkimukset (24,7 %), oikomishoito (20,1 %), ennaltaehkäisevät toimenpiteet (15,0 %) ja korjaava karieshoito (14,3 %) muodostivat 74 % kaikista hoitotoimenpiteistä. Tutkimusten, anestesian ja hoitotoimenpiteiden kokonaismäärän trendi oli 13 vuoden aikana tilastollisesti merkitsevästi nouseva ja korjaavan karieshoidon trendi laskeva ($p < 0,01$).
Aikuispotilaiden määrä tutkimusterveyskeskuksissa kasvoi vuoden 2001 37 377:stä 67 834:ään vuonna 2013 ja heille tehtiin tutkimusjaksolla 4,1 milj toimenpidettä (julkaisu II). Korjaava karieshoito (23,6 %), tutkimukset (16,1 %), röntgenkuvat (12,9 %), anestesia (12,7 %) ja kiireellinen hoito (8,5 %) muodostivat 73,8 % kaikista tutkimusjakson hoitotoimenpiteistä. Hampaiden tukikudosten hoito (parodontologia 7,8 %) ja ennaltaehkäisevät toimenpiteet (3,9 %) olivat harvinaisia ja proteettinen hoito oli erittäin harvinaista (0,9 %). Radiologian ($p < 0,01$), anestesian ($p = 0,01$) ja toimenpiteiden kokonaismäärän ($p = 0,01$) kasvava trendi oli tilastollisesti merkitsevä, samoin ennaltaehkäisevän hoidon laskeva trendi ($p=0,01$). Tutkimusvälitrendi oli kasvava; nuorilla ja eläkeikäisillä tutkimusväli piteni 13 vuoden aikana yhdestä vuodesta 18 kuukauteen ja työikäisillä 1 vuodesta ja 3 kuukaudesta 2 vuoteen 2 kuukauteen. Aikuisiin verrattuna lapset ja nuoret olivat kuitenkin kolme kertaa harvemmin (OR = 0,31) hoidon tarpeessa.
Valtakunnallisesti terveyskeskusten 1,7 miljoonalla potilaalla oli 8,9 miljoonaa hoitotoimenpidettä vuonna 2009 (Julkaisu IV). Työikäisille tehtiin 1,457 korjaavan hoidon toimenpidettä, 1,147 tutkimusta, 455 parodontologista 193 ehkäisevää ja 327 kirurgista toimenpidettä 1,000 potilasta kohti.
Vaikka lasten ja nuorten suun terveys parani ja korjaava karieshoito väheni, toimenpiteiden kokonaismäärä kasvoi. Heille tehtiin paljon tutkimuksia, suuri määrä oikomishoitoa ja ennalta ehkäiseviä toimenpiteitä. Lapsia suuremmassa hoidontarpeessa olevien aikuisten hoidossa keskityttiin terveyskeskuksissa hampaiden paikkaamiseen parodontologian, protetiikan ja ennaltaehkäisyn kustannuksella. Lasten ja nuorten hoidossa käytettyä säännöllisiin tarkastuksiin ja kokonaishoitoon painottuvaa hoitofilosofiaa ei terveyskeskuksissa noudatettu aikuisten hoidossa.

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ABBREVIATIONS

Social Insurance Institution	SII
Public Dental Service	PDS
Health Center	HC

INTRODUCTION

In general health care improving equal access to services and ensuring that services are of sufficient quality to be effective have been in focus of development work for decades. Much effort has been put into defining characteristics of high-quality health care services, e.g., that they should be timely, equitable, integrated, safe, and efficient (WHO 2018, Institute of Medicine 2001).

To improve health system performance and health outcomes has not been an easy task due to the complexity of the systems and the lack of or poor quality of available data. Methods used to improve quality of health care have included workforce strategies, registration and licensing mechanisms, external evaluations and accreditation, public reporting and benchmarking mechanisms etc.

However, on one hand the continuously rising health care costs caused by new treatment methods and ever-increasing demands and on the other hand limited resources have required further work to ensure that the resources are used on provision of appropriate care. There are five aspects that currently conceptualize the term appropriate health care; they are evidence-based care, clinical expertise, patient centeredness, resource use, and equity. These terms are most often used in combination which indicates an integrated understanding of appropriate care among health care professionals (Robertson-Preidler et al. 2017). In this work, health information systems that measure and drive quality of care and financing methods that support provision of treatment of high quality have been crucial. Well-done epidemiological surveys have also been valuable in this context.

As regards measuring outcome and overall efficiency, dental care is trailing, partly due to the different organization of the care provision system from medical care, e.g., most dental care being private business (Widström and Eaton 2004a) and the lack of tradition of reporting diagnoses or other outcome data. Nor has comparison of care providers been customary and supervision of the dental field has not been prominent. Overall, developing outcome measures for oral health care and using them for evaluation and steering purposes is still just beginning (Hummel et al. 2017).

The present study clarifies and analyses the contents of oral health care as treatment provided in Finland during 2001-2013 in a cross-sectional and a longitudinal setting. Thus, it brings light into outcome and quality aspects of dental care.

REVIEW OF THE LITERATURE

Oral health care provision system

Finland has so far had a highly decentralized and basically publicly funded social welfare and health care system. A major social and health care reform in the near future will result in a more centralized organization but in this thesis the decentralized model is still valid. In 2021, local municipalities were responsible for organizing the basic social welfare and public health services including the dental services defined by law (Finnish Ministry of Social Affairs and Health 1972, Finnish Ministry of Social Affairs and Health 2010).

Services have been organized by one municipality alone, by several municipalities together or they have been outsourced to other local authorities, non-governmental organizations or private service providers. Each municipality has belonged to one of the 20 hospital districts providing specialised medical and dental services. Nationally, five university hospital areas have provided the most demanded health care (Finnish Ministry of Social Affairs and Health 1989a). At local level, the Public Dental Service (PDS) has been a separate part of the Health Center (HC) providing welfare and general health care services. In 2003, there were 279 PDS units, each with one or several dental clinics (Suominen-Taipale et al. 2009).

In 2020 the number of PDS units was 134 (Kuntaliitto 2020). Each PDS has its own Chief Dentist who is under the leadership of the Leading Doctor of the HC (Alestalo 2015).

Besides tax revenues from national and municipal taxation, the PDS has been financed by patient fees to a much greater extent than general health care. However, all dental care for children and adolescents under 18 years has been free of charge. The maximum patient fees for adults have been defined nationally by a decree (Finnish Ministry of Social Affairs and Health 1992).

When the present health care provision system was founded in 1972 (Finnish Ministry of Social Affairs and Health 1972), the PDS was responsible primarily for the young (<18 years) and adults were assumed to visit private dentists or clinical dental technicians (denturists) and paid for treatment out-of-pocket. From 1980, adults were successively given access to subsidized services in the PDS, starting from the youngest age groups, the 18–25-year-olds. After that, access was slowly expanded to include middle-aged adults. From 1985 onward, the adult age groups entitled to use the PDS also received partial reimbursement of the cost of private dental care from the Social Insurance Institution (SII). In 2002, a major Oral Health Care Reform abolished all age restrictions and even adults born before 1956 received access to the PDS or to reimbursement from SII if they used private dental services (Finnish Ministry of Social Affairs and Health 1963, Finnish Ministry of Social Affairs and Health 1972, Finnish Ministry of Social Affairs and Health 2010). Thus from 2002, municipalities were responsible for organizing oral health care services including emergency treatment for everyone who requested it regardless of age, residence or social background but on the basis of treatment needed. Oral health care was to include health promotion and monitoring oral health for groups and, on the individual level, examinations, prevention, treatment of oral diseases and prosthetic rehabilitation (Finnish Ministry of Social Affairs and Health 2019).

Because waiting lists to some public health services and dental services had become long, regulations considering timeframes on access to treatment were introduced by law in 2005. Thus people had to be able to contact their HC/PDS call-center during weekday opening hours. An evaluation of treatment need had to be done in three days by a doctor/ dentist or nurse/dental assistant. A medical appointment had to be given within three months and a

dental appointment within six months. Emergency care had to be administered immediately (Finnish Ministry of Social Affairs and Health 2004). An order to pay fines was introduced in case the HC/PDS was not able to provide the services within these time limits.

The major reform in 1.1.2023 changed the organization and financing of the welfare and health care services. The Finnish Government establised 21 welfare districts plus Helsinki and the Åland islands. The social- and healthcare services were transferred from the municipalities to the new Welfare Districts. Election for those in power in the welfare districts was held in January 2022. Financing of the Welfare Districts was transferred from communities to the Government.

In 2020, there were 5360 working aged (< 65 years) dentists, 3139 dental hygienists and 7710 dental assistants. In addition, there were about 827 dental technicians, of whom about 300 were clinical dental dental technicians (AVOINDATA.FI).

About half of the active dentists in Finland work in the PDS as a salaried work force and the other half in the private sector (Suomen Hammaslääkäriliitto 2018). Most dental technicians work privately.

Oral health

Children and adolescents

Caries experience in 12-year-olds measured by means of clinical examinations using the DMFT index of has been the most commonly used indicator of dental health in children (WHO 2013). According to statistical data collected in the Finnish PDS units the mean DMFT value for 12-year-olds was 2.0 in 1988, 1.2 in 1991 and 1.2 in 2000 (Nordblad et al. 2004). From 2011 to 2018 the mean DMFT decreased further from 1.3 to 0.9 (SOTKA 2022). The proportion of caries-free children has increased: 30% the12-year-olds were caries-free in 1991, 38% in 2000, 54% in 2012 and 62% in 2018 (Nordblad et al. 2004, SOTKA 2022). Similar improvements can be seen in the other age groups whose mean dmft and DMFT indexes are collected, the 5 year olds and the 15 year olds (Nordblad et al. 2004, SOTKA 2022). Childrens' and adolescents' oral health has been poorer in the North than in the wealthier southern parts of the country (Widström and Järvinen 2011).

A recent study showed that schools with pupils with high socio-economic background had a higher tooth brushing frequency than those with children with poorer background indicating social differences in oral health (Anttila et al. 2018).

Great reductions in caries prevalence has been seen in the other Nordic and most European Union countries. Thus of the 12-year-olds only 18% were reported to have caries experience and the mean DMFT was 0.3 in Denmark in 2019. In Norway, 40% had caries experience (DMFT>0) and the mean DMFT was 1.0 in 2018. In Sweden, 32% had caries in 2017, and the mean DMFT was 0.7. Iceland reports older figures from 2005: 34% of 12-year-olds were caries-free and the mean DMFT was 2.1 (Bøge Christensen et al. 2021).

The Council of European Chief Dental Officers (CECDO) has been collecting information from its members on national mean DMFT- values of the 12-year-olds in the EU member states. The latest reported figures in the older member states varied between 0.5 in Germany and 3.4 in Lichtenstein. In the newer Eastern European EU-member states the reported figures varied between 2.1 in Czech Republic and 4.8 in Croatia (CECDO 2022). Periodontal diseases, other than gingivitis are not common among the young and thus the focus has been on caries. However, in a Finnish study among 15–16-year-old smokers there were early signs of periodontitis in 15% of the participants (Heikkinen 2011).

Erosive tooth wear is a newer problem among children and youngsters related to changes in eating and drinking habits. However, there are no properly established treatment practices yet (Johansson et al. 2012). As regards treatment of malocclusions and aesthetically disturbing conditions demanding orthodontic care, there have been great differences between the PDS-units as regards coverage of care, results and costs (Pietilä 2010).

Adults

Adults' oral health has been monitored by three nationally representative clinical epidemiological studies conducted in 1980, 2000 and 2011.The first study showed that adults (>30 years) in general had very poor oral health: caries, periodontal diseases and tooth loss were common, and edentulousness was widespread. Oral diseases and edentulousness were most common among persons with low education or low income (Vehkalahti et al. 1991).

In 2000, periodontal diseases were still common among adults. The other significant and frequent finding was the absence of one or more teeth without prosthetic replacement, even in highly visible areas in the mouth. Of all adults 15% and 44% of those 65 years or over were edentulous in 2000. During the following 10 years edentulousness decreased and in 2011 the corresponding figures were 7% and 21% (Suominen-Taipale et al. 2008). Although adults in 2011 had slightly higher mean numbers of remaining teeth than in the previous studies, partial or full removable dentures were still common: 27% of those between 55-64 years, 50% of those between 65-74 years and 70% of those aged 75+ years had removable dentures. The prevalence of untreated caries was 31% in men and 15% in women, and the mean number of decayed teeth was 0.8 and 0.3 respectively. Of men 70% and of women 58% had deepened periodontal pockets (≥4 mm), and the corresponding mean number of teeth with deepened pockets (≥4 mm) were 5.6 in men and 3.7 in women. Persons with low education and low income had worse oral health than persons with high education and income (Koskinen et al. 2012).

The latest nationally representative data on adults' oral health were collected in 2017 by means of interviews. Two-thirds (64%) of the adults reported having good-oral health. One-third reported having had pain or other discomfort related to teeth and dentures during the previous year (Koponen et al 2017). In 2000, 68% of the women and 60% of the men felt that their oral health was good and in 2011 the corresponding figures were 79% and 71% (Suominen-Taipale L et al. 2008) indicating no major improvement in people's subjective assessments during the last 20 years.

Socioeconomic inequalities in oral health have been a permanent phenomenon in Finland (Bøge Christensen et al. 2021). Edentulousness has been more frequent and dentate persons have had fewer teeth in the less well-off northern and eastern Finland, than in the wealthier parts of the country. Since the 1980s, improvement in oral health has been most significant among those with the highest education and income. However, from 2000 to 2011, among adults, the need for restorative dental treatment decreased and the education-related inequality decreased in it (Raittio et al. 2018).

A recent study showed that erosive tooth wear is common among middle-aged adults. Almost half of the persons examined had erosive wear that required at least preventive measures. Severe tooth wear was found among 10% of the subjects (Alaraudanjoki 2018).

To sum up, studies on adults during the last decades have pointed out that periodontal diseases are common among them. The special concern is the abundant occurrence of

periodontal diseases in the early middle age, among the 30–44-year-olds. The other significant and frequent finding has been the absence of one or several teeth without prosthetic replacement, even in highly visible areas in the mouth.

When compared with the other Nordic countries, it can be stated that edentulousness is most frequent in Finland (Widström et al. 2015b). Use of removable dentures is much more common in Finland than in Sweden where fixed prosthetic constructions seem to be the first choice in prosthetic treatment (Lundegren 2012). Danish and Swedish adults also have better periodontal health and fewer carious teeth than Finnish adults (Holt 2013, Hugoson et al. 2005).

Tooth brushing habits

In 2002, 41% of the 11–15-year-olds claimed to brush their teeth more than once a day. In 2006, the corresponding proportion was 46% and in 2010 it was 56%. Girls' brushing frequency has always been higher than boys' (Honkala et al. 2015). In 2013, 66% of the 11-year-old girls and 53% of boys brushed their teeth more than once a day. The corresponding proportions for the 13-year-olds were 73% / 45% and for the 15-year-olds 74% girls and 45% boys. When 20 countries were compared, the proportions of Finnish children were at the bottom end of the list (Inchley et al. 2016). In 2000, of the dentate adults, 45% of men and 76% of women said they brushed their teeth at least twice a day. In 2011, 53% of men and 81 % of women and in 2017 53% of men and 83% of women claimed to do so (Vehkalahti et al.1991, Suominen-Taipale et al. 2008, Koskinen et al. 2012).

Use of dental services

The PDS has collected information on numbers of patients since 1972 when the present oral health care provision system was introduced. In the early years, the recommendation was to call all age groups of children and adolescents entitled to care in the PDS for examination annually (the youngest children were seen by child welfare clinics). In the 1990s, 55-88% of the 3 to 18-year-olds were annually examined in the PDS units throughout the country before individualized and in practice longer (18 to 24 months) recall intervals were recommended for the young in 1998 (Lahti et al. 2001). According to statistical data, 82.0% of those younger than 18 years had been seen in the PDS in 2001, 67.0% in 2013 and 66.0% in 2019 (SOTKA, 2022). According to a special survey, 75.0% of all the young (<18 years) had made dental visits in 2008; of them two-thirds (57.4%) had made annual visits during a three year period in 2006 – 2008, a third (32.2%) had had visits in two of the three years and 10.4 % only in one year. Almost all visits (98.0%) had been to the PDS (Widström et al. 2013).

According to a nationally representative questionnaire study in 2000, 55% of adults (≥ 30 years) claimed that they had visited a dentist during the previous 12 months and 69% during the previous 24 months. Dental visits were most common among dentate 55–64 year olds: 76% of women and 63% of men having had visits during the previous year. Overall, women and persons with high level of education or income, used dental services more often than men and persons with low education and income. Subjects living in eastern or northern Finland reported such use less frequently than did those living in other parts of the country. Of persons wearing full dentures, 6% told to have their dentures checked once a year, 25% once in five years, and 69% less frequently or never (Suominen-Taipale 2008).

A national register study revealed that 64.3% of the young (<18 years) and 47.7% of the adults (18+ years) had had dental visits in 2009. The PDS had seen almost all (98.6%) of the young who had had dental visits that year (690,462). The rest had visited private dentists (9,860). Almost the same numbers of adults had visited the public (1,010,296 persons) and the private sectors (1.030.858 persons) (Widström and Linden 2018; Figure 1).

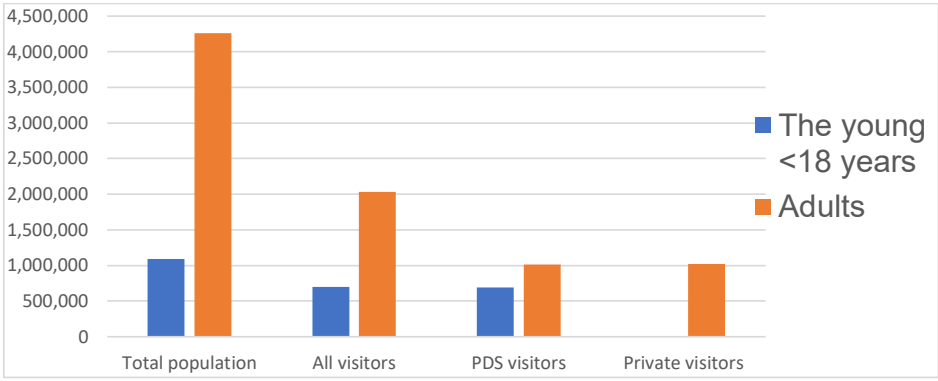

Figure 1. Number of the total population numbers of all dental visitors, visitors to the PDS and visitors to the Private sector, by the young (<18 years) and adult (18+ years) in 2009.

Relatively small changes in the overall use of dental services occurred between 2000 and 2011 (Suominen et al. 2017). Older people claimed to have increased their use of public and private sector dental services indicating decreased edentulousness and increased treatment needs. Visiting public dental services had increased among adults born before 1956 who had not been entitled to use the PDS before the Oral Health Care Reform in 2001 - 2002. In the private sector, use of services had decreased among younger adults. Being a regular dental visitor was the most significant reason for having had a dental visit during the previous year (Suominen et al. 2017).

Statistical information about adult visitors to the PDS and those private sector visitors who had been eligible for partial reimbursement of treatment from the National Social Insurance Institution (SII) has been collected since 2003. In 2008, 26.0% of all adults had visited the PDS and 19.7% the private sector. In 2019, 26.7% had visited the PDS and 16.4% the private sector (SOTKA 2022).

A longitudinal register study considering the years 2006 - 2008 showed that 57.3% of the working aged (18 – 64 years) and 69.1% of the older (65+) dental attenders were annual visitors in the private sector. A third (27.1%) of the 18-64 year olds and 19.8% of the elderly had attended in two of the three years. Visiting in one year only was unusual in the private sector; slightly more than 10% belonged to this group. In the PDS, annual attendance was uncommon (31.9%), and adult visitors were fairly evenly distributed over the three categories, visiting in one, two or all three years. Annual or biannual visits seemed to be the norm among children in the PDS and adults in the private sector. Adults in the PDS showed irregular attendance patterns probably partly due to scarcity of resources for patient recall in the PDS (Widström et al. 2013) Traditionally, the private sector has provided frequent care and used recall appointments, whereas the public sector has provided adults with more emergency services and has had long waiting lists for non-emergency care. The PDS has

not recalled adults. Danish, Norwegian and Swedish adults are more frequent dental visitors than the Finnish ones (Widström et al. 2015b).

A newer indicator of service utilization is measuring unmet health care needs. In 2019, 5.5% of Finnish adults (>16 years) reported unmet needs for dental examinations and treatment because of high prices, long distances and especially long waiting lists. That figure was high compared with other European countries (Eurostat 2021).

Earlier studies on treatment provided

In 1981, 88% of the 2–6-year-old children had at least one dental visit. Almost all of them (98%) were examined. Restorations were provided for 23% of the visitors and the number of restorations provided was 2.7 per child. Of the 7–16-year-olds. 95% had visited the PDS and 97% of them were examined. Most 7-16-year-old children (79%) were given advice on oral selfcare, 30% received at least one fluoride warnish treatment and 15% received sealants. Every fourth child received periodontal care. At least one filling was made to 56% and the number of restorations provided was 1.7 restorations per child. Only 2% of the young (<18 years) had had endodontic care. Also radiology was uncommon (Milen 1986).

In the nationally representative epidemiological study in 2000, the participating, adults (30+ years) were asked about treatment measures they had received during the most recent treatment course. The most common treatments reported by dentate subjects were clinical examinations (88%), removal of calculus (70%), and fillings (66%). Few respondents reported guidance on tooth brushing (7%) or use of fluoride (3%) or dietary counselling (2%). The 30–44 year olds reported radiographs (40%) and fluoride varnishes (47%) more often than the older respondents (27% and 23%, respectively).

A greater proportion of private patients reported examinations (91% vs. 85%), removal of calculus (75% vs. 61%), and fluoride treatments (39% vs. 33%) than the public sector patients. The latter reported more often radiographs (39% vs. 33%), extractions (13% vs. 9%) and endodontic treatments (15% vs. 12%) than the private sector patients (Suominen-Taipale 2008).

In 2004-2009 Nihtilä el al. investigated treatment provided to adult heavy and low users of dental services in a large PDS unit in southern Finland. The study showed that during the five-year follow-up period restorative treatment was the most usual treatment provided to 88.8% of the heavy and 79.6% of the low users. Two-thirds (67.0%) of all study subjects had been examined at least once and 46.0% twice. About half of the heavy users (49.6%) and 45.7% of the low users had had preventive treatment measures, most often by dental hygienists. Prosthetic treatment was rare. Typical for adult's heavy use of oral health services was a cycle of repetitive repair or replacement of restorations, often as emergency treatment, a lack of proper examinations and preventive care. The authors concluded that immediately after the major Dental Reform that the quality of care of the new adult patients was not good (Nihtilä et al. 2016).

A national register study in 2009 showed that the PDS provided 8,885,271 million treatment measures and the private sector 5,152,072 million treatment measures in 2009 (Widström and Linden 2018). About half (4,725,047; 53.2%) of all treatment measures in the PDS were provided for working aged adults, more than third (3,248,468; 36.6%) for children and one tenth (911,756; 10.2%) for the elderly. In the private sector, more than three quarters

(3,948,661; 76.6%) of treatment measures were provided for the working aged, more than every fifth (1,173,026; 22.7%) for elderly and very few (30,385; 0.7%) for children.

The most common treatment categories for the working aged adults were, in the public sector, examinations (including complementary examinations and radiographs), 1,601 per 1,000 patients and fillings therapy 1,457 per 1,000 patients. The private sector produced more restorative treatment, 1,743 per 1,000 patients, and fewer examinations, 1,003 per 1,000 patients. For the elderly, the most common treatment measures were the same, fewer examinations, 1,532 per 1,000 patients and the same number of restorative treatment, 1,561 per 1,000 patients in the PDS. In the private sector, restorative treatment was even more common for the elderly, 2,004 per 1,000 patients, whereas examinations were almost as frequent as for the younger adults (1,009 per 1,000 patients).

As regards the working aged, the private sector produced almost twice as many periodontal treatment measures and clearly more preventive measures and restorative treatment than the public sector. Among the elderly, periodontal treatment measures were also almost twice as usual and preventive measures, endodontic treatment and restorative treatment slightly more common in the private sector than in the public sector where oral surgery and examinations were more usual than in the private sector.

Compared with the national epidemiological study in 2000, the results indicate that examinations continued to be frequent, restorative treatment had decreased and radiology had increased (Suominen-Taipale 2008).

Due to a long reimbursement history of adults´ private dental care, the social insurance system Denmark has collected statistical information on treatment measures provided for adults for several decades. In 1990, adults had 1,494 and in 2010, 1391 examinations per 1,000 patients. The corresponding numbers of periodontal treatment measures were 1,255 in 1990 and 1,143 in 2010 and the numbers of fillings were 1,320/1,030. The numbers of extractions were low, 165 in 1990 and 172 in 2010 per 1,000 patients. The falling numbers of treatment measures reflect improvements in oral health, especially in the younger age groups. In 2008, a 70 year old person had had twice as many treatment measures as a 20 year old person (Holt 2013).

In 2008, Sweden introduced a dental health care register: the Swedish Quality Registry for Caries and Periodontal Diseases (SKaPa). The register collects information on oral diseases, treatment provided and other dentistry related matters by automatic transfer of data from electronic patient records from affiliated public and private dental care organisations. In 2018, the register covered 6.9 million persons out of the total population of 10 million. SKaPa produces reports on de-identified data, both cross-sectional and longitudinal (von Bültzingslöwen et al. 2019).

In 2018, examinations made up 45%, preventive treatment 13%, treatment of oral diseases 19%, restorative treatment 15% and prosthetics 2% of all treatment measures provided for children and adults. The number of examinations, 1,453 per 1,000 patients in 2018 had increased from 1,111 in 2011. The numbers of preventive treatment measures (392/352), endodontics (38/47) and prosthetics (69/86) had not changed much but the number of restorative treatments had decreased (492/709) (SKAPA 2019).

Guiney et al. investigated whether increased tooth retention and decreases in caries were reflected in the volume and types of treatment provided to adults within a public social insurance scheme in Ireland between 1997 and 2008. They found that provision of

restorations, extractions, and dentures decreased and preventive and diagnostic treatments per dentist increased, which supports reported improvements in oral health (Guiney et al. 2013)

Challenges in oral health care

The frame of equal social welfare and public health services for the Finnish population was set in the Health Care Act of 1972 (Finnish Ministry of Social Affairs and Health 1972). However, dental care was an exception in 30 years. It was made available in the first place only for children and, later, for younger adults. Among children and adolescents socioeconomic and regional equity was reached in the 1980s. Among adults, income related inequity in the use of dental services was quite common as recently as the in late 1990s due to the age limits regarding access to the PDS and subsidized care with SSI in the private sector (Nguyen and Häkkinen 2004). The local municipalities, having strong autonomy and being responsible for financing the public services (with government subsidy), felt free to determine their supply of public dental services according to the size of the local private sector. Thus, there were differences in access to the PDS between municipalities and regions. There were also big differences in efficiency between the PDS units (Widström et al. 2004b). After the age restrictions were abolished in 2001-2002 the overall use of dental services increased slightly from 2000 to 2011. Older adults increased and younger adults decreased their utilization. Visiting the PDS increased especially among those who became entitled to subsidized care in 2000. However, being a regular visitor was the most significant determinant for having visited a dentist during the previous year. Recall, costs of care and socioeconomic factors continued to steer choices between the public and private sectors sustaining inequity in access to care (Suominen et al. 2017). Between 2013 and 2017, the subsidy of private (basic) services was cut from 32.1% to 15.4% (Linden and Nolvi 2019). Furthermore, the, for a longer period quite moderate, patient fees in the public sector were raised by 30% in 2016 (Finnish Ministry of Social Affairs and Health 2017). Currently, there are long waiting lists to the PDS and shortage of patients in the private sector.

At present dental care personnel is challenged by the major health care reform that will transfer the organization of health care (including dental care) and social services from a high number of local municipalities to a lower number of Welfare districts in 2023. All social and healthcare personnel will have a new employer and it is possible that existing PDS units inside the new districts will be closed or merged, and the personnel will need to be moved around (Mikkola 2020). This causes stress and increases the working load for the dental personnel. The latest complication is the coronavirus pandemic that started in March 2020. A lot of visits were cancelled or moved to a later occasion either by the care providers or the patients. This may have long-term public health consequencies (Kestilä 2020). To sum up, the developments during recent years have not been favourable for oral health.

AIMS OF THE STUDY

The general aims of this thesis were to survey performance of the Finnish oral health care provision system and quality of dental care in the public sector after the major Dental Care Reform in 2001-2002 giving all adults access to the PDS or subsidized services in the private sector. Special emphasis was on targeting and contents of treatments provided. The volume and coverage of care were also studied. The findings were to be compared with oral health and treatment needs from national epidemiological surveys.

The specific aims were:
Paper I: To survey treatment needs and treatment measures provided in the PDS for children and adolescents under 18 years of age and changes in them during a 13-year period from 2001 to 2013.

Paper II: To survey treatment needs and treatment measures provided for adults in the PDS and changes in them from 2001 to 2013.

Paper III: To investigate dental visiting patterns and examination intervals in the PDS during a 13-year period from 2001 to 2013 and the relationship between examinations and treatment needs, and how examination intervals accorded with recommendations in other countries.

Paper IV: To compare treatment measures provided on children and adults in the PDS at national level in 2009. A further aim was to discuss the service profiles of adult patients against findings from national clinical studies on oral health and treatment needs and other relevant surveys.

MATERIALS AND METHODS

Data collection

Papers I - III

Five PDS units in southern Finland using a specific electronic patient registration system (WinHit, In Net OY; www.winhit.fi) were asked to participate in a longitudinal retrospective register study. In 2001, the number of inhabitants in these PDS units' catchment areas was 271,301 and in 2013, 320,055 (+15.2 %) persons.

Using personal unique identifiers, information on the patients (n = 295,521), their dental visits (n = 3,281,300), examinations (n = 702,662) and all other treatment measures provided by dentists, dental hygienists and dental nurses in the years 2001–2013 were retrospectively collected from the municipal databases. Individual sequence numbers were created to replace the personal identifiers. For each year, the numbers of all patients that had at least one visit to the PDS during that year, those who had visited and been examined and among the examined, those in need of (basic) periodontal or caries treatment (CPI > 2, D + d > 0) were calculated (WHO 2013). Each individual's visits and examinations were separately grouped by year and the time (in years) between visiting years and examination years was counted. All these numbers were counted separately for the young (< 18 years), the working-age adults (18–64 years) and the elderly (65+ years).

Paper IV

Register data on patients and treatment provided in the PDS in 2009 could be collected from 166 municipal databases (86%). The material included all persons that visited those PDS units that year.

Methods

Papers I - III

For analysis the children and adolescents were in Paper I grouped into three age categories: 0-6, 7-13 and 14-17 years. In Paper II the age groups used were 18-39, 40-64 and 65+ years and in Paper III 0-17, 18-64 and 65+ years. The items of treatment provided were classified into 13 main treatment areas: clinical examinations including complementary examinations (laboratory tests etc.), preventive care (instruction about oral hygiene, dietary advice, fluoride varnish, fissure sealants etc.), periodontics, restorative care (permanent and temporary fillings, crowns made of filling material), endodontics, treatment of temporomandibular disorders (TMD), orthodontics, prosthetics, anesthesia (local anesthesia, sedatives, nitrous oxide), emergency treatment, radiology, oral surgery and other treatment (removal of sutures, local medications, certificates etc).

In papers I - II, IV the treatment measures collected were converted into treatment time (minutes, hours) using the average durations of the treatment measures as observed in a recent study in Helsinki (Tarvonen 2012).

Paper IV

In this paper the treatment measures were classified into the same main treatment areas as in the papers I – II. The data were grouped by age (0-17, 18 – 64 and 65+ years), by

geography, e.g. as Southern (including the Southern and Western parts of the country) and Northern (including the Eastern and Northern parts of Finland).

Statistical Methods

Papers I - III

Data editing, descriptive analyses and trend analyses were provided using the R 3.2 environment for statistical computing. The multi-level modelling procedures xtreg and xtlogit were provided using Stata (StataCorp 2013) to study the differences in the odds of being examined or being in need of treatment between age groups. Multi-level modelling was also used to study the differences in examination intervals between the age groups.

To study possible trends in treatment need, in the interaction between treatment need and preventive treatment provided and in the various treatment categories, the log-volumes of categories were modelled as linear over time, allowing for correlated residuals (Chandler and Scott 2011). Statistical significance was tested at the level of $p<0.05$.

Paper IV

In this paper data were processed using the SAS 9.3 software. Treatment patterns were compared between age groups and geographical areas. Chi-square tests with Bonferroni correction compared groups for multiple comparisons.

The approval to collect the data from the PDS units (Papers I - IV) was provided by the National Institute for Health and Welfare (THL 1697284289204448) and permission to use the local data in papers I - III by the directors of health services in each of the five PDS units.

RESULTS

Use of dental services and visiting patterns

Papers I - III
From 2001 to 2013, the number of visitors to the five PDS units participating in the longitudinal study increased by 39.3% from 77,059 to 107,352 persons (Figure 1).

Figure 2. Numbers of visitors to the five PDS units by age category and in total in 2001 - 2013.

Among the PDS-visitors, the proportion of the working aged increased by 55.5%, from 35,223 to 54,779 patients and that of the elderly by 506.1% from 2,154 to 13,056 patients. The number of the young patients was stable throughout the study (Figure 1). In 2001, the young made up 51.5%, the working aged 45.7% and the elderly 2.8% of the visitors. In 2013, the corresponding shares were 36.8%, 51.0% and 12.2%.

Paper IV
In 2009 there were totally 1 704 226 patients in the PDS in Finland. The young made up nationally 40.5%, the working-aged 49.4% and the elderly 10.1%.

Examinations

Paper III

The numbers and proportions of persons examined in the five PDS units participating in the longitudinal study fluctuated during the study period. Of all visitors during the 13 years, 80.7% had had at least one examination. Almost all, 96.6% of the young, 71.2% of the working aged, and 63.2% of the elderly had been examined (Figure 3).

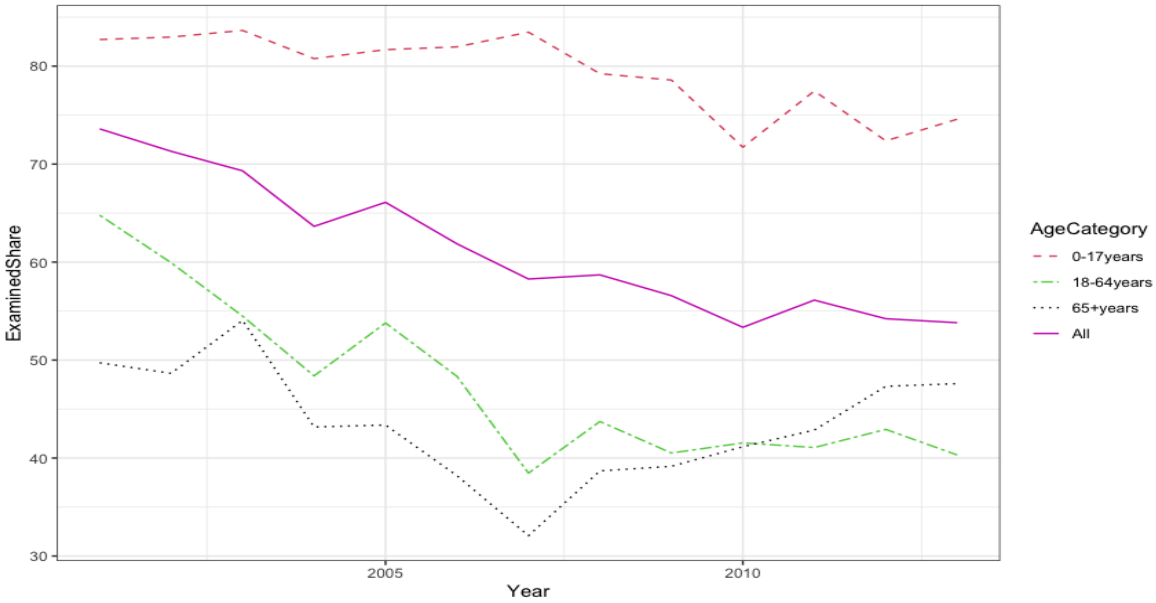

Figure 3. Proportion (%) of visitors to the five PDS -units who had had an oral examination during the study period in 2001-2003 by age group and study year.

Table 1. Trend analysis on the number of patients, those examined, and those in need of treatment. Furthermore, on the interval between two examinations and between two years with dental visits; separately for the three age categories (0–17 years, 18–64 years and 65+ years) in the five PDS units. (For the three separate age groups only statistically significant findings are presented).

	AgeCategory	mu	sd	t	p	phi
Number of patients	0-17years	0.001	0.003	0.535	0.604	-0.385
Number of patients	18-64years	0.042	0.004	9.598	<0.001***	0.246
Number of patients	65+years	0.153	0.032	4.821	<0.001***	1.000
Number of examined patients	0-17years	-0.011	0.002	-4.838	<0.001***	0.021
Number of examined patients	18-64years	-0.038	0.011	-3.345	0.007**	0.568
Number of examined patients	65+years	-0.004	0.035	-0.105	0.918	1.000
Number of those examined in need of treatment	0-17years	-0.036	0.015	-2.470	0.031*	0.762
Number of those examined in need of treatment	18-64years	-0.008	0.012	-0.696	0.500	0.256
Number of those examined in need of treatment	65+years	0.127	0.013	9.955	<0.001***	0.174
Time to prevention vs. treatment need						
No treatment need	0-17years	0.090	0.053	1.682	0.121	1.000
No treatment need	18-64years	0.042	0.100	0.415	0.686	1.000
No treatment need	65+years	0.056	0.050	1.139	0.279	0.594
In need of treatment	0-17years	0.109	0.116	0.935	0.370	1.000
In need of treatment	18-64years	0.001	0.135	0.005	0.996	0.967
In need of treatment	65+years	-0.089	0.154	-0.578	0.575	1.000
Examination interval	0-17years	0.038	0.022	1.719	0.116	1.000
Examination interval	18-64years	0.069	0.035	1.954	0.079	1.000
Examination interval	65+years	0.025	0.015	1.643	0.131	1.000
Visiting interval	0-17years	0.032	0.018	1.779	0.106	1.000
Visiting interval	18-64years	0.056	0.021	2.723	0.021*	1.000
Visiting interval	65+years	0.038	0.011	3.520	0.006*	1.000

mu proportional change (log) per year
sd Root Mean Square Error (RMSE), the standard deviation of the residuals (prediction errors)
t the t test statistic for null hypothesis of zero proportional change
p statistical significance
Phi correlation coefficient measures the strength of association between two variables

Trend analysis (Table 1) showed that the numbers of 18–64-year-old (p<0.001***) and 65+ year-old (p<0.001***) patients increased statistically significantly. The numbers of examined decreased in all age groups, the trend was statistically significant among the 18-64 year-old (p<0.001***) and the 65+ year-old (p<0.001***) patients. The number of patients needing treatment decreased among the <18 years (p=0.031**) and among the 65+ year-olds (p<0.001***). However, their share of those examined did not increase (Table1; Figure 4).

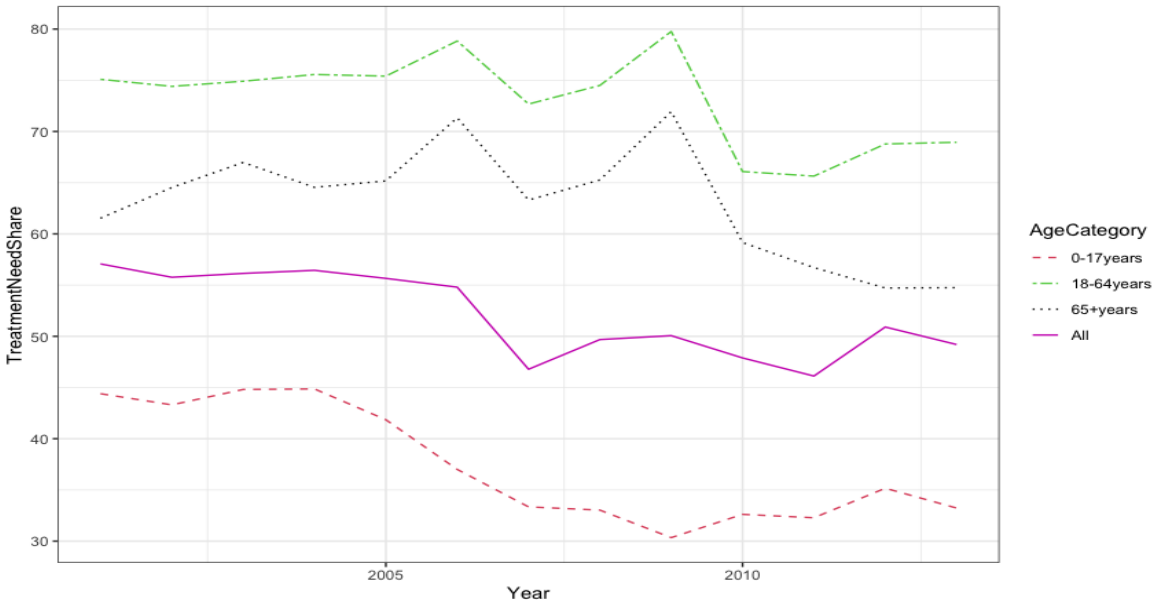

Figure 4. The shares of the visitors (%) in need of treatment of those examined in the five PDS-units by age group and study year.

A smaller number of visitors (183 children, 6,727 working aged adults and 1,805 elderly) had not been examined although they had visited the PDS in at least three separate years (Paper I).

The cross-sectional study (Paper IV) in 2009 showed that the young (<18 years) was the age group with most examinations (1,265 examinations per 1000 visitors). The working age adults (18-64 years years) had 1,142 and the elderly had 1,175 examinations per 1000 visitors.

Examination intervals

Paper III
Most examination intervals in the young (65.2%) and elderly (77.0%) were 1 year or less. However, only half (49.5%) of the examination intervals in the 18 – 64 year olds were so short. For them, examination intervals of three or more years were not unusual (21.2%) (Figure 5). Examination and visiting intervals increased during study years 2001-2013 in all age groups and among 18–64-year-olds (p=0.02*) and 65+ year-olds (p=0.005**) the change was statistically significant (Table 1; Figure 5).

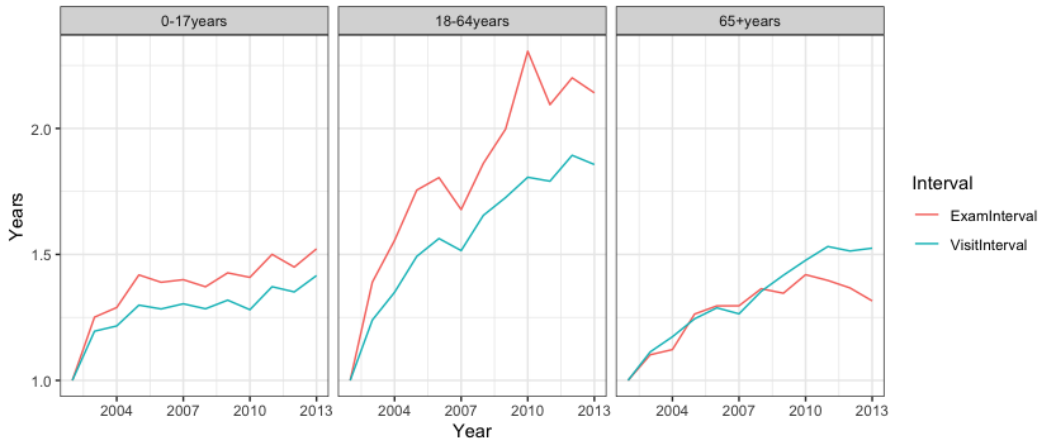

Figure 5. Mean examination and visiting intervals in the five PDS units during the study period in 2002-2013 by age group.

Treatment provided

Papers I, II

Altogether 2,488,805 treatment measures were provided for the young and 4,099,050 treatment measures for the adults during the 13-year study period in the five PDS units. Examinations (613,753; 24.7%), orthodontics (499,033; 20.1%), preventive measures (372,473, 15.0%), restorative treatment (355,325; 14.3%) and anaesthesia (199,974; 8.0%) made up 82.0% of all treatment measures for the young during the entire study period (Figure 6). For adults, the five most frequent treatment measures were restorative treatment (968,772; 23.6%), examinations (658,394; 16.1%), radiology (529,875; 12.9%) anaesthesia (521,169; 12.7%) and emergency treatment (348,229; 8.5%). They made up 73.8% of all treatment measures provided (Figure 6, Figure 7).

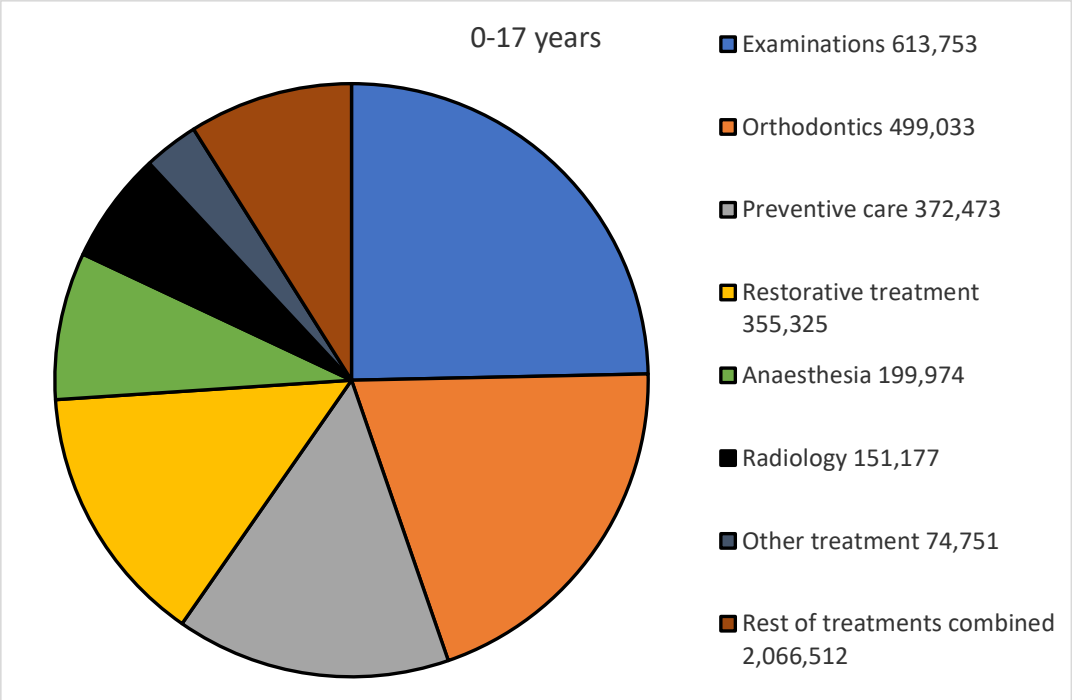

Figure 6. Treatment profile of children and adolescents <18 years old in the five PDS units. All treatment measures provided during the study period in 2001-2013.

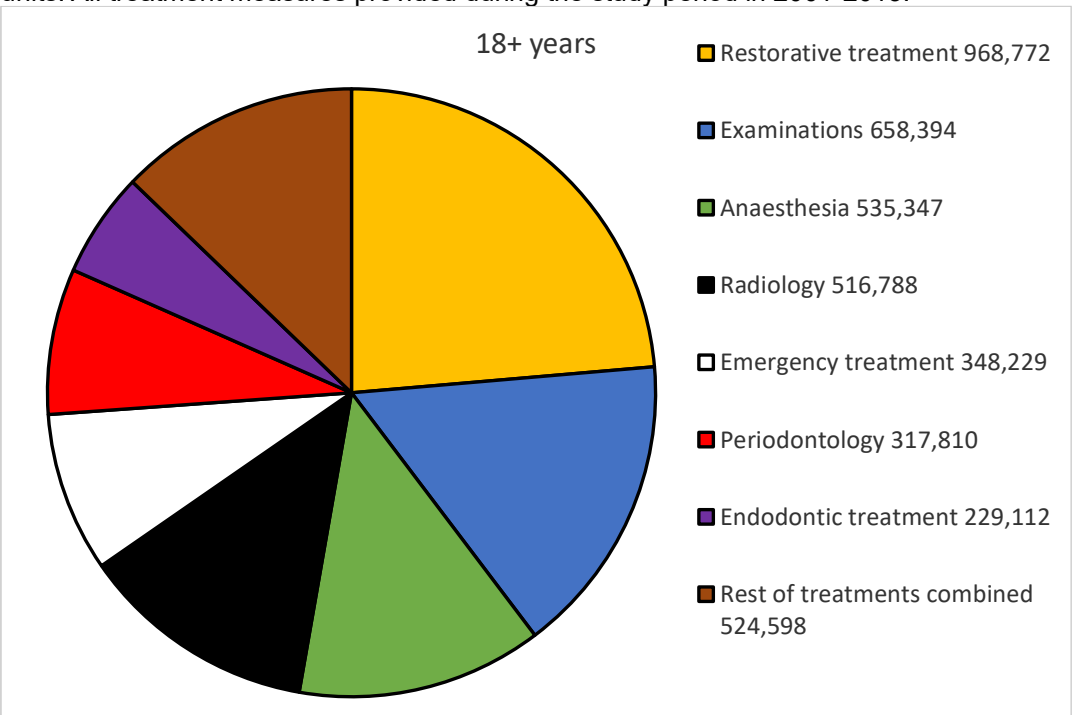

Figure 7. Treatment profile of adult patients (18+ years) in the five PDS units. All treatment measures were provided during the study period 2001-2013.

Periodontal treatment (7.8%), prevention (3.9%) and endodontic (5.3%) made up a small part of the adult care provided and prosthetics, treatment of TMD disorders and orthodontics were extremely uncommon (less than 1%).

Paper I

The total number of treatment measures per 1,000 patients provided for the young (0-17 years) in the five PDS units increased by 16.8% from 4,560 in 2001 to 5,347 in 2013. Examinations increased by 14.3% from 1,151 to 1,322, orthodontics by 16.9% from 944 to 1,109, preventive measures by 67.9% from 485 to 818, anesthesia by 47.7% from 297 to 440 respectively and restorative treatment decreased by -57.4% from 1,001 to 486 treatments per thousand patients (Figure 8).

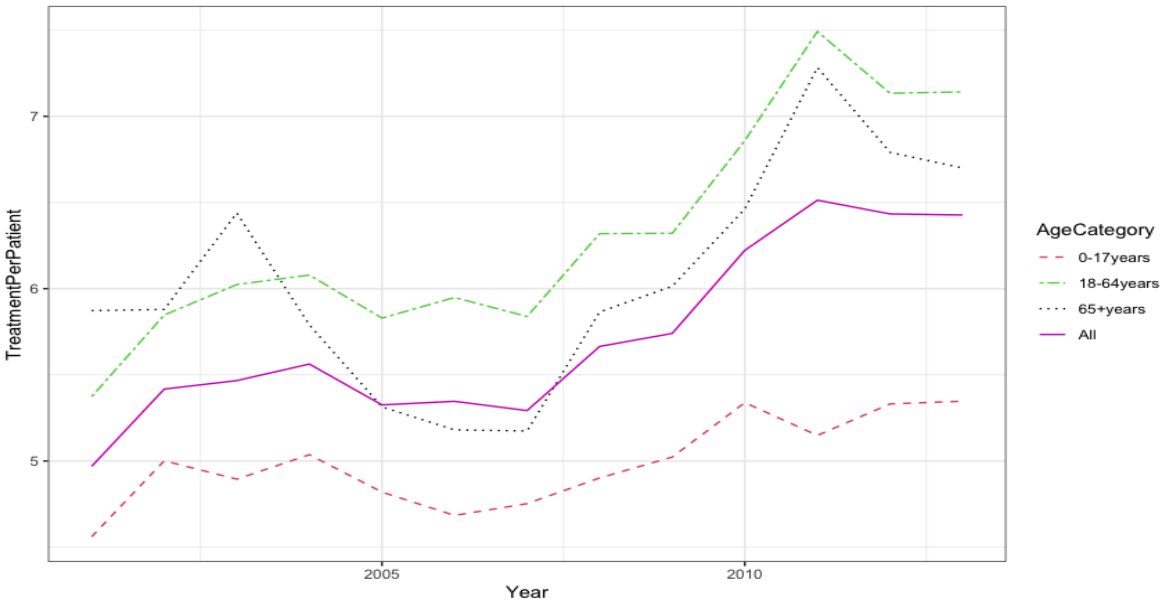

Figure 8. All treatment measures per 1,000 patients.

During the whole study period, 30.2% of children received orthodontic treatment, early and late orthodontic care included.

In the trend analysis, there was an increasing trend (p=0.028*) in total annual treatment measures per patient (Table 2). The increasing trends (Table 2) in examinations and anaesthesia and the total number of treatment measures, as well as the decreasing trend in restorative treatment were statistically highly significant (p<0.001***) for all the young.

Table 2. Trend analysis on the number of treatment measures per patient in each treatment category provided separately for the three age categories (0–17 years, 18–64 years and 65+ years) in the five PDS units. For the three age groups only statistically significant categories are presented.

	AgeCategory	mu	sd	t	p	phi
All treatment measures	0-17years	0.011	0.004	2.523	0.028*	0.552
All treatment measures	18-64years	0.023	0.006	3.868	0.002**	0.621
Anaesthesia	0-17years	0.032	0.007	4.638	<0.001***	0.375
Anaesthesia	18-64years	0.033	0.006	5.823	<0.001***	0.516
Examinations	0-17years	0.012	0.002	5.129	<0.001***	0.263
Oral surgery	18-64years	0.037	0.009	4.257	0.001**	0.788
Other treatment	18-64years	0.175	0.014	12.587	<0.001***	0.005
Other treatment	65+years	0.183	0.024	7.765	8<0.001***	0.183
Preventive care	18-64years	-0.065	0.023	-2.833	0.016*	0.639
Preventive care	65+years	-0.074	0.017	-3.949	0.002**	0.612
Radiology	18-64years	0.045	0.005	9.967	<0.001***	-0.094
Radiology	65+years	0.070	0.012	5.570	1<0.001***	0.320
Restorative treatment	0-17years	-0.056	0.010	-5.348	<0.001***	0.672
Treatment of temporomadibular disorders	18-64years	0.051	0.006	8.129	<0.001***	0.357
Treatment of temporomadibular disorders	65+years	0.082	0.008	9.924	<0.001***	-0.355

Paper II

The total number of treatment measures per 1,000 patients provided for adults in the five PDS units increased by 32.9% from 5,373 to 7,142 among 18–64-year-olds and by 14.1% from 5,872 to 6,700 among 65+ year-olds (Figure 8). Restorative treatment decreased by -7.7% from 1,517 to 1,400 among 18–64-year-olds and by -1.8% from 1,575 to 1,548 among 65+ year-olds, preventive care by -51.8% from 292 to 141 among 18–64-year-olds and by -60.3% from 659 to 262 among 65+ year-olds and prosthetics by -49.0% from 73 to 37 among 18–64-year-olds and by -61.3% from 355 to 138 among 65+ year-olds respectively. Examinations increased by 27.0% from 921 to 1,169 among 18-64 year-olds and by 42.6% from 865 to 1,233 among 65+ year-olds, radiology by 98.0% from 560 to 1,110 among 18-64 year-olds and by 144.1% from 336 to 821 among 65+ year-olds, anaesthesia by 47.1% from 694 to 1,021 among 18-64 year-olds and by 17.4% from 505 to 592 among 65+ year-olds, emergency treatment by 127.9% from 253 to 577 among 18-64 year-olds and by 54.2 % from 340 to 525 among 65+ year-olds, periodontology by 5.65% from 495 to 523 among 18-64 year-olds and by 27.2 % from 468 to 594 among 65+ year-olds and endodontics by 55.6% from 255 to 397 among 18-64 year-olds and fluctuated between 192 and 286 treatments per 1,000 patients among 65+ year-olds.

A statistically significant increasing trend was found in all age groups ~~in~~ regarding other treatment and radiology and regarding treatment of temporomandibular disorders in f~~or~~ the adult age groups (p< 0.001***) through the years. There was also an increasing trend in anaesthesia among the 18–64-year-olds (p<0.001***) and in oral surgery among the 18–64-year-olds (p=0.001**). There was a decreasing trend in preventive care among the 18–64-year-olds (p=0.016*) and among the 65+ year olds (p=0.002**).

Paper IV

The cross-sectional study (Paper IV) in 2009 revealed 8.9 million treatment measures provided on 1.7 million patients. The most common treatment categories were examinations (including radiography), restorative treatments and anaesthesia, making up 61.3% of all treatment measures. Preventive measures (8.4%) and periodontal treatments (6.3%) were less common. Treatment of TMJ disorders and prosthetics were extremely rare in all age categories.

For 1,000 young patients (<18 years) the most common treatment categories were 1,267 examinations, 1,007 orthodontic and 792 preventive and 554 restorative treatments. For the working aged (18-64 years) there were 1,457 restorative, 1,142 examinations and 830 anaesthesia treatments. For the elderly (65+ years) there were 1,561 restorative, 1,142 examinations and 545 periodontal treatments (Table 3, Figure 9).

Table 3. Numbers of treatment measures in 2009 per 1000 treated patients by age group and for each treatment category in the PDS in Finland.

Treatment category	0-17 years	18-64 years	65+ years
Examinations	1,265	1,142	1,175
Restorative treatment	554	1,457	1,561
Anaesthesia	333	830	482
Preventive care	792	193	218
Orthodontics	1,007	24	< 1
Periodontics	130	455	545
Radiology	134	473	357
Oral surgery	166	327	417
Endodontics	45	328	196
Certificates	140	210	199
Other treatment	126	139	137
Treatment of TMJ disorders	13	36	16
Prosthetics	< 1	27	102
All treatments	4,705	5,630	5,405

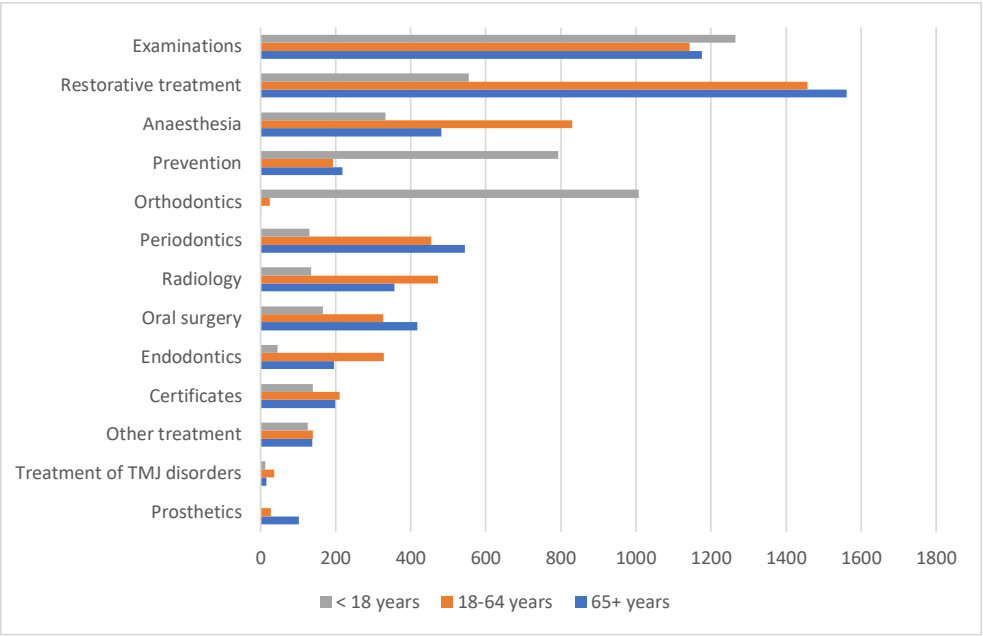

Figure 9. Distribution of the treatment provided by age group and treatment category in 2009 per 1,000 treated patients in the PDS in Finland.

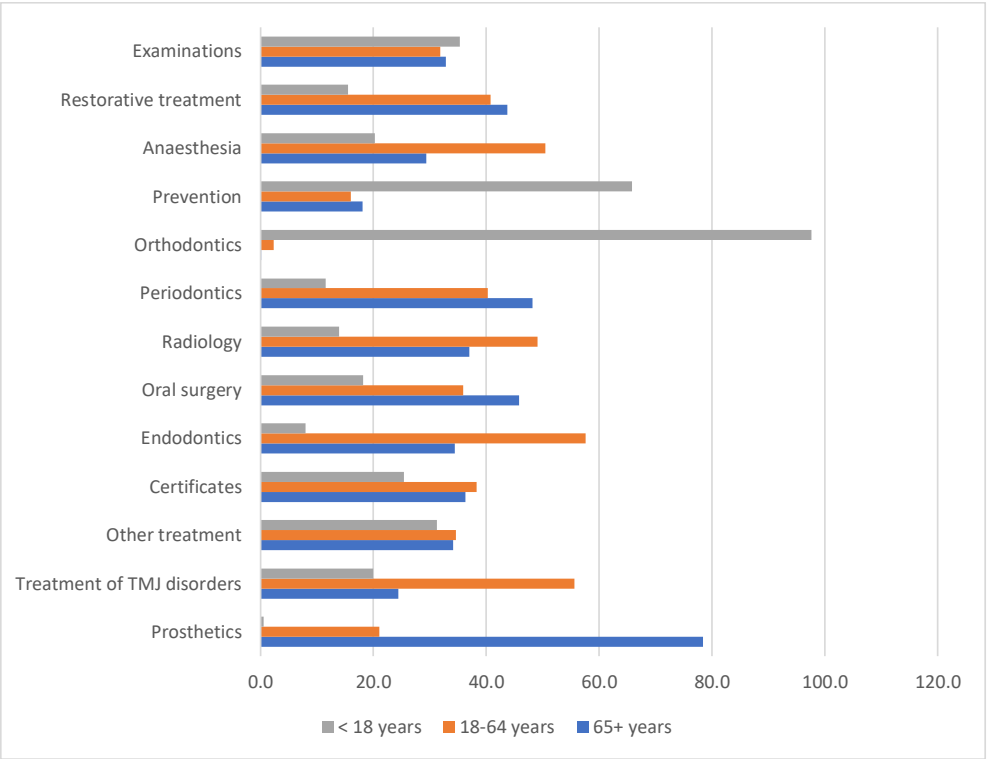

Figure 10. Percentages of treatment measures by patient age group in 2009 per 1,000 treated patients and for each of the main treatment categories in the PDS in Finland.

Majority of the Finnish population lives in the south, consequently 77.9% of the treatment measures provided for the young and 78.3% for the working aged were carried out in the densly populated areas. The treatment profiles were similar in both regions studied. Among the elderly, fewer restorative, anaesthesia and radiology treatment measures were provided in the North than in the South.

A fifth (18.2%) of all treatment measures were provided by dental hygienists or dental assistants: a third (29.7%) of all on children and adolescents, 11.1% on working aged and 14.1% on the elderly. Dental auxiliaries had provided 77.3% of the preventive, 63.4% of the periodontal, 19.6% of the examinations and 13.6% of the orthodontic treatments. There were no differences between Southern and Northern regions in all the above respects.

Treatment measures converted to treatment time

Paper I
Among children and adolescents, the differences between numbers of treatments and when they were converted to treatment time, were not as extensive as among adults. The share of anaesthesia decreased from 7.4% to 2.9% and radiology from 5.6% to 1.8%. Treatments related to caries, restorative treatment (15.9%), examinations (23.2%), endodontics (1.9%) and emergency treatment (3.0%) made up 43.9% of dental personnel's treatment time. In orthodontics, the share stayed at the same level, 18.4 and 18.3 (Figure 11).

Paper II
When the treatment measures provided for adults are converted into time, the share of periodontics doubled from 7.8% to 15.2% and endodontics from 5.3% to 11.6% respectively. The share of prosthetics tripled from 0.9% to 2.7% but remained low. Radiology decreased from 12.9% to 3.2% and anesthesia from 12.7% to 4.2%. The share of restorative treatment increased from 23.6% to 28.4%, preventive treatment from 3.9% to 4.8% respectively. Treatments related to caries, restorative treatment (28.4%), examinations (12.8%), endodontics (11.6%) and emergency treatment (9.2%) made up 62.0% of dental personnel's treatment time (Figure 11).

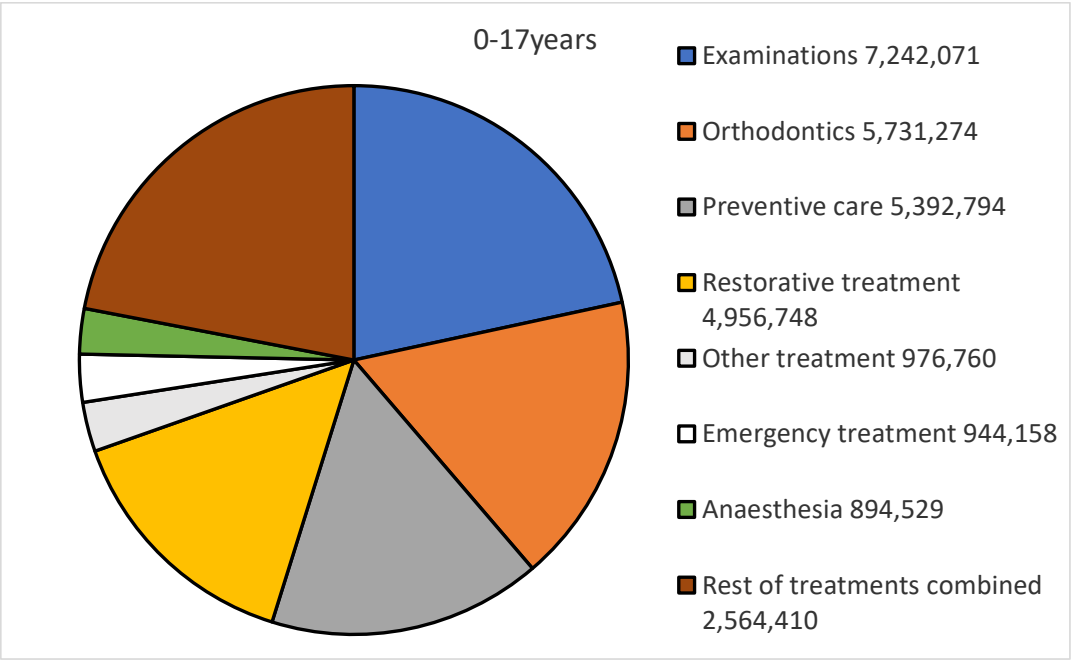

Figure 11. Treatment profile of children and adolescents (<18 years) in the five PDS units. All treatment measures provided were converted to treatment time during the study period in 2001-2013.

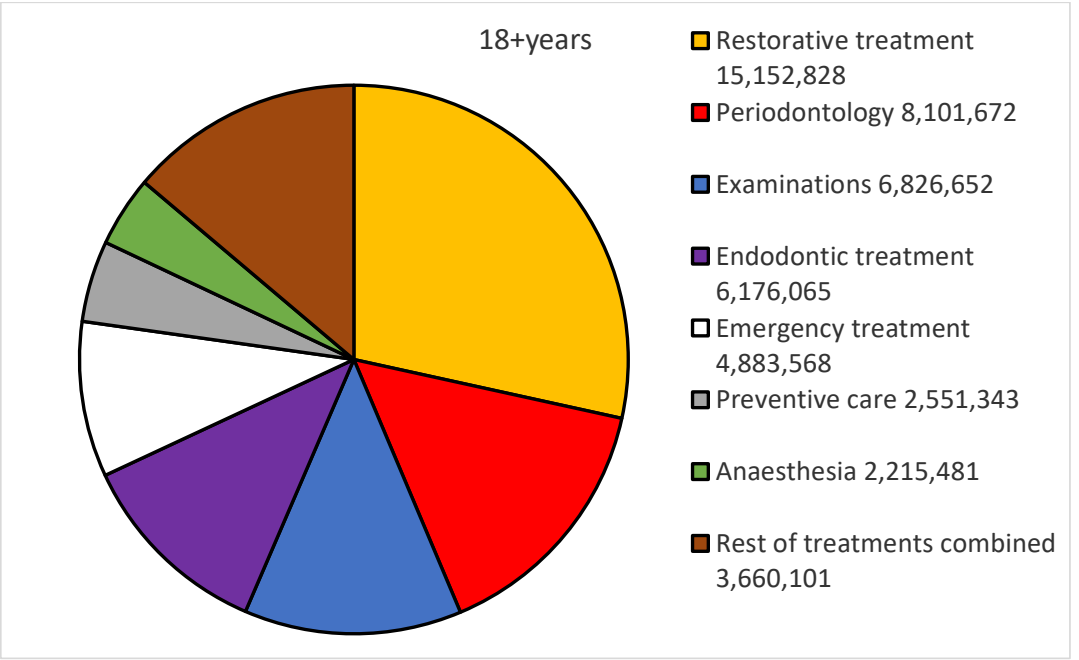

Figure 12. Treatment profile of adults (18+ years) in the five PDS units. All treatment measures provided converted to treatment time during the study period in 2001-2013.

Paper IV
In the cross-sectional study in 2009 the share of anaesthesia and complementary examinations (mostly radiology) halved when treatment measures were converted into time. The share of endodontics doubled and the share of prosthetics tripled but remained low. The shares of periodontics and restorative treatment increased slightly. Overall, there were not great changes in the treatment patterns.

Average time spent on preventive care

More time for preventive treatment per patient was used among those not in need of treatment compared with those in need of treatment.

Among children and adolescents there was a weak increasing trend from 2.5 minutes in 2001 to 7.6 minutes in 2013 (ns) among those not in need of treatment and from 1.4 minutes in 2001 to 5.2 minutes in 2013 (ns) among those in need of treatment. Among working age adults, time for prevention increased only a little, from 2.0 minutes in 2001 to 3.3 minutes in 2013 (ns) among those not in need of treatment and among those in need of treatment, the time spent fluctuated between 0.4 minutes in 2008-2009 and 2.8 minutes in 2004. Among the elderly some more time for prevention was spent on those not in need of treatment, 2.7 minutes in 2001 to 6.7 minutes in 2013 (ns) and less time for those in need of treatment from 3.1 minutes in 2001 to 1.1 minutes in 2013 (ns) (Figure 13; Table 1.). These trends were, however, not statistically significant.

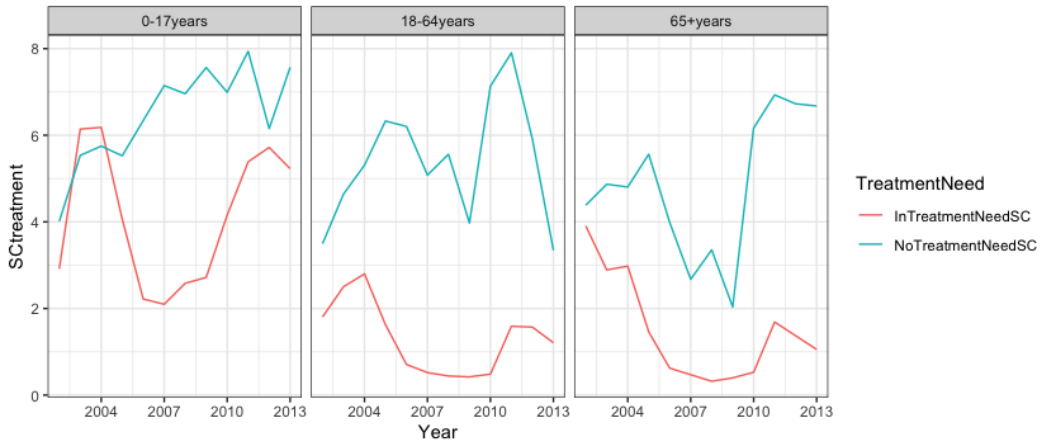

Figure 13. Average time used for preventive treatment measures (in minutes) in the five PDS units for those in need and those with no need of basic caries and periodontal treatment by age group during 2001-2013.

In the cross-sectional study the young were provided with almost four times more preventive care (792 per 1,000 patients) than the working aged (193 per 1,000 patients) and the elderly (218 per 1,000 patients).

DISCUSSION

Main findings

The main findings in this thesis were: During the 13-year study period, the number of adults who had visited the PDS increased, and the number of children and adolescents remained stable. The share of working aged (18–64 years) adults among attenders increased from 46% to 51%, the share of elderly (65+ years) from three to 12% and the share of the young (<18 years) fell from 51% to 37%. The proportions of those examined visitors declined in all age categories, among the young from 83% to 75%, among the working-aged from 65% to 40 % and among the elderly from 50% to 48%. The share of those in need of treatment among the examined decreased, among the young from 44% to 33%, among the working-aged from 76% to 69% and among the elderly from 63% to 55%. An increasing trend was detected for examination intervals; among the young and the elderly, the change was from one year to eighteen months, among the working aged from one year and three months to two years.

The clinical treatment provided for adults focused strongly on treating caries and its consequences. Examinations, restorative treatment, endodontics and emergencies made up half (53.5%) of all treatment measures and took 62.0% of the total treatment time of the staff during the whole study period.

As regards treatment provided, the main findings among the young (< 18 years) were the declining trends in restorative treatment and the increasing trends in the total numbers of treatment measures and especially examinations, orthodontics and anesthesia.

In the national study in 2009, the treatment of the PDS concentrated on examinations on all age groups, prevention and orthodontic treatment on the young and restorative treatment on adults. Periodontal treatment and prosthetics on the adults were not in line with the great treatment needs found in national epidemiological studies.

Methodological considerations

The studies in this thesis are based on materials from two populations. Papers I - III deal with register data considering patients who had used public dental services in five municipalities in southern Finland and Paper IV deals with register data covering the patients who had visited the public dental services in all of Finland.

The longitudinal study (I – III) evaluated the content and trends in treatment and the intervals between treatment periods in 2001-2013. The content of treatment was investigated nationally in 2009 in the PDS (IV) by the cross-sectional study, which consisted of a total material. It was demanding to collect because the Finnish PDS units had many different patient database systems. Measures based on health care administrative data often appeal as they have been routinely recorded, and no additional investment is needed for data collection, but in this study much effort was required for data cleansing and making each PDS units´ datasets comparable with each other. A strength of the longitudinal design in the studies I-III was that it was possible to follow patients' visiting patterns, treatment needs, and treatment received for 13 years. Longitudinal studies of this type are rare in dentistry. Thus, this thesis presents quite unique information on contents of oral health care.

There are many advantages in using registry data for research. There are statutory rules and protocols for the recordings and dental treatment codes used in patient documents in Finland. Furthermore, recording of certain oral health indices (treatment needs) and all treatment measures is mandatory in the PDS and part of each dentist's salary is based on the treatment measures provided. Data from the PDS records have been considered generally reliable (Hausen 2001). Further, the data used in papers I - III were collected from each PDS unit's database backup by the same expert using the same script.

Still, there are some limitations in the study. The total number of Finnish PDS units is 133, (Kuntaliitto 2020) most of them being small (< 5000 inhabitants). Because the PDS-units use many different database systems and produce slightly different data, it is impossible to compare the units without massive adjustments. Thus, for the longitudinal study five medium sized or large PDS units in southern Finland were chosen using the same patient database system. Although the number of the participating units was low they covered 5.3% in 2001 and 5.4% in 2013 of the total population in Finland and 11.8% in 2001 and 11.6% in 2013 of the population in southern Finland.

The results in the longitudinal study (Papers I and II) were in line with the results of the nationally representative cross-sectional study (Paper IV) and indicate that the selected PDS-units were not outliers among the Finnish PDS units. So, the results of the longitudinal study can be considered generalizable to southern Finland and the results of the cross-sectional study are representative of the whole country. A further limitation was that no information on social background of the patients is recorded in the PDS register. Also, the information collected on treatment needs and the indicators used were rather crude. Erosions and attritions had to be excluded because recording them was quite random as were coded diagnoses used by dentists. Despite the limitations, the data presented provide a good overview of dental treatment provided and the trends in it over time.

Treatment needs presented in epidemiological studies do not take into consideration the examined individuals' own opinions and perceived needs or their dentists' skills and interests. A Swedish study in the early1990s revealed that adults in practice received considerably more restorative and less prosthetic treatment than they needed according to an epidemiological study (Wänman 1995). Grembovski et al. studied restorative therapy in young adults in the US and found in a number of cases both over and under treatment in relation to needs evaluation which were accounted for by both patient and dentist factors (Grembowski et al.1997). Also in Ireland significant differences were found between epidemiologically estimated needs and treatment provided for selected treatments. The gap between estimated need and treatment received was greatest for less-well-off adults (Guiney et al. 2012).

Treatment provided for adults in both the longitudinal and cross-sectional studies in this thesis showed great discrepancies between treatment needs assessed by professionals in nationally representative epidemiological studies (Vehkalahti et al.1991, Suominen-Taipale et al. 2008, Koskinen et al. 2012), which can, however, not only be due to overestimation of the true need for treatment by epidemiologists or patient preferences and choices but reflect problems in the oral health care provision system.

Discussion of the results

Use of dental services (Papers I- IV)

During the 13-year period, the population in the five PDS units' up-take areas increased by 15.2%. This was mainly due to internal migration to southern Finland. The number of adults visiting the PDS-units increased significantly. This was in accordance with the intentions of the Oral Health Care Reform in 2001-2002 (Niiranen 2008). The number of working aged patients increased considerably more than the number of the elderly patients. This was probably partly due to the fact that in 2000, 44% and in 2011, 21% of the elderly were still edentulous (Vehkalahti et al.1991, Suominen-Taipale et al. 2008, Koskinen et al. 2012). Another explanation is that the well-off and dentate elderly who used private services at the time when public services were not accessible probably preferred to continue visiting their own dentists.

It is also known that use of dental services among the elderly decreases with increasing age and increasing numbers of general diseases (Nitschke 2015). This is true even in countries where dental care is practically free (Schwendicke 2021). Knowing that, it would be beneficial for oral health care to be active with the elderly and, for example, to organize home visits by dental hygienists.

During the 13-year study period, most adults living in the local municipalities (77.5%) had visited the PDS on some occasion. The legal obligation to organize emergency dental services for all inhabitants in the PDS uptake-area was included in the Dental Care Reform; this certainly explains a large part of the expanded use (Niiranen 2008, Nihtilä 2016).

During the study period, the number of dentists in the participating five PDS units increased by 61.4% and the number of auxiliaries by 267.9%. The increased personnel resources were used in the treatment of adults only. It may seem that the increase in resources was rather generous in the PDS units concerned. As most of the new recruitments were freshly graduated and not very experienced and many or the new adult patients had had irregular visiting patterns and great treatment needs (Nihtilä 2016) treatment of adults was time consuming. In addition, organizing emergency services for the population was a totally new task for all personnel.

On national level, there has been a lack of personnel resources in the PDS for a long time. The biggest lack of dentists was in 2006 when 13.2 % of all vacancies in the PDS were not filled (SOTKA 2020). The lack of dentist workforce has been more severe in in eastern and northern Finland. However, the treatment profiles were quite similar in both geographical regions studied.

Examinations and need of treatment

Children

The longitudinal study (Paper III) showed that in the PDS the young were regularly recalled and examined which was in line with international best practice guidelines (NICE 2004, ADA 2016). However, an increasing trend from 1 year to 1.5 years was detected in their examination frequency. Children's and adolescents' examination intervals are by a Government Degree set to certain ages and the whole age group should be examined (Finnish Ministry of Social Affairs and Health, 2011). Mäklin has noticed that examination

routines vary greatly in the PDS units and many of them do examinations more often (Mäklin 2021).

The percentage of those examined and in need of treatment declined during the study years from 44.4% in 2001 to 33.2% in 2013. Due to obvious improvements in oral health the longer examination intervals can be considered appropriate. Overall, children's and youngster's recall practice followed the decades-old tradition of emphasizing children's care as a core function of the public dental services.

Dental care of children and youngsters is technically considerably easier than that of adults. Although this study did not separate treatments provided by the different provider groups, it can be stated, especially when considering the improvement of children's oral health, that more solidly established work division between personnel groups e.g. letting dental hygienists and dental assistants do most of the work with the young would probably lead to more effective health and economic results. Reaching adequate work-division would require renewing the dentists' salary incentives involving treatment. Taking out or transmitting the dentists' extra salary in treatment of the young to dental hygienists would facilitate the work-division process.

Adults

It was obvious from the longitudinal study (Paper III) that adults' dental care in the PDS was implemented with a quite different idea than that of the young even though their treatment need was much greater than that of the young. Adults were rarely examined and the trend of longer examination intervals, from one year three months to two years three months cannot be considered a positive development. Some PDS units in Finland recommend even longer intervals, for example, the PDS in Helsinki recommends that "healthy adults" should be examined by a dentist in every 4 to 5 years and visit a dental hygienist every 2 to 3 years (Helsinki social and health care 2022). In 2009, 11% of the adults examined in the PDS of Helsinki were put on a recall list of maximum 12 months, 56% of 24 months, 28% of 36 months and 5% of 37-60 months. According to Haukka the length of the individual recall interval was associated with the values of the patients' oral health indices DMFT, DT and CPI, so that poor oral health reduced the recall interval (Haukka et al. 2020).

International best practice guidelines recommend examination intervals of maximum 24 months for healthy adults (NICE 2004). Interestingly, adults' visiting intervals in the present study were considerably shorter than examination intervals (indicating need of emergency treatment) and the gap got wider towards the end of the study period. The situation was apparently due, at least in part, to care guarantee legislation (Finnish Ministry of Social Affairs and Health 2010). This obliges the PDS to begin a person's treatment inside a given time-limit; in dentistry, within six months from his or her initial contact with the clinic. In most PDS units adults are not put on a recall list (like the young are) to ensure that "old patients" do not block new patients' admission which would result in paying fines for the PDS. This cannot be considered sensible because the underlying problem is lack of resources and/or inadequate use of the existing resources.

Treatment provided

Children, papers I, III, IV

Although the proportion of children in need of care decreased and so did restorative care, the total number of treatment measures increased. The results of the longitudinal study (Paper I) show that orthodontic treatment measures increased by 16.9% although there has been no change in the criteria for accessing free of charge orthodontic treatment in the PDS. Pietilä has shown that there have been great differences between the PDS units nationwide in how much resources have been devoted to orthodontics (Pietilä 2010). It is likely that the demand of orthodontics has increased at least in the wealthy southern parts of the country where the study was conducted. Although in the cross-sectional study in 2009 children in the northern part of Finland received slightly more orthodontic treatment. Nevertheless, the proportion of children (30.2%) who, during the study period had received orthodontic treatment, is in line with reports from the Scandinavian countries (Mohlin et al. 2007).

A positive development was the increase in anesthesia which reflects improved pain and fear management.

Time devoted to prevention, enabling interaction between dental personnel and patients and their caretakers made up only 18.8% of the total treatment time. The PDS has a long tradition of treating children separately from their parents, which has obscured the responsibilities between parents and health care. New means for interaction are needed to make parents better aware of their role in children's dental care but, on the other hand, dental personnel should understand better the challenges families have.

British dentists have been shown to feel frustrated and isolated when trying to provide preventive measures on high caries risk children due to difficulties related to the children, their parents and their different social and cultural environments and educational backgrounds, but also related to health policy and poor funding (Aljafari et al. 2015).

A worrying finding in this study was that the share of preventive treatment (including home care advice and instructions) was generally lower among those in need of treatment than those not in need of periodontal or restorative treatment. One reason may be the same as the British study pointed out: children at risk of disease and their parents are difficult to contact. Furthermore, a randomized trial conducted in Finland in the late 1990s showed that the three-year caries increment among children with high caries risk was equal in those having received very intense chair-side prevention and those who received the "lighter" basic prevention only. The intensified prevention included, among other things, decisively more fluoride varnish applications and sealants than the basic prevention. The conclusion was that chairside preventive measures that increase the caries resistance of the teeth only were insufficient to improve the caries situation. The authors stated that more active self-care would have been more useful (Hausen 2000). Much attention was paid to the study and dentists may consider preventive care less useful.

The fact that more preventive care was provided for those not in need of treatment raises noteworthy ethical questions about targeting resources. Are the "at risk" patients being neglected or is restorative treatment still regarded as "the final cure"? In Finland, the recently (2018) published evidence-based guidelines for the prevention and management of caries recommend, for caries active children and adolescents, advisory interventions to change unfavourable behaviours, the use of fluoride toothpaste twice a day, fluoride varnish application twice a year, fissure sealants and more specific measures under special

circumstances (Working group appointed by the Finnish Medical Society Duodecim, the Finnish Dental Society Apollonia 2009). A recent study of preventive routines in use in children's and adolescents' dental care in the PDS in Norway showed that clinical practice was "old-fashioned" and not in accordance with the newer evidence-based guidelines (Widström et al. 2016). Obviously, dentists did not see prevention as their task and the fact that they did not receive a fee for preventive treatment measures, reasonably supports this. There may be a disjuncture in the roles and goals of the dental team. It would be expected that dentists should value interactive prevention and would be working closely with dental hygienists to ensure that patients' health habits are guided effectively.

British studies have shown that financial incentives strongly influence dentists' choice of treatment (Niederman 2017). Treatments that could be provided quickly (and increased earnings) were preferred before time consuming treatments (Tickle 2011).

According to Grytten, evidence supports the concept that health care providers respond to monetary and nonmonetary rewards and that the design of an incentive program is crucial also in dentistry in order to attain health gains for patients. He emphasizes a need continuously to monitor the quality of services provided and the supervisory role of authorities (Grytten 2017). Because it appears that each financing system has also adverse side effects, there should be an individual incentive system for each care provider in relation to quantity of treatment for patients and different aspects in quality of care (Grytten 2005). Both public dentists' salary incentive system and private dentists' SII imbursement system are based on fee-for-service principle. Both are outdated and should be changed in the coming years. It could be an idea to look after how medical doctor's salaries are constructed (Kunnallinen työmarkkinalaitos 2020).

Adults, papers II - III, IV
Restorative treatment dominated adults' treatment at the expense of periodontal and prosthetic treatment and preventive measures. In the national cross-sectional study children and adolescents received almost four times more preventive measures than adults. The national epidemiological studies (Vehkalahti et al.1991, Suominen-Taipale et al. 2008, Koskinen et al. 2012) have shown that, in addition to caries, gingivitis and periodontitis and great numbers of missing teeth even in anterior visible sectors are common in Finnish adults. When compared with Danish and Swedish studies, this study found more restorative treatment, less periodontal treatment and much less prosthetic treatment (Holt 2013, Hugoson et al. 2005, Norderyd et al. 2015).

In the longitudinal study (Paper II), periodontal treatment made up only 7.8% of all treatment measures provided and 15.2% of the total treatment time. In the national cross-sectional study (Paper IV) periodontal treatment made up 6.3% of all treatment measures and 9.7% of treatment time. It can be questioned, what is wrong with the basic training of dentists when periodontal care was so under-represented, not only in the longitudinal but also in the nationwide study. The prevalence of periodontal disease is high, especially in the older age groups, according to population surveys. Most of the treatment for periodontology is technically simple and maybe therefore restorative treatment is practiced more in dental education. In the PDS, dentists also receive additional salary for periodontal treatment, although a technically skilled dentist may gain considerably more from restorative treatment. Rantahakala et al. showed that public dentists perceived their skills in periodontics weak, partly due to lack of experience when having treated mostly young patients (Rantahakala 2012).

It is, however, obvious from this study that both the dentists and dental hygienists need further training in periodontics and that teamwork between the two professional groups needs to be encouraged.

In the treatment of adults in particular, there has in Finland developed an ever-accelerating desire of effectiveness and a new goal that patients should be treated with a single visit. This paradigm is especially ill-suited to periodontal treatment and reflects the technicality of dental practice. Patients with periodontal problems and bad home care habits should therefore be treated separately from the “rapid treatment process”.

The share of prosthetic treatment provided in the longitudinal study was only 0.9% and 0.5% in the national cross-sectional study of all treatments and this is not acceptable regarding the needs of the population. Lack of appropriate prosthetic treatment options has led to peculiar attempts to save teeth in poor condition using composite materials (Nihtilä 2016). It is as if prosthetics had been defined out of the treatment options available in the public sector. Prosthetic treatment is expensive even in the public sector, as the patient has to pay all the technical work in addition to PDS patient fees. This is likely to influence the demand. Because the PDS has long been treating mainly younger persons, many dentists’ prosthetic skills can be inadequate and need upskilling (Nihtilä 2016). In addition, clinical dental technicians make up a relatively large professional group in Finland, but they are not allowed to provide partial dentures and full dentures are becoming unusual.

Preventive treatment measures were rare. Dentists probably did not see prevention as their role which, given the fact that dental hygienists were employed in the services and the fact that the dentists were not remunerated for this. Also, elsewhere poorly incentivized prevention has resulted in low priority or neglect of the whole treatment (Tickle 2011)

Also among adults, those in need of periodontal or restorative treatment received less preventive treatment (including home care advice) than those not in need of treatment. Similar controversial findings were noticed in the UK where a study showed that adults coming from poor areas were less likely to receive prevention in the form of instruction and advice than adults coming from wealthier areas, pointing out a clear inverse social gradient in relation to need. According to the authors, individual practitioner and patient attitudes to the delivery and receipt of preventive care played a role here (Wanyonyi 2017). Also, in Finland dentists and dental hygienists may prefer to treat those who are on the same knowledge-level and wavelength with them.

The youngest adult age group in this study, the 18–39-year-olds (paper II), had had access to free comprehensive and prevention-oriented treatment in the PDS as children and youth and they have been expected to be less in need for conservative treatment. Yet the study suggested a clearly increasing trend in surgical treatment ($p=0.001$) and indicated slightly increasing trends in emergency treatment (ns), and endodontics (ns) and decreasing trends in restorative care (ns). This group also appeared to follow the same trend as the older age-groups which were not offered recalls and regular care.

Of the other Nordic countries, especially Denmark and Sweden have invested more in adult dental care for decades and among adults their oral health has improved more than in Finland, and their socio-economical differences in oral health have been smaller than in Finland (Bøge Christensen et al 2021, Karvonen et al. 2017).

When this study started, there were no national best practice guidelines about clinical treatments, and treatment was in the first place provided on basis of dentists’ and dental

hygienists' basic education and possible continuing education. A first best practice guideline about treatment of wisdom teeth was published in 2008 (Working group appointed by the Finnish Medical Society Duodecim, the Finnish Dental Society Apollonia 2008), a guideline about treatment of caries in 2009 (Working group appointed by the Finnish Medical Society Duodecim, the Finnish Dental Society Apollonia 2009).

and about periodontal treatment in 2010 (Working group appointed by the Finnish Medical Society Duodecim, the Finnish Dental Society Apollonia 2010). National guidelines about prosthetic treatment in 2013 (Working group appointed by the Finnish Medical Society Duodecim, the Finnish Dental Society Apollonia 2013), about endodontic treatment in 2016 (Working group appointed by the Finnish Medical Society Duodecim, the Finnish Dental Society Apollonia 2016) and about restorative therapy in 2018 (Working group appointed by the Finnish Medical Society Duodecim, the Finnish Dental Society Apollonia 2018) were published after the materials for this study were collected. It is also well-known that the mere publication of best practice guidelines does not mean that they are read and come into use without education, leadership and follow-up (Sipilä and Lommi 2014). Here the local HC and PDS unit leaders have a central role.

In a national register study comparison of the treatment patterns of adults in the PDS and private sector showed differences. In the public sector more effort went to examinations and emergency care than in the private sector where more traditional, comprehensive care was provided including prosthetics (Widström and Linden 2018). It is well known also from other countries that socio-economically disadvantaged adults and persons with low education use in the first-place public dental services and the well-educated and wealthier persons choose private services. Public clinics put more emphasis on the extraction of teeth and less emphasis on preventive and maintenance care when adults are treated (Brennan et al. 2008, Pūriene et al. 2008, Pälvärinne et al. 2019).

For adults, the public sector provided considerably more examinations and clearly more surgical treatment measures than the private sector in Finland. One explanation is that the PDS has responsibility for emergency care for the whole population, provided high numbers of emergency examinations. On the other hand, the SII reimbursed only one examination per patient per year in the private sector. Periodontal treatment was two times more common in the private sector than in the public sector. However, the overall amount of periodontal treatment was low in both sectors, also among the elderly, where the periodontal treatment need is most common.

Both sectors provided relatively few preventive treatment measures for adults, especially when taking into consideration that treatment by dental hygienists was included in the data and it is well known that adults' oral health habits are not good (Vehkalahti et al.1991, Suominen-Taipale et al. 2008, Koskinen et al. 2012, Widström and Linden 2008).

General discussion

At present, about 15% of the 5,300 dentists are specialists. About 50% of them work in the private sector, 30% in HCs and 16% in hospitals (Rellmann 2016). The dental specialties in Finland are diagnostics (radiology, oral pathology), clinical dentistry (emphasis on periodontology, endodontics and cariology, pedodontics or prosthetics), orthodontics, oral and maxillofacial surgery and health care (administration). The biggest group of specialists are orthodontists and 69% of them work in the PDS. Around 31% of clinical specialists and 18% of oral and maxillofacial surgeons work in HCs (Suomen Hammaslääkäriliitto 2019).

A recent study estimated that 30% of dental patients currently lack the specialist care they would need (Rellmann 2016). The problem has been the lack of specialization positions and trainers. Specialist training should be increased in all existing specialties, with the greatest need for specialists in clinical dentistry in the PDS.

When comparing the situation with the general medicine, a significant proportion, about 80% of doctors specialize. Even in the HC, a large proportion of permanently employed medical doctors are licensed medical specialists in general practice. Their contribution as consultants for young doctors and in the treatment of demanding patients in multidisciplinary teams is important for the quality of care. The results of this thesis show that treatment of adults, was one-sided and concentrated on restorative treatment. More specialists would guarantee a broader selection of treatments.

During the study period, national steering of the public dental services was information-based. Lack of proper governmental steering by legally binding orders and budget management enabled the larger municipalities with large private sectors to invest the minimal resources in the public dental services. Implementing a big change in the working conditions of the public dental service personnel like the removal of the age restrictions in 2002 was, would have required firm leadership from the local leaders of the HC and the PDS. The PDS chief dentists often had to divide their working hours between clinical and leadership tasks. Thus, their touch was more a fellow colleague dentist than a boss, but at the same time they were responsible for the implementation of new standards and radical changes in the local PDS units. They were put in a difficult position because their personnel did not support actions giving them more work and more difficult patients (Alestalo 2015).

After 2013, according to statistical information, adults' use of dental services on country level decreased from 2006 to 2016, mostly due to a decrease in the use of services in the private sector, where the SII imbursement cutbacks increased patient costs (Tervola et al. 2021). Between 2013 and 2017, the subsidy of private (basic) services was cut from 32.1% to 15.4% (Linden and Nolvi 2019). From 2012 to 2017, the attendance rate of adults (20+ years) decreased from 25.1% to 22.8% in the private sector (Vehkalahti et al. 2021).

From 2014 to 2019, DMFT–index of the 12-year-olds examined decreased from 1.2 to 0.9 and the percentage of children with DMFT=0 increased from 55.0% to 61.3%. This means that the beneficial progress in children's oral health has continued through 2000's. The coverage of children's dental care in the PDS did not change during 2013-2019. The use of public dental services by the working aged increased slightly from 26.7% to 28.3% and by the elderly from 22.1% to 26.5% (SOTKA 2022).

The poor quality of adult dental care in the PDS as regards adults' long examination intervals and lack of recalls pointed out in this study has been observed even in other PDS units (Nihtilä 2016) and it is not likely that the operational practices have changed, the resources have been approximately the same since 2013. A few studies have been published of the quality of clinical procedures in Finland. Thus, a study found that using rubber dam during endodontic treatment was documented only in 28.9% of the treatments. It was used more frequently by salaried dentists in the PDS (43.9%) than by private dentists (9.9%) working for fee for service. Working length measurement of the root canal was documented for 72.9% of the root canal therapies and again more frequently by PDS (85.2%) than by private dentists (57.4%). The study indicated that the quality of endodontic treatment was not very good (Leinonen and Vehkalahti 2021). Another study found that almost half of bitewing images (44.1%) were not of acceptable quality. Most usual challenges were in projection position and chemical quality (Hyvönen et al. 2021). A recent study in the PDS in the city of

Espoo noted that of all diagnoses recorded during 2010-2012 caries accounted for 40.1% and periodontal diseases only for 9.7%. Overall, there was great variability in recording diagnosis codes (Kallio et al. 2020). Apparently, the electronic patient records should have a feature which obliges the professional to choose a diagnosis for the treatment of the patient to ensure diagnoses to be used (Lehto et al. 2021).

Obviously, there is a great need for further education of the dental personnel to improve the quality of care. More systematic quality evaluation is necessary in the PDS when Finland introduces the new health care organizations. During recent years, big oral health care corporations in the private sector have been purchasing high numbers of independent practices and they prepare for the future by arranging consistent steering and quality systems (Siipola 2016).

No major new national acts regarding dental care except guidelines on how to treat patients during the covid-19 pandemic have been given after 2013. Nor have any bigger changes happened in the PDS. The health care field has been expecting the new reform moving the responsibility of organizing social and health care from municipalities to bigger health care districts that has been impending for more than ten years.

However, during the covid-19 pandemic, a large debt for care has been incurred, not just beyond in general health care but also in oral health care and the public services have become even more crowded than before (Mikkola 2020). The crowding brought about by the covid-19 pandemic also is a sign of multi-level problems throughout the public dental service system.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, this thesis adds to the sparse, previously published literature on dental treatment provided in general and especially in a longitudinal perspective. The study reveals a continuing need for collecting transparent and reliable registry-based information on the clinical activities in order to ensure that patients benefit from treatments they receive and that the care providers work cost-efficiently. Careful consideration should be given to the contents of the information and building appropriate database systems which ensure correct routine recording of health and treatment information. However, data recording should be smooth and economical. The time of professionals should not be wasted on recording information that cannot or will not be used.

Over the 13 years a significant increasing trend was found in working aged-adults' examination intervals and tooth extractions and a decreasing trend in preventive care for all adults indicating worsening quality. Although more than ten years had passed since the Oral Health Care Reform opening the PDS services for the 46-year-olds and older, the type of adult care has not changed from emergency and filling therapy towards prevention and maintenance care as could have been expected especially when comparing with the totally different service pattern for children and youngsters in the same organization.

This thesis raises an important question about what can be done to get past the current pattern in adult dental care which concentrates on filling therapy at the expense of periodontal and prosthetic treatment and preventive measures. This oral care patch mode was in use especially in the PDS and was in notable contrast to the care pattern of the young characterized by regular examinations and comprehensive care. Besides a probable need for additional manpower or a need for increased productivity and teamwork there might be other reasons for the dominance of restorative treatment e.g. that so little evidence-based information was used as a basis for treatment. Periodontal status was seldom properly examined because recording of it is more complicated and time consuming than using the traditional CPI –index (Nomura et al. 2016). Best Practice Guidelines in dentistry are poorly followed and used in treatment compared with general medicine. Restorative treatment is technical, and dentists are good at providing complex restorations, but they did not offer prosthetic crowns, which in many cases would have increased the durability of the treatment considerably. Adults were not covered by the internationally highly recommended recall system and regular care as were the young. Many PDS units had problems with new patients and their accumulated treatment needs.

Overall, there has been little political pressure to look at the quality and performance of adult dental care. The five aspects that characterize appropriate general health care presented in the introduction: evidence-based care, clinical expertise, patient centeredness, sensible resource use, and equity were clearly not fulfilled in adult dental care in the PDS (Robertson-Preidler et al. 2017).

The fact that the staff of officers and employees and political decision makers in the local municipalities obviously do not understand the oral health care needs of adults, indicates

that oral health is still less valued and not belonging in the concept of general health in the health care service system and therefore does not get the same attention. This may suggest a need for advocacy to understand oral health problems and the impacts thereof and thus a greater need for prevention and treatment (including prosthetics) to be placed in the agenda of the broader health structures.

Changing ingrained paradigms requires that the management and quality development of the PDS organizations keep abreast of the change and strikes at it. In this respect, the challenge passes to the new health district organizations that will start running the public dental services in 2023.

There is a continuing need for collecting registry-based information on the clinical activities in order to ensure that patients benefit from treatments they receive and that the care providers work cost-efficiently. For example, the welfare districts should run continuing evaluation of treatment measures, examination intervals and the overall performance of PDS units providing care for patients of all ages.

New ideas, methods and incentives are needed in health promotion to improve the oral health habits of the Finnish population to the same level than the rest of the European Union.

More specialists are needed to guarantee quality in patients' advanced treatment. Specialists are most needed in providing care and as team leaders in periodontology and prosthetics where the greatest gaps are between treatment needs according to national surveys and treatment provided.

Public dentists' salary incentive system and private dentists' SII imbursement system are based on fee-for-service principle. Both are outdated and should be renewed.

Obviously, more resources are needed in public oral health care to ensure adequate recall system for adult patients.

For future research, an interesting question is to study children's needs in orthodontics and cost-efficiency of the treatment provided.

REFERENCES

Alaraudanjoki V. Erosive tooth wear and assiociated factors in northern Finland birth cohort 1966, Thesis. Oulu: University of Oulu; 2018.

Alestalo P. Management and leadership in the public dental Service in Finland between 2003 and 2011, Thesis. Helsinki: University of Helsinki; 2015.

Aljafari AK, Gallagher JE, Hosey MT. Failure on all fronts: general dental practitioners' views on promoting oral health in high caries risk children--a qualitative study. BMC Oral Health. 2015;15:45. https://doi.org/10.1186/s12903-015-0032-8.

American Dental Association (ADA). How Often Should a Person Go to the Dentist? Questions About Going to the Dentist - Mouth Healthy. 2016. http://www.mouthhealthy.org/en/dental-care-concerns/questions-about-going-to-the-dentist. Accessed 12 Feb 2022.

Anttila J, Tolvanen M, Kankaanpää R, Lahti S. Social gradient in intermediary determinants of oral health at school level in Finland. Community Dent Health. 2018;35(2):75-80.

Brennan DS, Luzzi L, Roberts-Thomson KF. Dental service patterns among private and public adult patients in Australia. BMC Health Serv Res. 2008;8:1.

von Bültzingslöwen I, Östholm H, Gahnberg L, Ericson D, Wennström JL, Paulander J. Swedish Quality Registry for Caries and Periodontal Diseases - a framework for quality development in dentistry. Int Dent J. 2019;69(5):361-368.

Bøge Christensen L, Árnadóttir IB, Hakeberg M, Klock KS, Suominen AL. Ojämlikhet i oral hälsa – nordiska erfarenheter. Tandläkartidningen. 2021;113(2):48-55

Chandler R, Scott M. Statistical methods for trend detection and analysis in the environmental sciences. New Jersey: Wiley; 2011.

Institute of Medicine (US) Committee on Quality of Health Care in America. Crossing the Quality Chasm: A New Health System for the 21st Century. Washington (DC): National Academies Press (US); 2001.

The Council of European Chief Dental Officers (CECDO) database on internet. https://cecdo.org/oral-healthcare/cecdo-database/. Accessed 24.3.2022.

Eurostat 2021. http://ec.europa.eu/eurostat/statistics-explained/index.php/Unmet_health_care_needs_statistics. Accessed 24.3.2022.

Finnish Ministry of Social Affairs and Health, 1963. Health Insurance Act (364/1963). www.finlex.fi. Accessed 24.3.2022.

Finnish Ministry of Social Affairs and Health, 1972. Primary Health Care Act (66/1972). www.finlex.fi. Accessed 24.3.2022.

Finnish Ministry of Social Affairs and Health, 1989a. Act on Specialized Medical Care, In Finnish (1062/1989). www.finlex.fi. Accessed 24.3.2022.

Finnish Ministry of Social Affairs and Health, 1992. Act on Client Charges in Healthcare and Social Welfare, In Finnish (912/1992). www.finlex.fi. Accessed 24.3.2022.

Finnish Ministry of Social Affairs and Health, 2004. Change of the Primary Health Care Act, in Finnish (855/2004), “guaranteed access to care”. www.finlex.fi. Accessed 24.3.2022.

Finnish Ministry of Social Affairs and Health, 2010. The Health Care Act, In Finnish (1326/2010). https://www.finlex.fi. Accessed 24.3.2022.

Finnish Ministry of Social Affairs and Health, 2011. Government regulation of prenatal care, school and student health of children and young people in preventive oral health, In Finnish (338/2011). www.finlex.fi. Accessed 24.3.2022.

Finnish Ministry of Social Affairs and Health, 2017. Act of fees in social and health care, In Finnish (773/2017). https://www.finlex.fi. Accessed 24.3.2022.

Finnish Ministry of Social Affairs and Health. 2019. Uniform criteria for access to non-emergency care 2019. https://julkaisut.valtioneuvosto.fi/handle/10024/161496. Accessed 24.3.2022.

Grembowski D, Fiset L, Milgrom P, Forrester K, Spadafora A. Factors influencing the appropriateness of restorative dental treatment: an epidemiologic perspective. J Public Health Dent. 1997;57(1):19-30.

Grytten J. Models for financing dental services. A review. Community Dent Health. 2005;22(2):75-85.

Grytten J. Payment systems and incentives in dentistry. Community Dent Oral Epidemiol. 2017;45(1):1-11.

Guiney H, Felicia P, Whelton H, Woods N. Comparing epidemiologically estimated treatment need with treatment provided in two dental schemes in Ireland. BMC Oral Health. 2012;12:31. https://doi.org/10.1186/1472-6831-12-31.

Guiney P, Felicia H, Whelton N, Woods H. Analysis of a payments database reveals trends in dental treatment provision. J Dent Res. 2013;92(7 Suppl):63S–69S. https://doi.org/10.1177/0022034513484327.

Suomen Hammaslääkäriliitto. Hammaslääkärit sairaanhoitopiireittäin 2018 (Dentists in health districts, in Finnish). https://www.hammaslaakariliitto.fi/fi/liiton-toiminta/tutkimukset-ja-tilastot/tilastot/hammaslaakarit-sairaanhoitopiireittain#.YpzdpJOA4-R. Accessed 24.3.2022.

Haukka A, Heikkinen AM Haukka J, Kaila M. Oral health indices predict individualised recall interval. Clin Exp Dent Res. 2020;6(6):585-595.

Hausen H, Kärkkäinen S, Seppä L. Application of the high-risk strategy to control dental caries. Community Dent Oral Epidemiol. 2000;28(1):26-34.

Hausen H, Kärkkäinen S, Seppä L. Caries data collected from public health records compared with data based on examinations by trained examiners. Caries Res. 2001;35:360–5. https://doi.org/10.1159/000047475.

Heikkinen A. Oral health, smoking and adolescence, Thesis. Helsinki: University of Helsinki; 2011.

Helsinki Social and Health Care. Hoitoonpääsy ja kutsukäytännöt 2022. (Access to treatment and recall practices, In Finnish). http://www.hel.fi/static/sote/tiedotteet/asiakkaille/Hoitoonpaasy_ja_kutsukaytannot_vauvasta_vaariin.pdf. Accessed 24.3.2022.

Holt C. Brugen af og betaling for tandpleje i Danmark, Sverige og Norge. (The use of and payment for dental care in Denmark, Sweden and Norway, in Danish). Den Norske Tannlegeforeningens Tidende. 2013;123:12–18.

Honkala S, Vereecken C, Niclasen B, Honkala E. Trends in toothbrushing in 20 countries/regions from 1994 to 2010. Eur J Public Health. 2015;25 Suppl 2:20-3.

Hugoson A, Koch G, Göthberg C, Helkimo AN, Lundin SA, Norderyd O, Sjödin B, Sondell K. Oral health of individuals aged 3-80 years in Jönköping, Sweden during 30 years (1973-2003). II. Review of clinical and radiographic findings. Swed Dent J. 2005;29(4):139-55.

Hummel R, Bruers J, van der Galien O, van der Sanden W, van der Hejden G. Outcome measures for oral health based on clinical assessments and claims data: feasibility evaluation in practice. BMC Oral Health. 2017;17:125. https://doi.org/10.1186/s12903-017-0410-5.

Hyvönen M, Jaakkola A, Tanner T, Päkkilä J, Kämppi A, Patinen P, Tjäderhane L, Sipola A, Huumonen S, Anttonen V. Quality and Findings of Bitewing Radiographs among Twenty-Year-Old Conscripts in Finland. Int J Dent. 2021:8;2021:8894917.

Inchley JC, Currie DB, Young T, Samdal O, Torsheim T, Augustson L, Mathison F, Aleman-Diaz AY, Molcho M, Weber M, Barnekow V (Eds.) (2016). Growing up unequal: gender and socioeconomic differences in young people's health and well-being: Health Behaviour in School-aged Children (HBSC) study: international report from the 2013/2014 survey. (Health Policy for Children and Adolescents; No. 7). WHO Regional Office for Europe. http://www.euro.who.int/__data/assets/pdf_file/0003/303438/HSBC-No7-Growing-up-unequal-full-report.pdf?ua=1. Accessed 24.3.2022.

Institute of Medicine; Committee on Quality of Health Care in America. Crossing the Quality Chasm: A New Health System for the 21st Century.Washington, D.C: National Academy Press; 2001.

Johansson AK, Omar R, Carlsson GE, Johansson A. Dental erosion and its growing importance in clinical practice: from past to present. Int J Dent. 2012;2012:632907.

Kallio J, Kauppila T, Suominen L, Heikkinen AM. Recording of diagnoses in public primary oral health care in a retrospective longitudinal observational study in a Finnish town:

Underrepresentation of periodontitis diagnoses. Clin Exp Dent Res. 2020 Aug;6(4):457-461. doi: 10.1002/cre2.291.

Karvonen S, Martelin T, Kestilä L, ja Junna L. 2017. Tulotason mukaiset terveyserot ovat edelleen suuria. Suomen sosiaalinen tila 3/2017. Tutkimuksesta tiiviisti 16/2017. (Health inequalities in income levels remain high, in Finnish). Institute of Health and Welfare, Helsinki. https://www.julkari.fi/bitstream/handle/10024/135167/URN_ISBN_978-952-302-896-8.pdf?sequence=1&isAllowed=y. Accessed 24.3.2022.

Kestilä L, Härmä V, Rissanen P. Covid-19-epidemian vaikutukset hyvinvointiin, palvelu-järjestelmään ja kansantalouteen, Asiantuntija-arvio, syksy 2020 (Effects of covid-19 epidemic to welfare, service system and national economy, expert assessment autumn 2020, in Finnish). Tampere:PunaMusta Oy;2020. https://www.julkari.fi/bitstream/handle/10024/140661/URN_ISBN_978-952-343-578-0.pdf?sequence=1&isAllowed=y. Accessed 24.3.2022.

Koponen P, Borodulin K, Lundqvist A et al. Terveys, toimintakyky ja hyvinvointi Suomessa: FinTerveys 2017 tutkimus. Helsinki: Insitute of Health and Welfare; 2018. https://www.julkari.fi/bitstream/handle/10024/136223/Rap_4_2018_FinTerveys_verkko.pdf?sequence=1&isAllowed=y. (Health, functional capacity and welfare in Finland – FinHealth 2017 study. English summary). Accessed 24.3.2022.

Koskinen S, Lundqvist A, Ristiluoma N, eds. Terveys, toimintakyky ja hyvinvointi Suomessa 2011 In: THL Raportti 68. Tampere: Juvenes Print - Suomen yliopistopaino Oy; 2012. (Health, functional capacity and welfare in Finland in 2011. English summary.)

Kunnallinen työmarkkinalaitos 2020. Kunnallinen lääkärien virkaehtosopimus 2020-2021 (Communal agreement of medical professionals 2020-2021, in Finnish). https://www.kt.fi/sopimukset/laakarit/2020-2021. Accessed 24.3.2022.

Kuntaliitto. Sosiaali- ja terveydenhuollon järjestäminen 2020 (Organising of social- and welfare 2020, in Finnish). https://www.kuntaliitto.fi/sosiaali-ja-terveydenhuollon-jarjestaminen-2020. Last access 24.4.2022.

Lahti S, Hausen H, Widström E, Eerola A. Intervals for oral health examinations among Finnish children and adolescents: recommendations for the future. Int Dent J. 2001;51:57–61.

Lehto M, Pitkälä K, Rahkonen O, Laine MK, Raina M, Kauppila T. Do electronic reminders alter recorded diagnoses in primary care office-hours practices of health centers: A register-based study in a Finnish city. SAGE Open Med. 2021;9:20503121211036117.

Leinonen S, Vehkalahti M. Compliance with Key Practices of Root Canal Treatment Varies by the Reward System Applied in Public Dental Services. J Endod. 2021;47(10):1592-1597.

Linden J, Josefsson K, Widström E. Frequency of visits and examinations in the Public Dental Service in Finland – a retrospective analysis, 2001–2013. BMC Oral Health. 2017;17:138. https://doi.org/10.1186/s12903-017-0436-8

Linden J, Widström E, Sinkkonen J. Children and adolescents´ dental treatment in 2001–2013 in the Finnish public dental ervice. BMC Oral Health. 2019;19:131. https://doi.org/10.1186/s12903-019-0828-z

Linden J, Widström E, Sinkkonen J. Adults' dental treatment in 2001–2013 in Finnish public dental service. BMC Oral Health 2020;20:121. https://doi.org/10.1186/s12903-020-01091-w

Linden M, Nolvi K. Kela-korvauksen leikkaukset ja yksityisen hammashoidon kysyntä Suomen kunnissa 2006-2017 (SSI imbursement cuts and private demand for dental care in Finnish municipalities 2006–2017, in Finnish). Kansantaloudellinen aikakauskirja 2019;115:494-519.

Lundegren N. Oral health and self-perceived oral treatment need of adults in Sweden. Swed Dent J Suppl. 2012;(223):10-76.

Mikkola H. Korona vie uusiin tehtäviin, mutta millaisiin? (Covid-19 is leading to new tasks, but which kind, in Finnish. Finnish Dental Journal. 2020; https://www.hammaslaakarilehti.fi/fi/uutinen/korona-vie-uusiin-tehtaviin-mutta-millaisiin. Accessed 24.3.2022.

Milen A. Lasten ja nuorten hampaiden tila ja hoito Suomessa 1981-82 : hampaiden terveyden, hammashoidollisten tapojen ja hammassairauksien ehkäisyn ja hoidon kartoitus sekä tietojärjestelmäkokeilu (In Finnish, Dental health status, habits and care of Finnish children and youths in 1981-82 ; a feasibility study of an information system). Helsinki: Lääkintöhallitus; 1986

Mohlin B, Dømgaard P, Kurol J, Pietilä T. Hälsorisker vid obehandlade malocklusioner (Health hazards caused by untreated malocclusions. English summary). Tandläkartidningen. 2007;99(2):40–5 http://www.tannlegetidende.no/asset/2007/P07-01-24-9.pdf. Accessed 24.3.2022.

Mäklin H, Anttonen V, Laitala M-L. Lasten ja Nuorten suun terveystarkastukset Suomessa (Children's statutory oral health examinations in Finland. English summary) Suom hammasl. 2021;11:26-30

Nguyen L, Häkkinen U. Income-Related Inequality in the Use of Dental Services in Finland. Applied Health Economic Health Policy. 2004;3:251-262.

NICE, the National Collaborating Centre for Acute and Chronic Conditions. Dental recall - Recall interval between routine dental examinations. Clinical guideline [CG 19]. 2004. http://guidance.nice.org.uk/CG19. Accessed 24.3.2022.

Niederman R, Huang SS, Trescher AL, Listl S. Getting the Incentives Right: Improving Oral Health Equity With Universal School-Based Caries Prevention. Am J Public Health. 2017;107(S1):S50-S55.

Nihtilä A-M, Widström E, Elonheimo O. Adult heavy and low users of dental services: treatment provided. Swed Dent J. 2016;40(1):21–32.

Niiranen T, Widström E, Niskanen T. Oral health care reform in Finland - aiming to reduce inequity in care provision. BMC Oral Health. 2008;28(8):39.

Nitschke I, Stillhart A, Kunze J. Utilization of dental services in old age. Swiss Dent J. 2015;125(4):433-47.

Nomura Y, Okada A, Kakuta E, Gunji T, Kajiura S, Hanada N. A new screening method for periodontitis: an alternative to the community periodontal index. BMC Oral Health. 2016;16(1):64.

Nordblad A, Suominen-Taipale AL, Rasilainen J, Karhunen T. Suun terveydenhuoltoa terveyskeskuksissa 1970- luvulta vuoteen 2000 (Oral Health Care at Health Centres from the 1970s to the year 2000. English summary). National Research and development Centre for Welfare and Health (stakes), reports 278. Saarijärvi: Gummerus Kirjapaino; 2004.

Norderyd O, Koch G, Papias A, Köhler AA, Helkimo AN, Brahm CO, Lindmark U, Lindfors N, Mattsson A, Rolander B, Ullbro C, Gerdin EW, Frisk F. Oral health of individuals aged 3-80 years in Jönköping, Sweden during 40 years (1973-2013). II. Review of clinical and radiographic findings. Swed Dent J. 2015;39(2):69-86.

WHO. Oral health surveys: basic methods - 5th edition. World health organization. Geneve: WHO press; 2013.

Pietilä I. Delivery, Outcome, and Costs of Orthodontic Care in Finnish Health Centres. Thesis 2010. Institute of https://www.utupub.fi/handle/10024/63989. Accessed 24.3.2022.

AVOINDATA.FI. Professionals in social and healthcare. https://www.avoindata.fi/data/fi/dataset/sosiaali-ja-terveydenhuollon-ammattihenkilot/resource/94f56e8b-8942-4b1b-afd7-f8639f1cb7ef Accessed 24.3.2022.

Pūriene A, Petrauskiene J, Balciūniene I, Janulyte V, Kutkauskiene J, Musteikyte M. Privati ar valstybine odontologine gydymo istaiga? Lietuvos pacientu nuomone ir patirtis [Private or public dental care? Patients' perception and experience in Lithuania]. Medicina (Kaunas). 2008;44:805-811.

Pälvärinne R, Birkhed D, Forsberg B, Widström E. Visitors' experiences of public and private dental care in Sweden in 1992-2012. BDJ Open. 2019;5:12.

Raittio E, Vehkalahti MM, Helminen S et al. Education-related inequality in restorative dental treatment need over 11 years in two areas of Finland. Community Dent Oral Epidemiol 2018;46:70–7.

Rantahakala L, Nihtilä A, Mäntylä P. Periodontal diagnosis and treatment practices in Helsinki Metropolitan Public Dental Services. Suom Hammasl. 2012; 1: 24-32.

Rellman J. Erikoislääkäri- ja erikoishammaslääkärikoulutustarpeen arviointi vuoteen 2030. (Assessment of the need for specialist training in medicine and dentistry until 2030. English summary). Ministry of Social Affairs and Health, 2016. https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/75535/RAP_2016_57_ErikoislaakariRellman.pdf?sequence=1&isAllowed=y. Accessed 24.3.2022.

Robertson-Preidler J, Biller-Andorno N, Johnson TJ. What is appropriate care? An integrative review of emerging themes in the literature. BMC Health Serv Res. 2017;17(1):452.

Schwendicke F, Krasowski A, Gomez Rossi J, Paris S, Kuhlmey A, Meyer-Lückel H, Krois J. Dental service utilization in the very old: an insurance database analysis from northeast Germany. Clin Oral Investig. 2021 May;25(5):2765-2777.

Sipilä R, Lommi M-L. Hoitosuositukset eivät muutu hoitokäytännöiksi Itsestään (Treatment recommendations do not automatically translate into treatment practices. English summary). Duodecim. 2014;130:832–839.

Siipola E. Suun terveydenhuollon kilpailuolosuhteet, Case Helsinki ja Espoo (Conditions of competition in oral healthcare, in Finnish). Tampere: University of Tampere; 2016. https://core.ac.uk/download/pdf/250141222.pdf.

Skapa, Svenskt kvalitetsregister för karies och parodontit. www.skapareg.se. (The Swedish quality registry for caries and periodontal disease, in Swedish). Accessed 24.3.2022.

SKAPA Svenskt kvalitetsregister för karies och parodontit. Årsrapport 2018. http://www.skapareg.se/wp-content/uploads/2019/06/arsrapport-2018.pdf. (Annual report 2018. The Swedish quality registry for caries and periodontal disease, in Swedish). Accessed 24.3.2022.

SOTKA, Municipal Database for Social and Health Care in Finland. National Institute of Health and Welfare. https://sotkanet.fi/sotkanet/fi/index. Accessed 24.3.2022.

StataCorp. 2013). Stata Statistical Software: Release 13. College Station, TX: StataCorp LP

Suomen Hammaslääkäriliitto. Erikoishammaslääkäritilasto 2019. (Statistics about specialized dentists, in Finnish). https://www.hammaslaakariliitto.fi/fi/liiton-toiminta/tutkimukset-ja-tilastot/tilastot/erikoishammaslaakaritilasto. Accessed 24.3.2022.

Suominen-Taipale L, Nordblad A, Vehkalahti M, Aromaa A. Eds. Oral health in the Finnish adult population. Health 2000 survey. Publications of the National Public Health Institute (KTL) B25. Hakapaino Oy: Helsinki; 2008. https://www.julkari.fi/bitstream/handle/10024/103030/2008b25.pdf. Accessed 24.3.2022.

Suominen-Taipale AL, Widström E, Sund R. Association of Examination Rates with Children's National Caries Indices in Finland. Open Dent J. 2009;16;3:59-67.

Suominen AL, Helminen S, Lahti S, Vehkalahti M, Knuuttila M, Varsio S, Nordblad A. Use of oral health care services in Finnish adults - results from the cross-sectional Health 2000 and 2011 Surveys. BMC Oral Health. 2017;17(1):78.

Tarvonen P-L, Ekqvist M, Turunen S, Hiekkanen S, Suominen L. Helsingin terveyskeskuksen suun terveydenhuollon tuotteistushankkeen loppuraportti. Helsinki:

Helsingin terveyskeskuksen raportteja 3 2012. (Time used for different dental treatment measures, in Finnish).

Tervola J, Aaltonen K, Tallgren F. Kotitalouksien terveysmenojen vaikutukset toimeentuloon Suomessa – Tiivistelmä WHO:n maaraportista. Tutkimuksesta tiiviisti 48/2021 (Impact of household health expenditure on living in Finland - Summary of the WHO country report). Helsinki: Institute of Health and Welfare 2021.

Tickle M, McDonald R, Franklin J, Aggarwal VR, Milsom K, Reeves D. Paying for the wrong kind of performance? Financial incentives and behaviour changes in National Health Service dentistry 1992-2009. Community Dent Oral Epidemiol. 2011;39(5):465-73.

Wanyonyi KL, Radford DR, Gallagher JE. Dental Treatment in a State-Funded Primary Dental Care Facility: Contextual and Individual Predictors of Treatment Need? PLoS One. 2017 Jan 24;12(1):e0169004.

Vehkalahti M, Paunio I, Nyyssönen V, Aromaa A, ed. Suomalaisten aikuisten suunterveys ja siihen vaikuttavat tekijät (Oral health of Finnish adults and determinant factors. English summary). Kansaneläkelaitoksen julkaisuja AL:34. Vammalan kirjapaino, Turku 1991.

WHO. Quality in primary health care. Technical series on primary health care. World Health Organization 2018. https://www.who.int/docs/default-source/primary-health-care-conference/quality.pdf. Accessed 24.3.2022.

Widström E, Eaton K A. Systems for the Provision of Oral Health Care, Workforce and Costs in the European Union, European Economic Area and Accession States in 2003 – A Council of European Chief Dental Officers Survey. Oral Health Prev Dent 2004a;2:155–194.

Widström E, Linna M, Niskanen T. Productive efficiency and its determinants in the Finnish Public Dental Service. Community Dent Oral Epidemiol 2004b;32(1):31-40.

Widström E, Järvinen S. Caries Prevalence and Use of Dental Services in Finnish Children and Adolescents in 2009. Journal of Oral Health and Dental Management. 2011;10:185-92.

Widström E, Komu M, Mikkola H. Longitudinal register study of attendance frequencies in public and private dental services in Finland. Community Dental Health. 2013;30:143-148.

Widström E, Linden J, Tiira H, Seppälä TT, Ekqvist M. Treatment provided in the public dental Service in Finland in 2009. Community Dent Health. 2015a;32:60–64.

Widström E, Augustdottir H, Byrkjeflot LI, Pälvärinne R, Christensen LB. Systems for provision of oral health care in the Nordic countries. Tandlaegebladet. 2015b;119:702–711.

Widström E, Tillberg A, Byrkjeflot LI, Skudutyte-Rysstad R. Chair-side preventive interventions in the Public Dental Service in Norway. Br Dent J. 2016;221(4):179–8

Widström E, Linden J. Treatment provided in the public dental service and by private dentists in Finland. Oral Health Dent Manag. 2018;17:1024

Working group appointed by the Finnish Medical Society Duodecim, the Finnish Dental Society Apollonia. Finnish Best Practice Guideline. Third Molar 2008. https://www.kaypahoito.fi/en/ccs00056. Accessed 24.3.2022.

Working group appointed by the Finnish Medical Society Duodecim, the Finnish Dental Society Apollonia. Finnish Best Practice Guideline. Caries (control) 2009 https://www.kaypahoito.fi/en/ccs00105. Accessed 24.3.2022.

Working group appointed by the Finnish Medical Society Duodecim, the Finnish Dental Society Apollonia. Finnish Best Practice Guideline. Periodontitis 2010. https://www.kaypahoito.fi/en/ccs00082. Accessed 24.3.2022.

Working group appointed by the Finnish Medical Society Duodecim, the Finnish Dental Society Apollonia. Finnish Best Practice Guideline. Shortened dental arch (SDA) 2013. https://www.kaypahoito.fi/en/ccs00099. Accessed 24.3.2022.

Working group appointed by the Finnish Medical Society Duodecim, the Finnish Dental Society Apollonia. Finnish Best Practice Guideline. Endodontic treatment 2016. https://www.kaypahoito.fi/hoi50110#K1. Accessed 24.3.2022.

Working group appointed by the Finnish Medical Society Duodecim, the Finnish Dental Society Apollonia. Finnish Best Practice Guideline. Tooth restoration 2018. https://www.kaypahoito.fi/hoi50117. Accessed 24.3.2022.

Wänman A, Wigren L. Need and demand for dental treatment. A comparison between an evaluation based on an epidemiologic study of 35-, 50-, and 65-year-olds, and performed dental treatment of matched age groups. Acta Odontol Scand 1995;53(5):318–324