Caries Prevalence and Use of Dental Services in Finnish Children and Adolescents in 2009

Eeva Widström[1], Seppo Järvinen[2]

[1] Ph.D., D.D.S., D.Perio., M.Soc.Sci. Professor of Dental Public Health, National Institute for Health and Welfare (THL), Helsinki, Finland, and Institute of Clinical Dentistry, University of Tromso, Norway. [2] Ph.D., D.D.S. Specialist in Orthodontics and Associate Professor, National Institute for Health and Welfare (THL), Helsinki, Finland.

Abstract

Background: Since 1973, in Finland, practically all children and adolescents have been and are treated in the Public Dental Service (PDS). Since 2002, due to decreasing edentulousness, the PDS has been obliged to provide access also for adults and elderly people needing care. ***Aim:*** The main aim of this study was to survey the use of dental services and numbers of dental visits among 0-17-year-old Finnish children and adolescents and, specifically, to assess the traditional oral health index scores (percentages of caries-free, mean d/D and dmft/DMFT values) in the index age groups of the 5-, 12-, and 17-year-olds in 2009. Additional aims were to compare caries prevalence between different regions and between densely and sparsely populated areas, and to make comparisons with the situation six years earlier. ***Methods:*** The triennial special survey data on the performance of the PDS in 2009 collected by the PDS chief dentists from municipal databases and patient records were analysed. The participating PDS units (health centres) covered 86% of those under the age of 18 years in Finland. Data consisted of numbers of patients, types of dental visits, numbers of examined and caries prevalence (% dmft/DMFT=0, mean d/D and dmft/DMFT) in the index age groups of 5-, 12-, and 17-year-olds in each PDS unit. Chi-square, *t*-test, ANOVA and Bonferroni's post hoc tests were used in the analyses. ***Results:*** Most children and adolescents (70%) had made dental visits in 2009. Visits were more usual in the older (7-17 years; 76.8%) than the younger group (0-6 years; 55.3%). In comparison with earlier studies, the mean D (0.3) and DMFT values (0.7) in the 12-year-olds had improved considerably. However, the overall proportion of caries-free (26.0%) individuals was lower than in 2003. Similar changes could be seen in the 5- and 17-year-olds. A small number of the youngsters still had high mean DMFT values. ***Conclusions:*** Annual visits are no longer the standard procedure in children's and adolescents' dental care and dental hygienists have taken over most of the work. Oral health was found to be on the same good level as in the neighbouring Nordic countries. In this situation, a needs-based enrolment system and teamwork seem to be justified.

Key Words: Caries Epidemiology, National Caries Indices, Children, Adolescents, Public Dental Service

Introduction

Although methods to prevent this transmittable disease are well known, dental caries continues to affect large numbers of children and adolescents in the industrialised countries. A further worry is that its conservative treatment does not provide a permanent solution and once inserted, fillings tend to need frequent replacement. Thus treatment *per se* often tends to cause further treatment need during the rest of an individual's life. In Finland, a study showed that the median functional period of composite and glass-ionomer fillings in children's and adolescents' permanent teeth was 2-3 years [1]. This makes caries an expensive disease to treat. Much effort over a long period has been put into caries prevention in the Public Dental Service (PDS), with various attempts to improve oral health-related behaviours in the population.

Since 1972, Finnish children and adolescents have been offered oral health care by the tax-financed PDS covering the whole country, sparsely populated areas included. Examinations, all necessary care, and preventive measures have been provided free of charge for those under the age of 18 years. This is one of the reasons why practically all children and adolescents (99%) have used the public services. Since the public scheme started, the central authorities have collected information on children's and adolescents' use of dental services and their oral health status from the PDS [2].

Corresponding author: Eeva Widström, THL, P.O. Box 30, FI-00271 Helsinki, Finland; e-mail: eeva.widstrom@thl.fi

In the early years of the public scheme, systematic care and full annual coverage of children and adolescents were emphasised and the PDS had no major role in adult dental care. Thus, in the 1980s, about 90% of the 12-year-olds were seen in the PDS every year. From 1975 to 1988, the national mean DMFT-value in the 12-year-olds fell from 6.9 to 2.0 [2]. A similar improvement has been seen in the other Nordic and most Western European countries [3]. In the 1990s, children's and adolescents' oral health in Finland improved only slightly. The national mean DMFT-value in 12-year-olds stayed around 1.2 from 1994 to 2003 [4]. In 2002, a major dental care reform [5] abolished the age restrictions limiting adults' use of the PDS and generated a need to make existing care provision more efficient in order to meet the new and additional requirement to treat adults as well as children and adolescents.

It was not possible to monitor the effect of the changes on the oral health of children and adolescents in 2006 as organisational changes in the state administration prevented the triennial monitoring of care provision and caries data at a national level. However, in 2010 it was possible again to collect national data for the year 2009. From these data, it has been a standard practice in Finland to calculate the regional and national mean values of d/D and dmft/DMFT and the proportions of caries-free individuals of all those examined (in the index age groups of 5, 12 and 17 years of age) in all PDS units. As long as most individuals in these groups were examined annually throughout the country, monitoring was easy. This is has not been the case during the last 10-15 years as, according to a recommendation on individualised recall intervals for children [6], those with poorest oral health should be examined more frequently than the healthier ones. Using the 2003 data, a survey [4] was conducted to find out whether individual recall intervals influenced the national mean indexes for caries in 5-, 12-, and 17-year-olds. The study showed that low examination rates were associated with slightly poorer oral health. The examination-rate-adjusted mean d/D- values indicated better oral health than the traditional indices. This adjustment slightly worsened oral health in proportions of caries-free individuals, and had almost no effect on dmft/DMFT-values. Overall, the influence was modest. The high proportions of healthy children that were still examined (against the recommendation) and the relatively small number of those having extensive disease (frequently examined as recommended) probably masked the influence of examination rates on the indices in Finland and the conclusion was that in longitudinal follow-up and international comparisons, traditionally calculated indices could be sufficiently valid [4]. Against this background, the current study was performed.

Aim

The main aim of this study was to survey the use of dental services and numbers of dental visits among 0-17-year-old Finnish children and adolescents and, specifically, to assess the traditional oral health index scores (percentages of caries-free, mean d/D and dmft/DMFT values) in the index age groups of the 5-, 12-, and 17-year-olds in 2009. Additional aims were to compare treatment routines and caries prevalence between different regions and between densely and sparsely populated areas and to make comparisons with the situation six years earlier.

Methods

Data from the latest available triennial national survey on the performance of the PDS in 2009 were analysed. The data were collected from the 194 municipal PDS units' databases and patient records by the units' chief dentists. Sufficient data were provided by 154 PDS units, giving a participation rate of 79.4%. In 2009, the total number of 0-17-year-olds in Finland was 1,088,456. The data provided by the 154 PDS units covered 931,864 in these age groups (85.6%).

The national survey data used in this study consisted of the total numbers of 0-5-year-olds, 6-17-year-olds, and 0-17-year-olds living in the uptake area of the PDS units as well as the total numbers of children in the index age groups for caries monitoring, the 5-, 12-, and 17-year-olds (*Table 1*). In addition, the data consisted of numbers of children and adolescents who had made a dental visit (to a dentist, specialist dentist, dental hygienist, or a dental nurse), and the number of visits.

Those who had received treatment with orthodontic appliances were registered separately. In the index age groups, numbers of those examined with complete dental status recorded by a dentist or a dental hygienist were available. From them, the following data were collected:

- Numbers caries-free (dmft/DMFT=0).
- Numbers of decayed teeth (d/D) and sums of dmft/DMFT-values.

Table 1. *Numbers of participating PDS units (health centres) and numbers of children and youngsters in different age groups living in the individual PDS uptake areas in 2009 by geographical areas (county)*

County	South	West	East	Mid-North	Lapland	Aland Islands	Total
PDS units (n)	30	62	26	19	16	1	154
Children and youngsters in the index age groups							
Age (years)							
5	19,141	17,865	4,755	5,491	1,756	286	49,294
12	19,927	19,684	5,716	5,420	2,045	320	53,112
17	21,049	22,860	6,454	5,830	2,423	347	58,963
All children and youngsters							
Age (years)							
0-5	116,949	106,492	28,182	34,975	10,447	1,771	298,816
6-17	238,724	233,602	66,023	66,075	24,709	3,915	633,048
0-17	355,673	340,094	94,205	101,050	35,156	5,686	931,864

- Mean values of decayed teeth (d/D), and mean dmf/DMFT-values in each municipal PDS unit.

A child or an adolescent was defined to be caries-free when all of his/her deciduous/permanent teeth were sound and there were no fillings. A tooth was defined as decayed (d/D) when there was a caries lesion needing restorative care i.e., had caries into dentine. Caries experience was indicated by dmft/DMFT values and the Significant Caries (SiC) index [7]. Enamel caries was not recorded. The PDS units were grouped in geographical areas: 1=South, 2=West, 3=East, 4=Mid-North, 5=Lapland, and 6=Aland Islands.

The traditional method to define the national values of d/D and dmft/DMFT and the proportions of caries-free was used to calculate a ratio of the sums of each index value from each local PDS unit added together divided by the sum of all those examined. Data analyses were performed using statistical software (Microsoft Office Excel; Microsoft Corporation, Redmond, W.A., U.S.A.). ANOVA, chi-square and *t*-test were used to test differences between groups. When ANOVA showed significant differences between several groups, Bonferroni's post hoc test was used to point out the groups that differed from each other.

Results

Dental visiting patterns

The study indicated that overall 69.9% of the children and adolescents under the age of 18 years had visited the PDS in 2009. Dental visits were more

Table 2. *Numbers of children and youngsters and proportions (%) of the total populations (see Table 1) having had a dental visit in 2009 by age group and by geographical area (county)*

County	South	West	East	Mid-North	Lapland	Aland Islands	P^A	Total
0-5-year-olds								
n	56,517	67,713	16,056	17,747	6,296	985		165,314
%	48.3	63.6	57.0	50.7	60.3	55.6	<0.01	55.3
6-17-year-olds								
n	171,360	186,301	51,278	54,395	19,842	3,194		486,370
%	71.8	79.8	77.7	82.3	80.3	81.6	>0.05	76.8
0-17-year-olds								
n	227,877	254,014	67,334	72,142	26,138	4,179		651,684
%	64.1	74.7	71.5	71.4	74.3	73.5	<0.05	69.9

P^A; one-way ANOVA
Bonferroni correction: 0-5-year-olds: South/West P<0.01. 0-17-year-olds: South/West P<0.01, South/Lapland P<0.05

usual (76.8%) in the older age group (6-17-year-olds) than in the younger group (55.3%) (*Table 2*). In the southern region, the proportion of children (64.1%) seen by dental personnel (a dentist, dental hygienist, or a dental nurse) was significantly lower than in the other counties (*Table 2*). Of the 6-17-year-olds, 12.6% had made visits for orthodontic treatment. Unsurprisingly, in the younger age group orthodontic visits were not common (0.3%).

The 0-5-year-olds had had on average slightly more than one visit (1.3) and those in the older age group 3.1 visits. Regionally, the mean numbers of visits varied less in the younger than in the older age group. Highest mean numbers of visits were found in Mid-North (*Table 3*).

Examinations

Slightly more than half of the 5-year-olds (53.5%), 60.6% of the 12-year-olds, and 37.0% of the 17-year-olds had been examined during 2009. Most examined children were found in Aland Islands, where the percentages examined ranged from 61.1 % for 17-year-olds to 80.6% for 12-year-olds, and least in Mid-North, where the percentages examined ranged from 29.8% for 17-year-olds to 58.4% for 12-year-olds. The 12-year-olds group was the one that was examined most comprehensively (coverage highest) (*Table 4*).

Dental health

Just over a third (39.2%) of the 5-year-olds, a quarter (26.1%) of the 12-year-olds, and 7.3% of the 17-year-olds who had had an examination provided by a dentist or dental hygienist in 2009 were caries-free (*Table 5*). In all age groups, Aland Islands had the highest and Mid-North the lowest proportions of caries-free individuals. In the oldest age group, the proportion of caries-free individuals was low in all regions (*Table 5*).

Table 3. *Total numbers and mean numbers of dental visits among those who had had a dental visit in 2009 by age group and geographical area (county)*

County	***South***	***West***	***East***	***Mid-North***	***Lapland***	***Aland Islands***	P^A	**Total**
0-5-year-olds								
n	72,607	86,198	20,470	24,008	8,557	1,183		213,023
mean	1.3	1.3	1.3	1.4	1.4	1.2	<0.01	1.3
6-17-year-olds								
n	521,144	580,953	146,617	181,134	58,669	7,540		1,496,057
mean	3.0	3.1	2.9	3.3	3.0	2.4	<0.05	3.1
0-17-year-olds								
n	593,751	667,151	167,087	205,142	67,226	8,773		1,709,130
mean	2.6	2.6	2.5	2.8	2.6	2.1	<0.01	2.6

P^A; one-way ANOVA
Bonferroni correction: 0-5-year olds: South/Lapland P<0.05, West/Lapland P<0.01

Table 4. *Numbers of children and youngsters examined (dental health status recorded) in the index age groups and proportions (%) of the total populations by geographical areas*

County	**South**	**West**	**East**	**Mid-North**	**Lapland**	**Aland Islands**	P^A	**Total**
5-year-olds								
n	9,680	10,347	2,767	2,351	1,022	176		26,343
%	50.5	57.8	58.2	42.8	58.1	61.5	>0.05	53.5
12-year-olds								
n	11,476	12,606	3,413	3,167	1,260	258		32,180
%	57.6	64.6	59.7	58.4	61.6	80.6	>0.05	60.6
17-year-olds								
n	7,589	9,273	2,030	1,735	976	212		21,815
%	36.1	40.6	31.5	29.8	40.3	61.1	>0.05	37.0

Table 5. *Numbers and proportions (%) of caries-free children and youngsters in the index age groups in 2009 by geographical area (county)*

County	South	West	East	Mid-North	Lapland	Aland Islands	P^A	Total
5-year-olds								
n	7,692	7,534	1,965	1,389	622	140		19,342
%	40.2	42.2	41.3	25.3	35.4	49.0	<0.05	39.2
12-year-olds								
n	4,438	5,584	1,625	1,486	575	136		13,844
%	22.3	28.4	28.4	27.4	28.1	42.5	>0.05	26.1
17-year-olds								
n	1,305	1,908	518	249	248	47		4,275
%	6.8	8.4	8.0	4.3	10.2	13.5	<0.05	7.3

P^A; one-way ANOVA
Bonferroni correction: 5-year-olds: East/Mid-North P<0.05, Mid-North/Lapland P<0.05. 0-17-year-olds: West/Mid-North P<0.05, Mid-North/Lapland P<0.05

Table 6. *Total numbers and mean numbers of decayed teeth (d/D) in the index age groups in 2009 by geographical area (county)*

County	South	West	East	Mid-North	Lapland	Aland Islands	P^A	Total
5-year-olds								
n	3,498	4,066	1,047	1,897	451	102		11,061
mean	0.2	0.2	0.2	0.4	0.3	0.4	>0.05	0.2
12-year-olds								
n	4,640	5,588	1,271	2,132	704	102		14,376
mean	0.2	0.3	0.2	0.4	0.3	0.1	>0.05	0.3
17-year-olds								
n	7,796	10,408	2,245	2,599	1,197	128		14,376
mean	0.4	0.5	0.4	0.5	0.5	0.4	>0.05	0.4

P^A; one-way ANOVA

Mean numbers of decayed teeth were low in all age groups (*Table 6*) and the differences between the local areas were small and not statistically significant. Also, the mean dmft/DMFT index values were low in all age groups and there were differences between North and South. Only a few PDS units (31; 20.1%) had been able to give information on the SiC index with the intention of focusing attention on those individuals with the highest caries scores in each age group. In those PDS units that provided this information, the SiC index was two to three times higher than the mean dmft/DMFT value (*Table 7*).

Differences between PDS units

The variation between local PDS-specific mean dmft/DMFT values was great, as illustrated in *Table 8.* The caries prevalence was statistically significantly higher in the smallest rural municipalities than in the biggest cities (*Table 9*).

Table 8. *Mean dmft and DMFT in 31 PDS units with lowest and 31 with highest index values*

		Lowest 31 Mean	Highest 31 Mean	P^t
Age (years)				
5	dmft	0.1	0.8	<0.05
12	DMFT	0.3	1.3	<0.05
17	DMFT	0.8	2.9	<0.05

P^t; t-test

Comparison with the previous survey

Numbers and proportions of children examined in the index age groups had decreased over the last six years. The proportion of caries-free individuals had dropped considerably. However, dental health measured with the d/D and dmft/DMFT indices had improved in all age groups (*Table 10*).

Table 7. *Total numbers and mean numbers of dmft/ DMFT values and the SiC index in the index age groups in 2009 by geographical area (county). Numbers of PDS units having been able to give the SiC index indicated separately*

County	**South**	**West**	**East**	**Mid-North**	**Lapland**	**Aland Islands**	***P***	**Total**
5-year-olds								
n	4,925	5,750	1,677	2,568	742	124		15,786
mean dmft	0.3	0.3	0.4	0.5	0.4	0.4	$<0.5 P^A$	0.3
12-year-olds								
n	11,234	14,367	3,651	4,658	1,610	194		35,714
Mean DMFT	0.6	0.7	0.8	0.9	0.8	0.6	$<0.05 P^A$	0.7
17-year-olds								
n	23,208	33,291	7,272	7,639	3,906	674		75,990
mean DMFT	1.1	1.5	1.1	1.3	1.6	1.9	$<0.05 P^A$	1.3
5-year-olds								
SiC index	0.6	0.9	0.8	0.7	0.9			0.8
PDS units (n)	1	8	4	9	9		$<0.01^X$	31
12-year-olds								
SiC index	0.3	1.3	1.5	1.5	1.8			1.3
PDS units (n)	0^{ni}	17	3	7	4		$>0.05^X$	31
17-year-olds								
SiC index	3.1	2.8	3.0	2.6	3.3			2.9
PDS units (n)	1	17	5	4	4		$>0.05^X$	31

$^{ni;}$ not included
P^A; one-way ANOVA; $^{X;}$ chi-square test
Bonferroni correction: 5-year-olds: South/Mid-North P<0.5; 12-year-olds: South/Mid-North P<0.05; 17-year-olds: South/West P<0.01

Table 9. *Mean dmft and DMFT in the PDS units (health centres) of the ten biggest cities and the ten smallest (rural) municipalities*

Biggest cities		**Mean**	**Min**	**Max**
5-year-olds	dmft	0.3	0.1	0.5
12-year-olds	DMFT	0.6	0.3	1.1
17-year-olds	DMFT	1.0	0.5	1.9
Smallest PDS units		**Mean**	**Min**	**Max**
5-year-olds	dmft	0.6	0.6	1.4
12-year-olds	DMFT	1.4	0.5	2.9
17-year-olds	DMFT	2.3	0.5	4.4
P; *t*-test		<0.05	<0.05	<0.05

Table 10. *Comparison with the special survey conducted in 2003 [4]*

	Examined (%)	**Caries-free** (%)	**d/D** (mean)	**dmf/DMF** (mean)
5-year-olds				
2003	62.0	72.7	0.6	0.9
2009	53.5	39.2	0.3	0.3
12-year-olds				
2003	70.0	45.7	0.6	1.3
2009	60.6	26.1	0.3	0.7
17-year-olds				
2003	47.7	25.9	1.2	4.0
2009	37.0	7.3	0.4	1.3

Discussion

Monitoring the performance of the dental care provision system has been considered important in Finland and the triennial special surveys in the PDS have played a central role in this process. In recent years, each year, about 70% of the children and adolescents and slightly more than 50% of the adults have made a dental visit (half of the adults have visited the PDS and the other half private services). Although in both sectors, dental visits have become more usual in the older age groups (50+ years), adults' use of dental services is still much lower than in the other Nordic countries [8]. In the PDS, the numbers of children seen and treated have slightly decreased along with a decrease in caries prevalence. Now, slightly less than half of the patients in the PDS are children and adolescents. Monitoring caries incidence and prevalence in these groups is thus nationally important and, according to literature [9], this will also internationally remain an indispensable part of dental public health. The World Health Organization (WHO) continues publishing global oral health data on 12-year-olds, and the Council of European Chief Dental Officers regularly updates data on this age group in European countries. International comparisons have been considered as interesting and politically important and are frequently used when setting health political goals.

In an earlier study in Finland, assessments of oral health made by PDS dentists and trained epidemiologists who examined the same children were compared and found to be satisfactorily similar, especially in larger settings [10]. Uniform instructions on (simple) diagnostic criteria to be used are given to the PDS by the health authorities and there is a long tradition of monitoring oral health in children. In addition, specific codes are used to record every treatment procedure, including examinations, in the PDS. These codes are used to pay dentists additional productivity fees based on treatments provided. This may also encourage careful recording.

Clinical, epidemiological studies on random samples of youngsters are often recommended as the gold standard for monitoring oral health. Unfortunately, such studies require special arrangements and separate financing. Collecting data (on non life-threatening conditions) in connection with care provision is considered to be a more feasible way in countries where children and youngsters have organised care and are actively invited for examinations. In all the Nordic countries, statistical information on children's use of oral health services and oral health is collected regularly from the PDS. Most of these countries use index age groups, usually the 5- or 6-year-olds, 12-year-olds and 17-, 18-, or 19-year-olds, depending on the extent of free care. Although individual recall intervals are practised in Finland, a recent study showed that practically all children have been seen during a three-year period [11]. The authors therefore suggest that the data presented in this paper can thus be regarded as sufficiently reliable and the results can be generalised over the whole country. Data on the periodontal status of all patients seen in the PDS are collected using the Community Periodontal Index (CPI). However, because, over the last two decades, several studies have highlighted the deficiencies of the Community Periodontal Index of Treatment Need (CPITN) and more recently the CPI and questioned their value as reliable epidemiological tools [12], no data on the periodontal health of 0-17-year-olds in Finland are presented in this paper.

Slightly more than half of the 0-5-year-olds and two-thirds of the 6-17-year-olds had made a dental visit in 2009. Most dental visits, especially in the youngest age group, were likely to have been made to dental hygienists. In order to realise the ambitions of the recent dental care reform in 2002 aiming to improve access to care for the adult population [5], teamwork has been emphasised in the PDS and more dental hygienists have been employed. Today, Finland is one of the five EU member states with the highest proportion of dental hygienists:dentists [13].

In the older age group (6-17-year-olds), about one in ten had made orthodontic visits and they tended to be many which in part explains the relatively high mean number of visits made by this group. In Finland, there is a tradition that ordinary PDS dentists provide quite a lot of orthodontic treatment [14].

The examination rates varied between the index age groups. The youngest and especially the oldest were examined less often than the 12-year-olds, the age group that has traditionally been used as the main reference group in national and international monitoring. The lower examination rate for 5-year-olds may be explained by the fact that this age group was not going to school in Finland and it was not easy to reach pre-school-aged children. The 17-year-olds were also more difficult to recall, as some no longer went to school.

Mean numbers of decayed teeth were low in all age groups. Also, the mean dmft/DMFT values were considerably lower than in the previous study in 2003. Regional differences were still significant

and Southern Finland, with its relatively wealthier and more highly-educated population, showed the best results. Partly for historical reasons, in all Nordic countries dental care and oral health are worse in the North [15]. The small, Swedish-speaking, wealthy autonomous area, the Aland Islands, were also shown to have low caries prevalence.

Comparisons between large urban and small rural as well as "the best and the worst" PDS units showed some large differences between individual health centres. This may reflect true inter-municipality differences in oral health, as has been seen in Denmark [16], or differences in use of radiographic assessment and diagnostic criteria. The most surprising finding in this study was the low proportions of caries-free (DMFT=0) in all age groups. The individualised recall intervals probably explain most part of this finding [4] but there might be other reasons e.g., sealant restorations or fissure sealants.

Compared with data on 12-year-olds in the other Nordic countries, caries prevalence in Finland seems to be on a similar good level as in Denmark and Sweden, except that in Finland in 2009 there was a lower percentage of caries-free individuals in this age group [8]. There are several EU member states also showing comparable data [3]. However, although only a minority of PDS clinics provided a SiC, it seems likely from the data provided by these PDS clinics that caries remains a problem for a minority of Finnish 0-17-year-olds.

Conclusions

Annual visits are no longer the standard procedure in children's and adolescents' dental care and dental hygienists have taken over most of the work. Oral health was found to be on the same good level as in the neighbouring Nordic countries. In this situation, a needs-based enrolment system and teamwork seem to be justified.

Contributions of each author

- EW designed the study, collected data, and wrote the paper.
- SJ performed the data analysis and produced the tables. Both authors have read and approved the final manuscript.

Statement of conflict of interests

As far as the authors are aware, there are no conflicts of interest.

References

1. Forss H, Widström E. The post-amalgam era: a selection of materials and their longevity in the primary and young permanent dentitions. *International Journal of Paediatric Dentistry* 2003; **13**: 158-164.

2. 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, Finland: Gummerus Kirjapaino; 2004. [Finnish]

3. Council of the European Chief Dental Officers (CECDO). Oral Health Database [website]. Accessed (2011 Nov 15) via: http://www.cecdo.org

4. Suominen-Taipale AL, Widström E, Sund R. Association of examination rates with children's national caries indices in Finland. *The Open Dentistry Journal* 2009; **3**: 59-67.

5. Niiranen T, Widström E, Niskanen T. Oral health care reform in Finland: aiming to reduce inequity in care provision. *BMC Oral Health* 2008; **8**(3).

6. Lahti S, Hausen H, Widström E, Eerola A. Intervals for oral health examinations among Finnish children and adolescents: recommendations for the future. *International Dental Journal* 2001; **51**: 57-61.

7. Bratthall D. Introducing the Significant Caries Index together with a proposal for a new global oral health goal for 12-year-olds. *International Dental Journal* 2000; **50**: 378-384.

8. Nordisk Ministerrad. *Nordisk kvalitetsmaling i sundhedsvaesenet [Nordic Quality Measurement of Health Care].* TemaNord 2010: 572. Available from: http://www.norden.org/da/publikationer/publikationer/2010-572 [Danish/Swedish]

9. Marthaler TM. Changes in dental caries 1953-2003. *Caries Research* 2004; **38**: 173-81.

10. Hausen H, Kärkkäinen S, Seppä L. Caries data collected from public health records compared with data based on examinations by trained examiners. *Caries Research* 2001; **35**: 360-365.

11. Tuononen T, Suominen L, Widström E. Regular or individualised recall intervals in the Finnish Public Dental Service? [abstract E.A.D.P.H., Rome, Italy] *Annali di Stomatologia* 2011; **2(1-2)** Suppl: 16.

12. Leroy R, Eaton KA, Savage A. Methodological issues in epidemiological studies of periodontitis: how can it be improved? *BMC Oral Health* 2010; **10**: 8.

13. Widström E, Eaton KA, Luciak-Donsberger C. Changes in dentist and dental hygienist numbers in the European Union and Economic Area. *International Dental Journal* 2010; **60**: 311-316.

14. Pietilä I, Pietilä T, Varrela J, Pirttiniemi P, Alanen P. Trends in Finnish public orthodontic care from the professionals' perspective. *International Journal* of *Dentistry* 2009; doi: 10.1155/2009/945074

15. Widström E, Koposova N, Nordengen R, Bergdahl M, Eriksen H, Fabrikant E. Oral health care in the Barents region. *International Journal of Circumpolar Health* 2010; **69**: 486-499.

16. Ekstrand KR, Christiansen MEC, Qvist V. Influence of different variables on the inter-municipality variation in caries experience in Danish adolescents. *Caries Research* 2003; **37**: 130-141.