Dental age and dental health determined longitudinally from patient records in three towns in Finland

Marjut Korhonen and Markku Larmas

Department of Pedodontics, Cariology and Endodontics; Institute of Dentistry, University of Oulu and Oulu University Hospital; Health Center of Oulu, Oulu, Finland

Korhonen M, Larmas M. Dental age and dental health determined longitudinally from patient records in three towns in Finland. Acta Odontol Scand 2003;61:105–109. Oslo. ISSN 0001-6357.

The aims of this study were to test the suitability of normal dental records in determining the eruption times of teeth and to compare the retrospective longitudinal DMF values with the statistical cross-sectional means. Patient records for two cohorts (1970 and 1980) were collected from three Finnish towns. The study population comprised 1910 children. The eruption times of the permanent teeth, DMFT and DMFS curves (excluding F due to fractures and M due to orthodontic reasons) were investigated for the year of examination in different study locations. The cross-sectional DMF values were compared to longitudinally calculated data. Tooth eruption was earlier in girls than in boys. However, girls did not have significantly higher DMF values than boys. In all towns, dental health was significantly better in the 1980 cohort than in the 1970 cohort. Comparison of the cross-sectional DMF values in the municipal health center statistics showed that the mean statistics gave considerably higher values than the measured values did after 15 years of age. The inconsistency between measured longitudinal DMF values and the cross-sectional statistical DMF values indicates the importance of creating computer programs for analyzing data longitudinally from normal dental records. □ *Dental health survey; DMF index; DMFS; tooth count; tooth eruption*

Marjut Korhonen, Institute of Dentistry, University of Oulu, P.O. Box 5281, FI-90401 Oulu, Finland. Tel. +358 8 537 5011, fax. +358 8 537 5560, e-mail. marjut.korhonen@oulu.fi

Patient documents provide a large, retrospective longitudinal data bank for scientific analysis when oral health services include dental examinations (and treatments), e.g. at 1-year intervals. Since 1972, these services have been available to all children and youths under the age of 19 years in Finland. Annual examinations provide the basis for national mean DMFT and DMFS indexes in different countries which are also reported in scientific journals, the latest analysis reporting caries decline and incidence in terms of DMF scores among Norwegian adolescents (1).

From a strictly scientific point of view, DMF(S) values should be recorded by calibrated examiners only. Because, in practice, the F component determines a great part of the DMF(S) value after the age of 10 years in industrial countries, analysis of DMF values from normal dental records may be accurate enough also for scientific purposes.

Dental health is influenced by tooth age, which can differ considerably during the period of mixed dentition, i.e. during the pre-teens and teens (2–4). It should be noted that the term 'tooth age' can be replaced by the term dental age, which is also used for the age of a child based on an evaluation of the developmental stage of the dentition. We therefore use the term 'tooth age' when describing the age of a tooth from its eruption. The differences between DMF values may be due to differences in the eruption times of the teeth, e.g. the differences in the DMF values between boys and girls may simply be due to the earlier eruption of the teeth in girls (5). There is no doubt that the length of exposure of the teeth to cariogenic challenge is of primary importance on an individual level, but this is also true on a population level if the tooth eruption times vary systematically between cohorts. In Finland, scientific data on the eruption time-table have recently become available (6) and therefore comparison of data between scientific analysis and retrieved from dental records is possible.

The aim of this study was, first, to test the suitability of normal dental records in the routine determination of dental health in terms of longitudinal DMFT and DMFS values and the eruption times of teeth in the course of normal dental treatment to provide a scientific basis for everyday clinical practice. The second aim was to determine whether the eruption times of the teeth differ systematically between sexes and in different towns in Finland, one of which had fluoridated drinking water. The third aim was to compare the retrospective, longitudinal DMF values from dental records with the cross-sectional statistical means of the health centers in cohorts born in 1970 or in 1980 in these towns. Because most scientific cross-sectional DMF analyses are conducted by calibrated examiners who are unable to determine the reasons for extractions, the order of magnitude of for example orthodontic extractions or fillings due to trauma in the MF component is also determined here.

Materials and Methods

In this retrospective study, data were collected for three towns in Finland (Oulu, Turku and Kuopio). Patient records were collected for two cohorts; in the first were children born in 1970–71 (1970 cohort) and in the second children born in 1980–81 (1980 cohort). Either the subjects were randomly selected from the files of the health

Taylor & Francis healthsciences

DOI 10.1080/00016350310001460

center or a total sample of the age cohort was taken. The study protocol was approved by the Ethics Committee of the Medical Faculty of the University of Oulu.

The primary criterion for inclusion was that subjects had to be citizens born and living in the town in question. The oral health records were copied so that the children could not be identified (the last names and social security codes were rendered). The 1980 cohort consisted of 369 children from Oulu, 200 children from Turku and 386 children from Kuopio, whereas 281 children from Oulu, 268 children from Turku and 406 children from Kuopio made up the 1970 cohort.

The subjects were examined annually and treated free of charge by dentists in the municipal health centers. Observations were made on every tooth (excluding the third molars) on the tooth-surface level. Timing of the eruption of each individual tooth, placement of first fillings due to caries on each tooth surface and extractions were recorded. Extractions for orthodontic reasons were excluded from the DMF values. Up to the age of 16 years the normal interval between examinations was 10–13 months; thereafter an acceptable interval was 18 months. If an observation was longer than 18 months, it was censored. At least one dental examination was carried out in the 1990s.

Timing of the eruption of each individual tooth for boys and girls was recorded and determined to an accuracy of 1 month. The placement of a filling due to dental caries extending into dentin was classified as a D lesion. All earlier stages of carious lesions were considered to be sound.

Statistics for the mean DMF values of the health centers were obtained from the Annual Reports of each health center. In the longitudinal DMF determination, the 1970 cohort was registered as having been born on 1 January 1970 and the 1980 cohort on 1 January 1980, regardless of the real birth date. Real chronological age was related to the DMF value, and not when the fillings had been placed in the tooth.

A computer was set up to handle all the data with SAS statistical software. Differences between groups were tested using the t test and one-way Anova. A difference was considered to be statistically significant if the P value was <0.05.

Results

The first set of permanent teeth erupted during the first

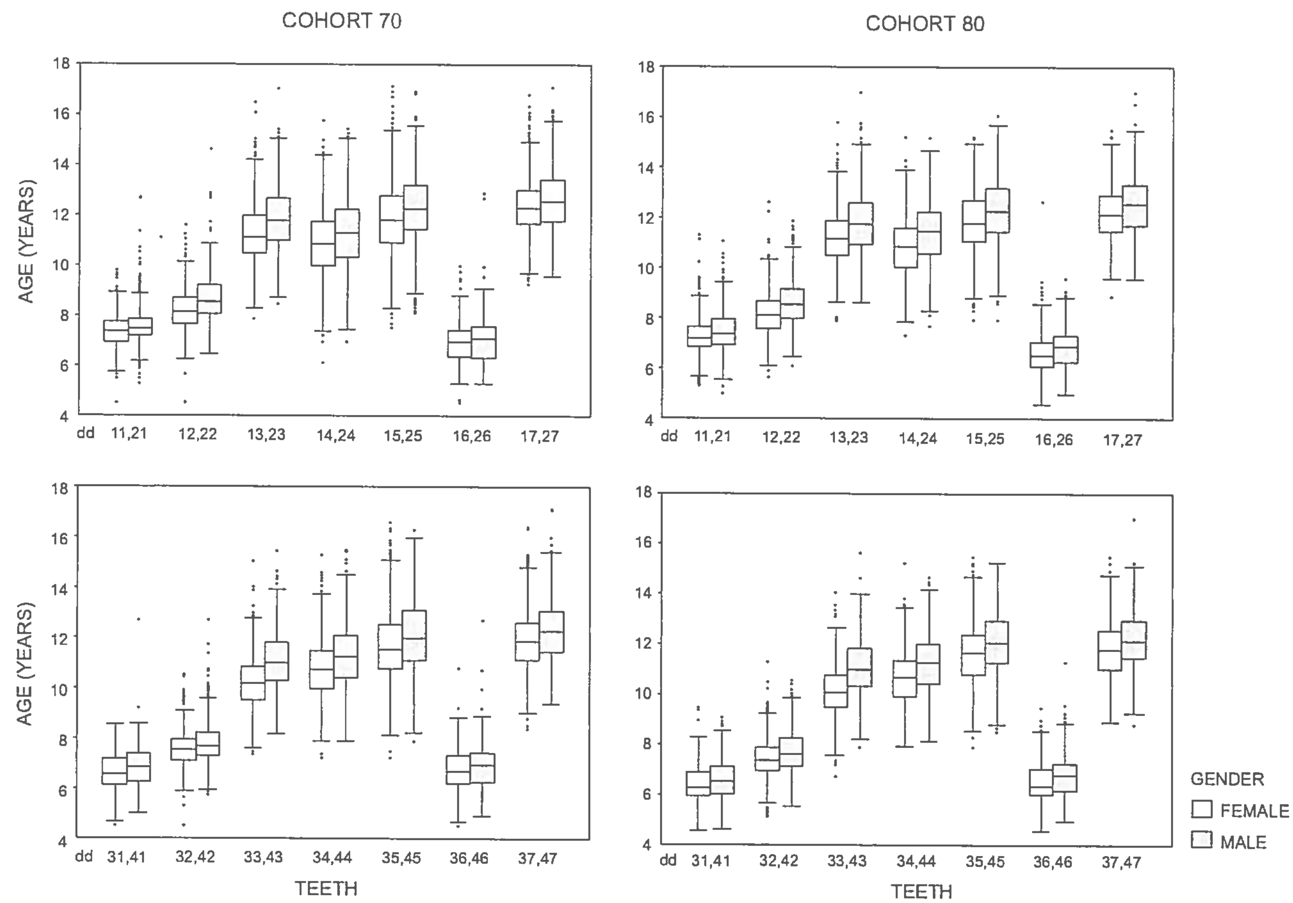

Fig. 1. Box-plot of the eruption times of permanent teeth in years. Mandible and maxilla are drawn separately for both sexes and both cohorts. Teeth are designated in accordance with the two-digit system.

transitional phase at the age of 6–8 years and the second set of permanent teeth at 10–12 years. The quartiles were relatively narrow but the ranges were large (Fig. 1). The extremes are also shown in Fig. 1. The tendency toward early or late eruption was seen in the figures for eruption times, so that if any tooth in the first transitional phase erupted early, all other teeth in the first and also the second transitional phases erupted early.

In both birth cohorts and in all towns teeth erupted earlier in girls than in boys. This difference was statistically significant. No consistent difference between towns was observed and therefore the mean eruption times for girls and boys, quartiles, range and extremes were drawn combined (Fig. 1).

Comparison between the town of Kuopio, with fluoridated water, versus other towns resulted in a statistically significant difference ($P < 0.05$) between eruption times in only a few individual teeth, and there was no consistent difference between fluoridated and low fluoride areas. When eruption times between the 1970 and 1980 cohorts were compared the difference was statistically significant mainly in the first transitional phase in girls; in boys, the eruption occurred earlier in the 1980 cohort than in the 1970 cohort.

DMF curves for the year of examination were drawn for each of the three towns. The shapes of the longitudinal DMFS curves of the birth cohorts 1970 and 1980 were different: the older cohort had a rapid upward bending at the age of 7–8 years in all towns, which was not the case in the 1980 cohort. The differences between the towns were more pronounced in the 1970 cohort. Any difference was not statistically significant (Fig. 2).

When the longitudinal DMFT values from the records were compared to the official cross-sectional statistics of the municipal health centers in 1985, the mean statistics gave about the same values in the 1970 cohort than the measured values did (Fig. 2). In Oulu, a great difference existed between the two data sets after the age of 16 years (Fig. 2). Fillings inserted due to fractures as well as teeth extracted for orthodontic reasons played a minor role (maximum 0.2 DMF units) compared to MF values due to dental caries.

Discussion

This study is based entirely on data retrieved from dental records; in other words, not data obtained by calibrated examiners. The caries data are based on fillings in teeth with dentin caries. Since it is well known that there is great variability between dentists in their criteria for placement of fillings, it should be requested how it is sure that fillings were done on carious lesions only. And since there has also been a general trend of dentists changing their criteria for restoration over time, it is questionable whether these data can be used to test differences in the real caries prevalence between the two cohorts.

Whenever a filling or missing tooth is observed in the mouth, the diagnosis of caries attack has been made by another person on a previous occasion. There are therefore no epidemiological studies anywhere in world dealing with the DMF values which have been conducted by calibrated examiners in practice, although there are hundreds of papers of DMF values by calibrated examiners published in different countries and areas. The concept of declining prevalence of dental caries is based on declining DMF scores, which in practice is the F value after the age of 10 years of age in industrialized countries. Because the F value is the component which

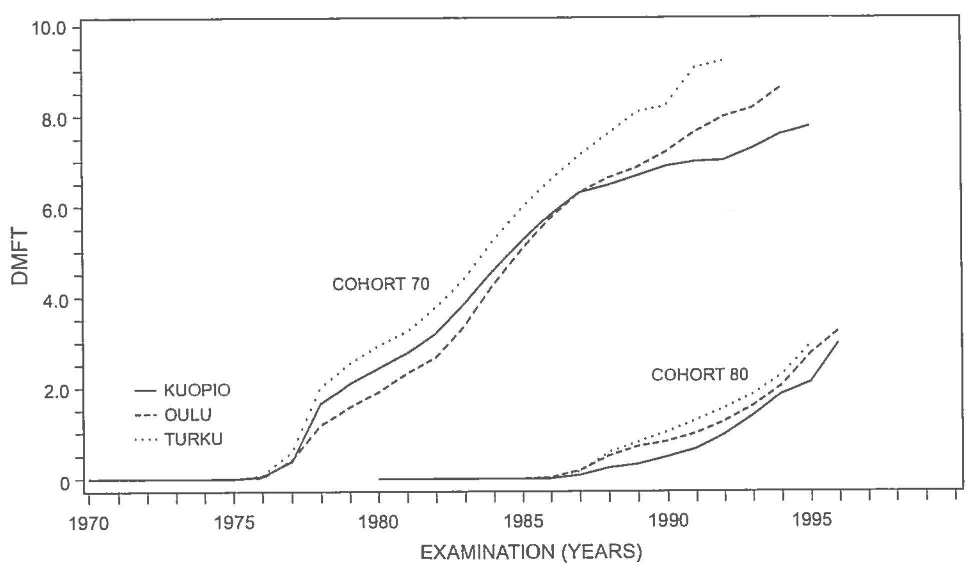

Fig. 2. DMFT curves for year of examination at different study locations. The Y-axis represents DMFT values and the X-axis the examination years. The subjects are converged to be born on 1 January 1970 in the 1970 cohort and on 1 January 1980 in the 1980 cohort regardless of their real birth date.

determines the DMF value, 'caries' in all epidemiological cross-sectional studies is determined by uncalibrated dentists. A recent study from Norway used the expression 'caries decline from 1985 to 2000' in the title, while in the text it was reported that 'the mean DT at the dentinal level remained at about 0.8 for 12-year-olds and 1.2 for 18-year-olds throughout the observation period' (1). The term 'DMFT scores decline' was used in the text and thus only the title of the article was misleading for those who are not familiar with studies of caries epidemiology.

It is now time to stop using DMF score as 'caries prevalence' and also to understand that calibrated dentists are not necessarily needed in the determination of F-values when most of the fillings are made of amalgam. On the other hand, trained examiners are needed when composite materials are the main determinant of the F value and, of course, in clinical trials when researchers analyze the incidence of new caries lesions during certain years, calibrated dentists are urgently needed.

In our previous work, we demonstrated that some of the problems concerning determination of the F component in caries prevalence studies can be avoided by tooth-by-tooth longitudinal determinations: we demonstrated that the increase in caries attack of the second phase of mixed dentition in the teens was less than the decline occurred at the first permanent molars in the same subjects in the 1980 cohort, resulting in a decline of DMF values, although a deterioration of caries situation has occurred in contemporary teeth (7). Here we can demonstrate that the proportion of teeth filled or extracted for orthodontic or traumatic reasons was minor. We also demonstrated that the statistical caries 'incidence' obtained from repeated cross-sections in certain years was not much different from the longitudinal caries increment when the change in the oral health situation was small. However, during a rapid change, as was the case in the 1970s in Finland, the difference was great (Fig. 2). This should be taken into account in the analysis, too.

Findings concerning the eruption pattern of permanent teeth as seen in normal dental records indicate that although the quartiles were narrow the individual variation in tooth emergence was great and that eruption occurs earlier in girls than in boys (Fig. 1), a difference that is statistically significant. The figures used are registered in the course of ordinary dental treatment with a normal interval of examination of 1 year (thus the mean can be reported with an accuracy of 0.1 years); a deduction of 0.5 years should be made from the reported mean ages. Thereafter, normal dental records give the same mean times for tooth eruption as recent accurate longitudinal epidemiological analyses do in Finland (6).

Longitudinal scientific studies are those which give accurate mean/median values and deviations for tooth emergence, but they are time and resources consuming to conduct. Therefore, they are normally conducted on a relatively small number of subjects. Recently, a longitudinal study of the emergence of permanent teeth was conducted on 187 Finnish children born in Helsinki or the vicinity in 1967–73 (6). The emergence was recorded in dental examinations on a semi-annual or annual basis by calibrated researchers (dentists) and confirmed by exact dates recorded in specially designed booklets by parents. In addition, clinical records were checked with the help of dental casts and panoramic tomograms (9). This accuracy in recording the emergence time should weigh against the weakness of the analysis, e.g. are the 187 children born in Helsinki (in 1967–77) a representative sample of 5.2 million Finns of today. Our results on more than 10 times the number of children in 3 other towns in Finland suggest that the answer is yes. Our values are exactly the same as in Nystrom's study (6), although they were recorded from the patient records. If the examination interval is 1 year at least during the first and second transitional phases of tooth eruption, this determination can be included in the normal treatment routine. Knowledge of the timing of emergence of specific teeth and normal variations are needed in clinical orthodontics and pedodontics, especially because the risk for the first carious attack is highest immediately after tooth eruption, at least in molars (8, 9).

Correctly filed normal dental records are evidently accurate enough for determination of tooth eruption. Consequently, very important times for dental examination are the first transitional phase (6–8 years of age) and the second transitional phase (10–11 years of age). Another clinical implication is the fact that early (or late) eruption of any of the first permanent tooth predicts early (or late) eruption of other permanent tooth, as has also been shown previously (4). This points to use of the term 'dental age': the tooth age of one single tooth reflects the development stage of the dentition, i.e. dental age of the subject.

Dental health is normally based on cross-sections of examinations of DMF(S) scores in certain years. In Finland, where dental examinations are performed regularly, a longitudinal data bank is also available; and therefore repeated cross-sections can be replaced by longitudinal data. When the present data based on records were compared to the longitudinal data collected from the repeated cross-sections, the shapes of the DMFT (and DMFS) curves were about the same but were considerably different from the cross-sections for example in 1985 in Oulu from the age of 16 years onwards (Fig. 3). The great difference clearly demonstrates the difference between longitudinal and cross-sectional studies. Subjects older than 16 years of the statistics cohort were born in the 1960s when the prevalence of caries was extremely high in Finland (9), resulting in the bending of cross-sectional DMF value at the age of 16 years in 1985. This indicates the importance of creating a computer program for analyzing data longitudinally when possible instead of using repeated cross-sections.

The differences between the annual statistics and the measured DMF values of the 1970 cohort are probably due to the fact that in the 1970s teeth extracted for orthodontic reasons, fillings due to fractures, and even enamel caries were often included in the DMF index. The incidence of fractures in Finland is about 2.1% per year in

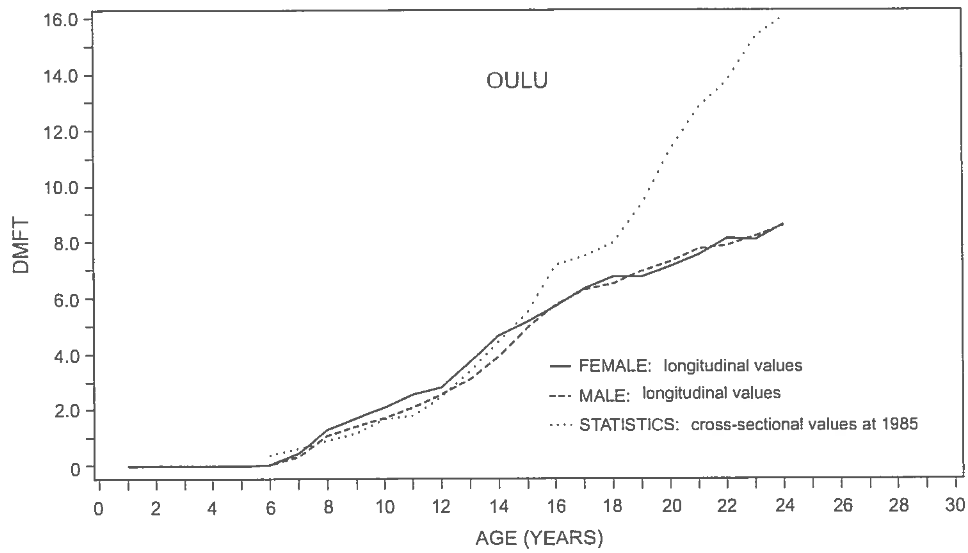

Fig. 3. DMFT curves for boys and girls separately, calculated longitudinally from Oulu data of the 1970 cohort compared to cross-sectional statistical DMF values in 1985 from Oulu. The study cohort was 15 years old in 1985; before that age their DMF values were worse than average and after 1985 much worse than the cross-sectional average.

7–16-year-olds, resulting in about 0.02 DMF units if the mean frequency of fractures is one tooth (10). This small misinterpretation of DMF statistics disappeared in the 1980 cohort.

In the national statistics, the curves for boys and girls are combined. Theoretically, this is not correct, because the significantly earlier tooth eruption in girls means that girls are exposed to caries for longer than boys are. However, this longer exposure time is only 3–5 months, which does not result in significantly higher DMFT and DMFS values in girls than in boys; and thus the curves for boys and girls can be combined. In conclusion, this study demonstrates that: (i) normal dental records with examination intervals of 1 year are accurate for individual determination of tooth eruption times, which can then be used as the basis of dental treatment; (ii) repeated cross-sections of DMF(S) scores can easily be replaced by longitudinal data, which is important especially when dental health is changing in either direction; (iii) the proportion of fractures in the F component, or orthodontic extractions in the M component, is not as high as had been predicted in the situation of low-caries communities; (iv) the follow-up of tooth eruption and first caries attack from patient records is not meant to replace scientific analysis, but it does give additional information on longitudinal changes for the clinical background.

References

1. Birkeland JM, Haugejorden O, Fehr FR vd. Analyses of the caries decline and incidence among Norwegian adolescents 1985–2000. Acta Odontol Scand 2002;60:281–9.
2. Haavikko K. The formation and the alveolar and clinical eruption of the permanent teeth: an orthopantomographic study. Proc Finn Dent Soc 1970;66:103–70.
3. Pahkala R, Pahkala A, Laine T. Eruption pattern of permanent teeth in a rural community in northeastern Finland. Acta Odontol Scand 1991;49:341–9.
4. Virtanen JI, Bloigu RS, Larmas MA. Timing of eruption of permanent teeth: standard Finnish patient documents. Community Dent Oral Epidemiol 1994;22:286–8.
5. Virtanen JI, Bloigu RS, Larmas MA. Effect of early or late eruption of permanent teeth on caries susceptibility. J Dent 1996;24:245–50.
6. Nyström M, Kleemola-Kujala E, Evälahti M, Pecks L, Kataja M. Emergence of permanent teeth and dental age in Finns. Acta Odontol Scand 2001;59:49–56.
7. Korhonen M, Käkilehto T, Larmas M. Tooth-by-tooth survival analysis of the first caries attack in different age cohorts and health centers in Finland. Acta Odontol Scand 2003;61:1–5.
8. Larmas MA, Virtanen JI, Bloigu RS. Timing of first restorations in permanent teeth: a new system for oral health determination. J Dent 1995;23:347–52.
9. Härkänen T, Larmas MA, Virtanen JI, Arjas E. Applying modern survival analysis methods to longitudinal dental caries studies. J Dent Res 2002;81:144–8.
10. Eriksson A-L. Occurrence of dental and dentoalveolar injuries and their late complications in the permanent dentition. A follow-up study of Turku children and adolescents (Dissertation), Turku 1993.
11. SAS Institute Inc. SAS Language guide for personal computers, Release 6.03 Edition, Cary, NC: SAS Institute Inc., 1988.

Received for publication 17 May 2002
Accepted 10 January 2003