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Ecological time-trend analysis of caries experience at 12 years of age and caries incidence from age 12 to 18 years: Norway 1985–2004

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Abstract

Objectives. The purpose of the present investigation was to report on caries experience among Norwegian 12-year-olds from 1985 to 2004 and to assess caries incidence from 12 to 18 years of age for birth cohorts 1973 to 1986. ***Material and methods.*** Aggregated data from the Norwegian Public Dental Services and from official statistics were employed. Information was available about the number of subjects, the proportion receiving treatment, sales of fluoride tablets, socio-demographics, caries prevalence, and the number of decayed, missing, and filled teeth (DMFT). ***Results.*** An almost linear decline in caries prevalence and mean D_3MFT (dentine level) occurred among 12-year-old children from 1985 until the year 2000, but from 2000 to 2004 an increasing trend was observed. The highest mean 6-year D_3MFT increment (age 12–18 years) was 4.1 (cohort 1976), while the lowest was 3.2 (cohorts 1982 and 1983). In multiple linear regression analyses of trend, baseline D_3MFT accounted for more than 91% of total explained variance in D_3MFT increment (Models I and III). Without baseline D_3MFT as predictor (Models II and IV), there was a significant association between education, social assistance, mobility, infant mortality, percentage examined, and the additive interaction terms year+income and year+education and D_3MFT increment after controlling for confounding and multicollinearity. ***Conclusions.*** Four consecutive years of increase in caries experience among 12-year-old children after 15 years of decline and evidence of stability or increase of the caries increment from 12 to 18 years of age among Norwegian teenagers give cause for concern.

Key Words: *Adolescents, caries experience, caries incidence, dental epidemiology, trend*

Introduction

Of the 35 WHO/EURO countries reporting the number of DMF teeth of children 12 years of age for at least two time-points after 1985, 71% (25) have reported a caries decline, 9% (3) an inconsistent pattern, 9% (3) no change, and 11% (4) an increase [1]. The highest mean score at age 12 was 4.4 DMFT (Bulgaria) in 2000, the lowest 0.9 DMFT (Denmark) in 2003. In Norway, the DMFT score of 12-year-old children dropped from 3.4 in 1985 to 1.5 in the year 2000 [2].

While there is plenty of cross-sectional evidence about the caries experience of 12-year-olds, less information is available about caries incidence during adolescence. Most incidence data stem from clinical trials among subjects 11 to 15 years of age in the 1960s and 1970s. Exceptions are studies in Sweden [3,4], Norway [5,6], and the Netherlands [7] between the mid-1970s and the early 1990s. No marked change in caries incidence was observed among adolescents in these countries during the period in question, although baseline caries experience declined.

In Norway, caries in the deciduous dentition of children 5 years of age changed in the 1990s; the former decline reversed into a marked increase [2]. Among 12-year-olds, the decline in caries appeared to reach a plateau at the end of the 1990s [2]. Studies have shown a positive association between caries in the deciduous and the permanent dentition [2,8–10]. Consequently, the purpose of the present investigation was to report on the caries experience among Norwegian 12-year-olds from 1985 to 2004, and to assess caries incidence from 12 to 18 years of age for birth cohorts 1973 to 1986.

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Material and methods

The Dental Health Service Act of 1983 obliged Norwegian counties to provide incremental dental care free of charge for all residents from birth to 18 years of age. Priority was assigned to prevention over restorative treatment. The services have almost exclusively been provided by salaried staff working in publicly owned and financed dental clinics.

The 19 counties in Norway each comprise between 3 and 9 dental health districts ($n = 103$), the populations of which are served by a varying number of clinics. Administrative and dental health data are aggregated from clinic to district, from district to county, and then reported to the national level. During the period 1985 to 2004, the total number of children 12 years of age varied between 51,453 (1995) and 63,213 (2003). Between 76.2% (2004) and 94.7% (1986) of these 12-year-olds were examined and treated each year. In the counties, the percentage examined varied between 36.6 and 100. Nationally, the number of subjects 18 years of age was between 52,506 (2001) and 66,453 (1985), of whom 71.4% (1999) to 83.4% (1993) were examined and treated within the Public Dental Services. The range between counties was 29.7% to 93.0%.

Dental data

Data from 1985 about caries prevalence at age 5 years were available, as well as prevalence and the number of DMF teeth for 12- and 18-year-olds for all counties. The clinical examinations of patients 12 and 18 years of age were routinely supplemented with one pair of bitewing radiographs. The components of the DMFT index were defined as follows: D = tooth requiring restorative treatment because of caries, lost or fractured filling; M = tooth missing because of caries; and F = filled or crowned tooth without need for treatment. The prevailing restorative treatment intervention level, i.e. cavitation or lesion into dentine (D_3T threshold) has been in use in the Public Dental Services since 1980. Information was not available at the individual level. Consequently, the estimates are based on aggregated dental data. The percent caries prevalence (D_3 threshold) and the D_3MFT counts were used to study caries trends from 1985–2004 and caries incidence from 12 to 18 years of age for birth cohorts 1973 to 1986 (observation period 1985–2004).

Background information

The Public Dental Services report the number of children examined and treated, the percent caries free, the number of D_3MF teeth, and the number of dental personnel. This information was supplemented with other background variables (Table I).

Table I. Definition of predictor variables

Name	Description
Dental variables	
CARIESPREVAL	Percent caries prevalence (d_3 threshold) at age 5 years
BASELINE	Average of the mean D_3MFT at 12 and 18 years of age, i.e. the Oldham method [17]
Background variables	
YEAR	Year when the subjects were aged 15, i.e. 1988 to 2001
FLUOREXP	Sale of fluoride tablets in defined daily dose (DDD) per person under 15 years of age per year (used in cross-sectional analyses at 12 years of age 1997–2004)
$FLOUREXP_{1\text{-}10}$	Average sale of fluoride tablets during the first 9 years of each cohort's life (used with D_3MFT increment 12 to 18 years as predictor variable)
EDUCATION†	Percent of the population 16 years of age and older who had completed a university or college degree
INCOME†	Average income in Norwegian kroner (NOK) by county
INFANTMORT†	Deaths under 1 year of age per 1,000 live births
SOCASSIST†	Income support in 1,000 Norwegian kroner (NOK) by county
MOBILITY†	Net mobility per year by county
IMMIGRANTS†	Percent first and second generation immigrants 0–17 years of age by county
Dental care variables	
EXAMINED	Percent of subjects 12 and 18 years of age examined and treated in the Public Dental Services
VACANCY	Vacant positions for dentists and dental hygienists in percent of the total number of positions in the Public Dental Services

†*Source*: Statistics Norway (available at: http://www.ssb.no).

Sale of fluoride (F) tablets was available and expressed as defined daily dose (DDD) per 1,000 inhabitants younger than 15 years of age. Data were available for the years 1973 to 2004 at national level (Figure 1; DDD/100 for technical reasons). This information was used to compute a lifetime fluoride tablet exposure variable for each birth cohort of children who reached 12 years of age in the period 1997 to 2004. The fluoride tablet sales figures in each county were weighted for population size and averaged for the years 1995 to 2004 for the cross-sectional analyses for the years 1997 to 2004 (caries trend). When studying D_3MFT increments from age 12 to 18 years, the fluoride exposure ($FLUOREXP_{1-10}$) of each cohort of children was defined as described in Table I.

Fluoride-containing toothpaste has more or less taken over the Norwegian market (Figure 1) [5], but information is not available by county.

Socio-economic status at county level was considered in terms of average income, income support (SOCASSIST), the proportion of the population that had completed a college or university education

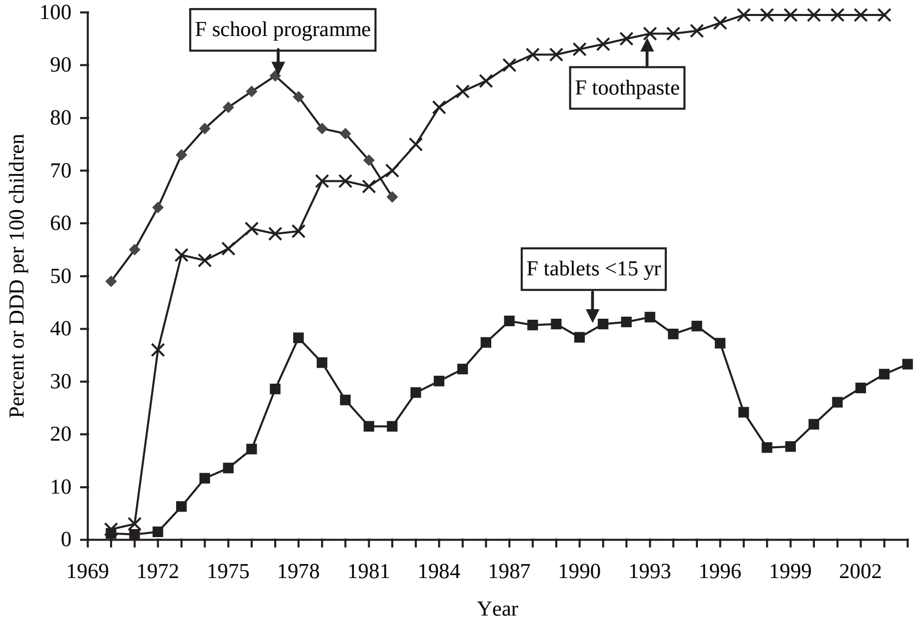

Figure 1. Sale of fluoride tablets in DDD/100 children younger than 15 years of age (1970–2004); percentage of 7 to 14-year-old schoolchildren who participated in fluoride mouth rinsing and/or brushing programs (1970–1981), and the percentage of total toothpaste sales that was fluoride toothpaste (1970–2003) in Norway.

and infant mortality. The proportion of the population 0–17 years of age classified as first or second generation immigrants [11; Central Bureau of Statistics, personal communication 2003/2004] was included as a predictor, as it has been reported that immigrant children may have higher caries experience than native-born children [12,13]. Other predictor variables were: net population mobility [11], the proportion of eligible children examined and treated per year, and the combined percent vacant positions for dentists and dental hygienists in the counties.

Statistical analysis

The data were analyzed using SPSS® version 13.0 for PC. As the caries data were aggregated for each administrative level, the findings are presented as percent caries prevalence and the mean number of D_3MFT, D_3T, and FT with range for counties. Relative change in caries prevalence and experience are expressed as compound annual growth or reduction rates because of the non-linearity of the caries trend [14]. Frequency distributions were compared using chi-square tests and Student's t-test for paired observations to test the null hypothesis that there was no difference from one year to the next in caries prevalence or D_3MFT score.

The predictor variables used in bivariate and multivariate analyses are described in Table I. Bivariate associations were assessed using Spearman's rank correlation coefficient (r_s) and the t-distribution on $n-2$ degrees of freedom to test the null hypothesis that rho $=0$. The predictors found to be most strongly associated with the dependent variables were entered into multiple linear regression analyses (enter or stepwise). Multiple linear regression models were employed because the distribution of counties according to percent caries prevalence as well as D_3MFT score exhibited neither significant skew nor kurtosis for 12-year-olds for the years 1997 to 2004. A maximum of four predictors was used in the regression analyses as there are only 19 counties [15]. Collinearity was controlled by keeping the variance inflation factor (VIF) below 10 [16]. Model fit was assessed by ANOVA and expressed in terms of adjusted R^2. The significance level was 5%.

The mean D_3MFT of a birth cohort at 12 and 18 years of age may be considered repeated measures on two occasions. To partly control for this, the average of the D_3MFT score at 12 and 18 years was used (the Oldham method [17]) as a covariate (Baseline, Table I) in the four multiple linear regression analyses with increments as the dependent variable. Model I was limited to birth cohorts 1977–1986 because income was not available according to county for cohorts 1972–1976 ($n=170$, missing D_3MFT values for one county in 2002). Model II ($n=170$) excluded the modified baseline D_3MFT covariate (the Oldham method) [17]. Model III ($n=265$) excluded income and Model IV ($n=265$) excluded both income and baseline D_3MFT from the regression analysis.

Public Dental Service officers have been encouraged to vary the length of recall intervals from 6 to 18 months depending on patients' needs. For this reason, the multiple regression analyses were repeated with the percentage of children treated as a control variable even though its bivariate correlation with the percentage caries prevalence was weak and statistically not significant (strongest $r_s = -0.258$). In addition, the three predictors most strongly associated with caries incidence were included in these analyses.

Results

Caries experience at age 12 years

Caries prevalence declined from 81.0% in 1985 to 52.2% in the year 2000 (reduction rate 3% p.a.), but increased to 59.8% by 2004 (growth rate 3.3% p.a.) (Figure 2). The range between counties varied from 12.2 percentage points in 1987 to 26.2 percentage points in 1996, but did not show a consistent increasing or decreasing trend from 1985 to 2004 (Figure 2).

The mean D_3MFT score was 3.4 in 1985 before declining steadily to 1.5 in 1999 and 2000 (Figure 2), or by 8.4% per year. From 2000 to 2004 the mean score rose to 1.7 D_3MFT. The difference between counties varied from 1.5 D_3MFT in 1989 and 1992 to 0.9 D_3MFT in 2000, 2001, and 2002 (Figure 2). The mean national D_3T score varied from 0.6 to 0.9 between 1985 and 2004 and the range between counties from 0.3 D_3T to 0.7 D_3T. The FT score varied from 2.5 in 1985 to 0.8 in 1999 (for 18 or 19 counties). The MT component of the D_3MFT scores was close to zero throughout the observation period.

Bivariate and multivariate analyses

Every year from 1997 to 2004, the caries prevalence and the mean D_3MFT scores of 12-year-olds were significantly and positively associated with the percent caries prevalence of the cohort at age 5 (Pearson's $r = 0.65$ to 0.83, $p < 0.01$). In these analyses at county level, prevalence rates and D_3MFT scores were negatively associated with sales of fluoride tablets in 10 of the 16 analyses (range $r = -0.38$ to -0.61, $p < 0.05$; for $r = -0.48$ to -0.61). Significant associations were found twice with percent examined and immigrants 0–17 years, once with education, and 7 times with infant mortality ($p < 0.05$). When the four predictors most strongly associated with caries prevalence or mean D_3MFT at age 12 were entered into linear multiple regression models, only the caries prevalence rate at age 5 was significantly associated with caries prevalence and D_3MFT ($p < 0.05$). All 16 regression models explained a significant proportion of total variance in respective dependent variables ($R^2_{adj} = 0.32$ to 0.66, $p < 0.05$). Had caries prevalence at age 5 been ignored and the regression analyses performed with the other four predictors most strongly associated with caries prevalence or D_3MFT, then there would have been no significant associations.

Caries incidence from 12 to 18 years of age

The mean D_3MFT increments from 12 to 18 years of age and the range between counties are shown according to time period and hence birth cohort in Figure 3. The highest 6-year mean D_3MFT increment was 4.1 (cohort 1976), while the lowest mean was 3.2 (cohorts 1982 and 1983), i.e. a variation of 0.9 D_3MFT at national level during the observation

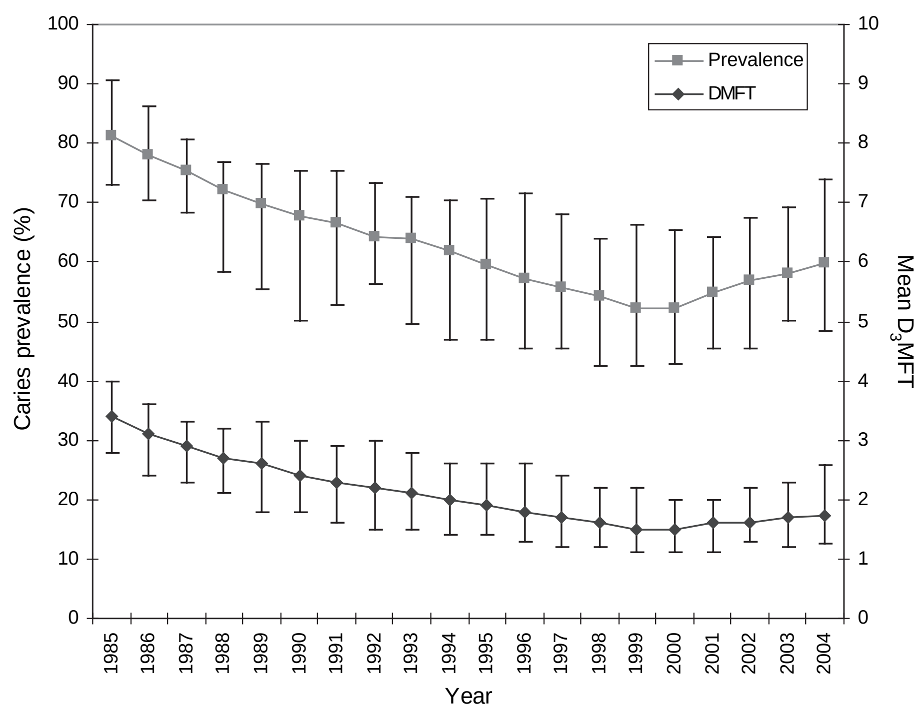

Figure 2. Percent caries prevalence and mean D_3MFT for persons aged 12 years in Norway from 1985 to 2004. The vertical line (I) shows the range between counties.

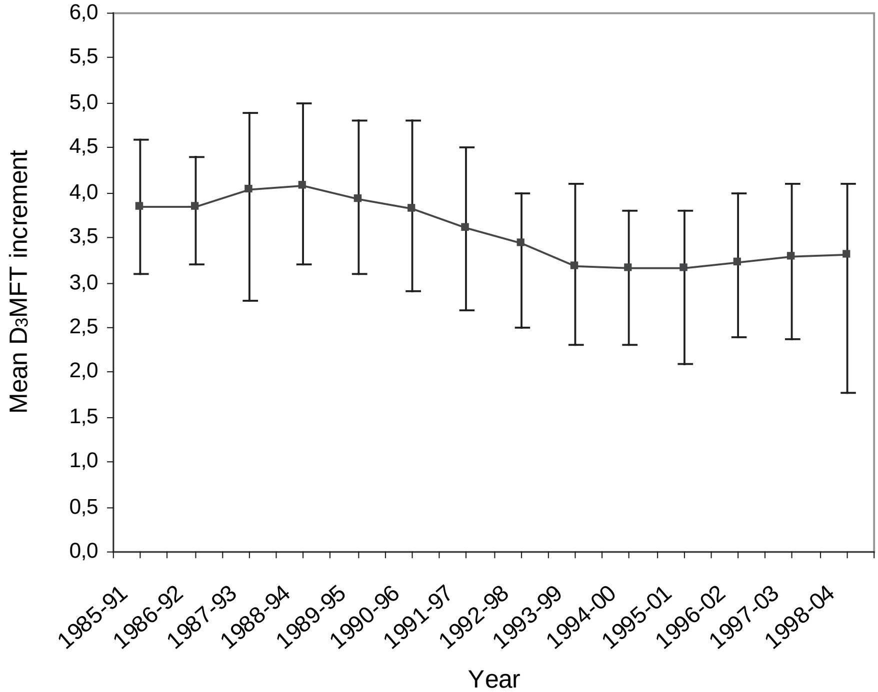

Figure 3. Mean D_3MFT incidence from 12 to 18 years of age for Norwegian cohorts born between 1973 and 1986. The vertical line (I) shows the range between counties.

period. The smallest difference in mean increment between counties was recorded for subjects born in 1974 (1.2 D_3MFT) and the greatest difference in the 1986 birth cohort (2.3 D_3MFT).

Bivariate and multivariate analyses

At national level ($n = 14$ years), multicollinearity between the predictor variables year, sale of fluoride tablets, education, mobility, infant mortality, caries prevalence (age 12 years), and baseline D_3MFT ($r_s \geq |0.85|$) meant that only two predictors could be included in the multiple linear regression analyses ($R^2 = 83.2\%$). In these models, percent examined was the only predictor that was significantly associated with D_3MFT incidence when successively controlling for the above predictors.

In the trend analyses (1985–2004) considering variation between counties ($n = 170$ or 265; Table III), the independent variables year (when the subjects were age 15), education, income, SOCASSIST (income support), and mobility were negatively associated with the mean D_3MFT increment from age 12 to 18 years ($p < 0.01$) (Table II). Baseline D_3MFT, infant mortality, and percentage examined were positively correlated with the increment ($p < 0.01$). There was significant multicollinearity between income, year, baseline D_3MFT, and education ($r_s \geq |0.60|$, $p < 0.01$) (Table II). To partly control for multicollinearity, two additive interaction variables, year+income and year+education, were constructed and used in the four regression models presented in Table III. Multiple linear regression analyses to control for confounding confirmed the significant association between baseline D_3MFT, SOCASSIST, income, and D_3MFT increment (adjusted $R^2 = 0.724$). Baseline accounted for 67.8% of total explained variance in D_3MFT increment after controlling for 'year+income', SOCASSIST, education, income,

Table II. Spearman's rank correlation coefficient (r_s) for the association between selected predictors and mean D_3MFT increment from 12 to 18 years of age for Norwegian birth cohorts 1973–1986 ($n = 170$ or 171 for income, otherwise 263 to 266)†

Variable	ΔD_3MFT	Year	Baseline	Infmort	Educ	Income	Exam %	Socassist	Mobility
ΔD_3MFT	1.00								
Year	−0.47	1.00							
Baseline	0.80	−0.79	1.00						
Infmort	0.36	−0.56	0.55	1.00					
Educ	−0.49	0.64	−0.65	−0.46	1.00				
Income	−0.34	0.85	−0.60	−0.26	0.82	1.00			
Exam %	0.23	−0.31	0.25	0.20	−0.37	−0.36	1.00		
Socassist	−0.48	0.40	−0.50	−0.27	0.54	0.15	−0.36	1.00	
Mobility	−0.45	0.04	−0.38	−0.19	0.51	0.35	−0.24	0.49	1.00

†For $r_s \geq |0.15|$, $p < 0.05$.

Table III. Multiple linear regression models in terms of the standardized coefficient (beta), standard error of beta, Student's *t*, observed probability (*p*) and R^2 change according to predictor (Table I). Dependent variable: D_3MFT increment from 12 to 18 years of age – Norwegian birth cohorts 1973–1985

Predictor	Beta	SE(ß)	*t*	*p*	R^2 change
Model I ($n = 170^{\dagger}$; adjusted model $R^2 = 0.724$; $F = 149.10$, 3/166 d.f., $p < 0.000$)					
Baseline	0.912	0.052	17.63	0.000	0.678
Year + income	0.238	0.051	4.68	0.000	0.030
Socassist	−0.158	0.043	−3.66	0.000	0.022
Model II‡ ($n = 170^{\dagger}$; adjusted model $R^2 = 0.339$; $F = 22.68$, 4/165 d.f., $p < 0.000$)					
Mobility	−0.464	0.083	−5.61	0.000	0.247
Year + income	−0.500	0.110	−4.53	0.000	0.035
Socassist	−0.319	0.084	−3.78	0.000	0.021
Education	0.517	0.141	3.66	0.000	0.052
Model III¶ ($n = 265^{\dagger}$; adjusted model $R^2 = 0.723$; $F = 173.04$, 4/260 d.f., $p < 0.000$)					
Baseline	0.943	0.054	17.43	0.000	0.658
Mobility	−0.122	0.041	−2.97	0.003	0.028
Year + educ	0.321	0.057	5.66	0.000	0.023
Socassist	−0.180	0.044	−4.10	0.000	0.018
Model IV$^{\$}$ ($n = 265^{\dagger}$; adjusted $R^2 = 0.417$; $F = 38.76$, 5/259 d.f., $p < 0.000$)					
Year + educ	−0.368	0.067	−5.50	0.000	0.325
Mobility	−0.227	0.059	−3.85	0.000	0.073
Socassist	−0.203	0.068	−2.98	0.003	0.010
Mortality	0.123	0.056	2.18	0.030	0.010
Exam %	−0.122	0.060	−2.11	0.036	0.010

$^{\dagger}n = 170$ or 265 because of missing D_3MFT values for one county in 2002.
‡Baseline D_3MFT excluded (Oldham's method (14)).
¶Income excluded.
$^{\$}$Income and baseline D_3MFT excluded.
Control variables:
Model I: Income, infant mortality, mobility and percent examined.
Model II: Income infant mortality and percent examined.
Model III: Infant mortality and percent examined.
Model IV: None.

infant mortality, percent examined, and mobility (VIF < 4.40) (Model I; Table III). When baseline D_3MFT was excluded, mobility, year + income, social assistance, and education were associated with D_3MFT increment after controlling for income, infant mortality, and percent examined (adjusted $R^2 = 0.339$; VIF < 4.10). Mobility explained 24.7% of total explained variance in D_3MFT increment (Model II; Table III).

As information about income was unavailable for the years 1988 to 1992 (when subjects were 15 years of age), the regression analyses were repeated without considering income (Model III; Table III). Adjusted R^2 changed from 0.724 (Model I) to 0.723 (Model III; VIF < 3.07). Baseline explained 65.8% of total variance. Other significant predictors were mobility, year + education, and SOCASSIST (Table III). The relationship between year + education and D_3MFT increment changed from negative in the bivariate analysis ($r_s = -0.56$) to positive in the multivariate analysis (Table III). Excluding the predictors baseline and income (Model IV) gave a significant effect of year + education, mobility, SOCASSIST, mortality and percent examined (adjusted $R^2 = 0.417$; VIF < 2.11) (Table III).

Discussion

Aggregate national caries data reported by the Norwegian Public Dental Services show an almost linear decline in caries prevalence and the mean number of D_3MFT among 12-year-old children from 1985 to 2000. This was followed by a rise from 2000 to 2004 (Figure 2). The increase corresponds to 3.3% per year, in contrast to an annual decline of 3.0% before 2000. The caries decline from 1985 to 2000 follows the pattern observed among 12-year-olds in the majority of WHO/EURO countries [1]. The mean number of D_3MFT was relatively stable at about 1.6 from 1997 to 2004. This is similar to the patterns reported from Denmark and Sweden, but at a somewhat higher level than in these countries [1]. A disturbing feature is that more Norwegian 12-year-old children were affected by caries in 2004 than in 2000 (59.8% versus 52.2%) (Figure 2). As the mean number of D_3MF teeth increased from 1.5 to 1.7, the mean score among children with caries experience was 2.9 D_3MFT in both 2000 and 2004.

Of the predictors included in the 16 linear multiple regression models (1997–2004; predictor information not available for 2004), only the cohort's caries prevalence at age 5 years had a significant impact on caries prevalence and experience at 12 years of age. Caries prevalence among 5-year-olds started to increase from 1998. In view of the known association between caries in the deciduous and the permanent dentition [2,8–10], an increase in caries experience at 12 years of age would have been expected from 2004 or 2005. When their caries experience increased from 2001 (Figure 2), it suggests changes in caries-related behavior and activity not limited to birth cohorts 1992–1996.

The mean 6-year increment from 12 to 18 years of age varied between 3.2 and 4.1 D_3MFT for these 14 cohorts. The caries increment decreased significantly until 1999 (cohort 1981), while a slight increase was recorded for the last three cohorts (1984 to 1986) (Figure 3). The mean annual D_3MFT increment from 12 to 18 years of age varied from 0.5 to 0.7 at national and from 0.3 to 0.8 at county level for birth cohorts 1973 to 1986. These findings are comparable with previously reported DMFT incidence estimates [4,5].

The four multivariate regression models explained 33% to 72% of total variance in D_3MFT increment. Baseline accounted for more than 91% of explained variance in D_3MFT increment (Models I and III). A significant influence of baseline D_3MFT on D_3MFT increment is in agreement with previous findings from Norway [6] and from other countries [18,19]. The remarkably high proportion of explained variance may partly be attributable to the use of aggregated data with limited variability; that is analyses based on means rather than individual scores. Furthermore, the dominating role of baseline in analyses of aggregated data shows the need to exclude baseline D_3MFT from regression models in order to assess the possible role of other explanatory variables (Models II and IV).

Other significant predictors were SOCASSIST, education, rate of mobility, infant mortality, percentage examined, as well as the interaction terms year+income and year+education (Models I–IV; Table III). The positive association between D_3MFT increment, year+income (Model I), and year+education (Model III) was unexpected and may be due to multicollinearity (Table III, Figure 3) [16] and the use of aggregated data.

The negative association between the rate of mobility and caries incidence from 12 to 18 years of age is most likely attributable to the positive correlation between level of education and mobility ($r_s = 0.56$; Table II). The negative association between the percentage of subjects examined and D_3MFT increment (Model IV; Table III) was expected because the higher the proportion of eligible persons examined, the more caries-free patients would be included in the material.

A possible explanation for the negative association between SOCASSIST and D_3MFT increment may be that more money was spent on income support by economically well off than by poorer counties.

Possible reasons for the findings

There may be several reasons for the caries decline and the subsequent increase, i.e. measurement error, availability of dental care, consumption of sweets, and use of fluorides.

More than 1,200 dentists and 300–400 dental hygienists served as examiners each year. The crude caries diagnostic criteria (D_3 threshold) have been used as indications for restorative intervention in the Norwegian Public Dental Services since 1980 [20,21]. These criteria have been found to reflect changes in caries prevalence [22]. The caries decline from 1985 to 2000 was mainly related to fewer filled teeth. This improvement corresponded on average to 1.7 FT, whereas the D_3T remained at 0.6 to 0.9. Thus inter-examiner variability is an unlikely explanation for the decrease and subsequent increase in caries prevalence and experience among Norwegian 12-year-olds between 1985 and 2004. It is also an unlikely explanation for the stability or increase in D_3MFT increment from 12 to 18 years of age after 2000 (cohorts 1982–1986).

The availability of dental care is reflected in the variable percent examined. This predictor had a significant impact in Model IV (Table III) and explained 1.0% of the explained variance. Thus, other predictors, e.g. baseline D_3MFT and socio-economic variables are more likely to explain the findings than the availability of dental care.

Total sugar consumption has remained relatively stable between 40 and 45 kg per person per year in Norway during the lifetime of the participants of this study, but the pattern of use has changed [23]. The intake of chocolates and sweets increased from 7.3 kg per person per year in 1975 to 13.2 kg in 2003 [23]. The total consumption of carbonated beverages increased from 58 liters per person per year in 1980 to remain between 132 and 137 liters per year from 1997 to 2004; 70% to 80% of which was sugar sweetened [23,24]. Nationwide surveys have found the intake of sweets and soft drinks to be high and frequent among Norwegian teenagers [23–27]. Lack of information about sugar consumption at county level precluded assessment of its possible impact on the caries experience and incidence in this investigation.

The sale of fluoride toothpaste increased throughout the period of examination (Figure 1). National surveys of Norwegian adolescents have found that the majority brush their teeth at least once a day [25–27] and nearly everyone uses fluoride-containing toothpaste (Figure 1). For this reason, and because sales figures were not available at county level, the possible effect of fluoride toothpaste use could not be assessed.

The sale of fluoride tablets was used as a predictor in bivariate and multivariate analyses at county level for children aged 12 years, and in time-trend analyses of caries increments from 12 to 18 years of age. No significant association was found between use of fluoride tablets and caries in the permanent dentition. One explanation may be that use of fluoride tablets is relatively uncommon among Norwegian children after 7 years of age [28].

Conclusions

The results of this ecological study show reversal of the caries decline among Norwegian 12-year-olds after 2000 and increasing caries incidence from 12 to 18 years of age for birth cohorts 1982–1986. The only predictor significantly associated with the observed caries trend among 12-year-olds was caries prevalence at age 5 years. Caries incidence from 12 to 18 years of age was significantly associated with the baseline D_3MFT score and SOCASSIST (income support). Other predictors that had a significant impact depended on the inclusion in or exclusion from the regression models of baseline D_3MFT and income. Caution is indicated when interpreting the findings, as use of aggregated data increases the risk of ecological fallacy.

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