Changes in demand for dental care among Danish adults, 1975–90

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The aims of this study were 1) to analyze changes in and determining factors for demand for dental care among Danish adults during 1975–90, and 2) to apply standard cohort analysis on sequential cross-sectional survey data, thereby enabling the separation and examination of age, period, and cohort effects. Samples of non-institutionalized Danes aged 15 years and more were interviewed in 1975 (n = 1204), 1980 (n = 1108), 1985 (n = 1123), and 1990 (n = 1003), in accordance with a standardized questionnaire. Overall demand for dental care increased from 59% in 1975 to 76% in 1990; the younger the respondents, the higher the demand. Standard cohort table analysis indicated that the main effect derived from cohort succession; that is, the higher demand of the new cohorts entering the population remained higher than that of previous cohorts. Logistic regression analysis indicated that from 1980 to 1990 the significant predictors for regular dental care shifted from being predominantly predisposing and need variables to predominantly enabling and need variables. □ *Age-period-cohort analysis; delivery of health care; health services needs and demand; health services research; use of dental services*

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The dental care system in Denmark has embraced the regular dental visit to such an extent that it became an essential part of the National Health Insurance legislation concerning dental services for adults, especially younger adults (1). During the 1970s and the 1980s Danish studies of demand for dental care were conducted with different approaches and targeting different segments of the population. Some of them comprise the adult population as a whole (2–5), and others target the younger groups only (1, 6–9), with one limited to using military conscripts, thus excluding women (7). In some studies special samples have been selected, such as patients in private practice (10, 11), certain regions of the country (6, 8, 9, 12), occupational groups (13), or special age groups (14, 15). Some studies have especially addressed socioeconomic status as an important predictor for demand (6–8, 12, 13), although an overall model for this relationship has only rarely been presented (16). Additionally, the definition of demand for dental care has not been consistent, using time since last dental visit (14), annual dental visits during the last 3 years (9, 11, 13) or 5 years (3, 17), or simply, self-reported 'regular dental visits' (4, 8, 15) as the dependent variable. Mostly, the studies have been carried out as cross-sectional surveys. Only three studies have had a longitudinal perspective: one study comprising young adults followed up from childhood (8), one study on young adults monitored for 4 years (9), and one study applying a repeated cross-sectional method to their population samples (7).

Owing to the variability in the studies, the overall conclusions with regard to the development in demand for dental care during the past 15–20 years are somewhat nebulous. However, as recently reported (18), the overall impression is one of gradual increase in demand for dental care over time despite the considerable increase in the average costs of dental services for adult Danes. The increase in demand seems to be reflected in all age groups in the population, but with greater demand expressed by younger than by older individuals. However, because single cross-sectional surveys cannot distinguish whether the pattern in demand indicates age, cohort, or possible period effects, a different analytical approach must be used.

Age-Period-Cohort analysis (APC) has been used by several investigators to identify and interpret changes in various population characteristics or behaviors (19–26), including physician and dentist use (23, 26). Ideally, to apply this approach, longitudinal datasets should be available, but because these are rare, sequential cross-sectional datasets such as repeated population surveys can also be used (19, 20, 24).

The aims of this study were to analyze the changes in demand for dental care among Danish adults during the period of 1975–90 in terms of the proportion of adults who reported regular use of dental care (27) and to analyze the effects of selected sociodemographic variables on the variation in demand. A further aim was to apply standard cohort analysis techniques to sequential cross-sectional survey data, thereby enabling the separation and examination of separate age, period, and cohort effects on the demand for dental care among Danish adults over time.

Study population and methods

The study populations comprised sequential cross-sectional samples of non-institutionalized Danes aged 15 and more. The populations were selected and inter-

viewed by Gallup Markedsanalyse A/S in the spring of 1975, 1980, 1985, and 1990 in accordance with a multistage stratified cluster sampling technique devised by the Statistical Bureau of Denmark (Danmarks Statistik). The sampling stages comprise random selection of defined geographic units in the capital and in the provinces, selection of clusters of addresses within each geographic unit, random selection of segments of several addresses within each cluster, and finally, random selection of interviewees from the selected addresses. The selection process ensures a national probability sample of persons aged 15 and more. No weighting for failure cases was performed. At each of the surveys the questionnaire was provided by the author and modified to fit the interview schedule of Gallup. A core of questions was retained in all surveys, and additional questions were added at each occasion in accordance with the need for studying certain current problems.

Since no agreement seemed to exist in the literature as to the most effective proxy for dental visit behavior, the dependent variable, demand for dental care, was determined in two ways: by inquiring about the respondent's actual dental behavior during the past 5 years and by inquiring about the respondent's last dental visit. The first variable was recoded into regular (at least once a year), irregular (less than once a year), and no dental visits. The second variable was recoded into last dental visit within 12 months, 1–5 years, and 5 years+. For each dataset and for the total dataset the two variables were cross-tabulated and a Spearman correlation coefficient was calculated. The coefficients were in the range of 0.81–0.90, statistically highly significant. Consequently, it was decided to use the trichotomous demand variable with each respondent classified as having regular, irregular, or no dental visits. Thus, the aggregate demand variable will express the proportion of the respondents who seek dentist regularly, irregularly, or not at all. Because of the relatively small proportion of respondents who reported irregular dental visits (2–9%), demand was further dichotomized into regular against all others, to present a standard cohort table necessary for the analysis of age, period, and cohort effects and for a logistic regression analysis.

Data analysis

With regard to the choice of independent variables to explain the variation in demand, it is well known that a range of behavioral models has been suggested to predict dental behavior in various populations, but, as expressed by Søgaard (28), no grand theory or model explaining health behavior has been developed. The conceptual framework guiding these studies has been the behavioral model of health services utilization developed by Andersen & Newman (29), in which the use of health services is defined as a function of the predisposing, enabling, and need characteristics of the individual. In Table 1 the variables used are ordered in accordance with Kiyak's modified model (30), and the dichotomization of the variables is indicated. The predisposing variables are categorized into the usual groupings in Danish demographic statistics, as were the general enabling variables, household income and place of residence. School dental care during the childhood years and oral hygiene instruction received at the last dental visit are dichotomized; the latter variable is used to indicate the extent to which the respondent was aware of and accepted the notion of receiving oral hygiene instruction during the dental visit. Two attitudinal need variables that should reflect the respondents' own assessment of their dental condition and two dental need variables—number of teeth and wearing of dentures—are included, which should be close proxies for dental health in the absence of real epidemiologic data. Each of the four datasets comprise identical variables except that a few of the variables were not collected during the first study in 1975. This should not affect the analysis seriously.

For each of the survey years, differences in demand for dental care between the various categories of the independent variables was examined by the chi-square test.

To assess the relative importance of the independent predisposing, enabling, and need variables as predictors of the dichotomous demand variable a backward stepwise logistic regression analysis was performed for each survey year. All analyses were performed by the SPSS for Windows 6.0. Because the logistic regression analysis does not provide an estimate of the squared regression coefficient for the log model, this was calculated manually for each of the regression models on the basis of the initial and the final log likelihood function;

$$\text{thus } R^2 = 100\left(1 - \frac{Lp}{Lo}\right).$$

Results

The final sample comprised a total of around 4400 respondents in the four surveys with minor differences between them. This corresponded to a response rate of about 70%. The population samples in the four surveys compared well with gender and age distribution of the total population of Denmark.

Fig. 1 summarizes the proportion of the study populations reporting regular dental visit habits during 1975–90 by age. Some trends were clearly distinguishable. For each survey year the younger the respondents, the higher was the percentage reporting regular dental visits. For the age groups above 35 years an increasing trend was also evident from one survey to the next, 5 years later. The two youngest age groups

Table 1. Specifications of the predisposing, enabling, and need variables selected for logistic regression analysis of demand for dental care: bivariate relationships between variables and dental visit pattern

Variable specifications	Dental visit pattern							
	1975†		1980†		1985†		1990†	
	n	Regular %	*n*	Regular %	*n*	Regular %	*n*	Regular %
Predisposing								
Age (years)	***		***		***		***	
15–24	204	90	169	91	188	93	131	90
25–34	242	75	238	87	206	89	195	88
35–44‡	206	66	203	77	251	85	215	89
45–54	178	52	148	57	136	61	149	83
55–64	159	42	152	44	144	51	117	68
65+	173	14	187	20	198	27	196	38
Gender	*		**		*		**	
Men‡	536	55	502	60	515	68	427	71
Women	626	62	595	69	608	71	576	79
Occupation	***		***		***		***	
Profess., white collar‡	426	77	378	83	398	87	423	90
Self-employed	179	52	129	62	88	75	60	70
Skilled workers	168	69	162	80	158	80	127	81
Unskilled workers	141	49	130	56	153	71	138	76
Students	27	100	53	87	49	90	32	84
Pensioners	221	24	245	26	277	33	217	45
Education			***		***		***	
Primary + low sec.		‖	711	52	631	55	472	62
Upper sec.‡		‖	258	88	363	87	350	87
Tertiary+‡		‖	128	87	129	89	181	90
Enabling								
Household income								
Mean in 1000 Danish Kroner		‖		145.1		232.1		309.4
Place of residence	***		*		**		*	
Copenhagen + environ.‡	315	67	302	71	336	75	252	79
Provincial towns	461	66	489	64	506	69	482	76
Rural areas	386	42	306	60	281	64	269	71
School dental care	***		***		***		***	
Yes‡	423	78	621	83	703	85	695	87
No	712	47	454	40	406	43	295	51
Hygiene instruction			***		***		***	
Yes‡	275	91	300	91	328	95	298	94
No	879	49	749	58	795	59	544	84
Need								
Perceived condition			***		***		**	
Very good/good‡		‖	581	88	660	91	628	90
Fair/poor		‖	224	74	172	79	179	83
Perceived bleeding			*		*		*	
No bleeding‡		‖	657	79	767	79	631	87
Bleeding		‖	193	85	170	82	182	92
Denture wearer	***		***		***		***	
No denture present‡	721	81	682	88	787	88	733	89
Denture present	418	20	373	22	336	27	270	40
Number of teeth	***		***		***		***	
20+ teeth present‡	686	84	659	89	728	92	708	90
<20 teeth present	460	21	423	26	376	29	295	42

* Chi-square; $p < 0.05$.
** Chi-square; $p < 0.01$.
*** Chi-square; $p < 0.001$.

† For simplicity, non-regular respondents omitted here.
‡ Reference category for the logistic regression analysis.
‖ Data unavailable in 1975 dataset.

were quite stable at about 90% throughout the period, except the initial increase in the 25- to 34-year-olds.

With a few exceptions, the bivariate relationships between the independent variables and the dichotomous dental visit pattern (Table 1) showed that regular dental behavior was reported by higher proportions of younger persons, women, respondents at higher occupational levels, respondents with higher education, respondents with a higher household income, Copenhagen residents, respondents who had frequented school dental care

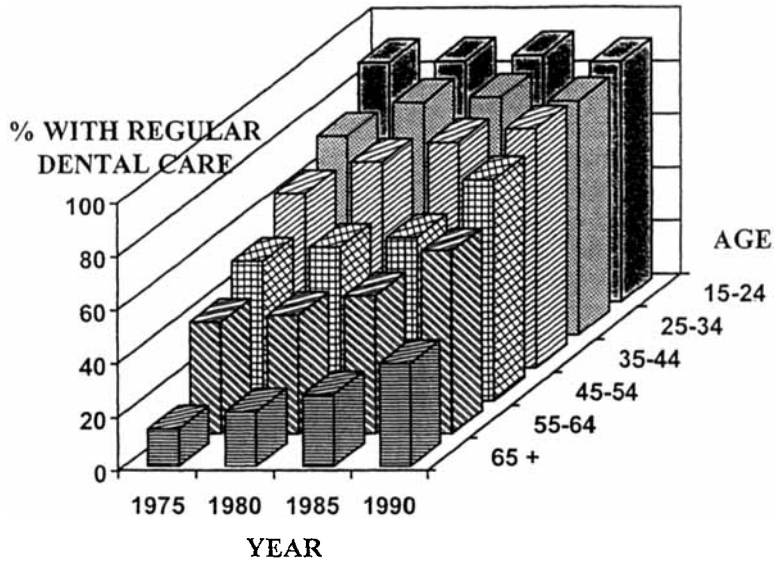

Fig. 1. Percentage distribution of study populations reporting regular dental care habits on the basis of age group and year of survey.

during childhood, respondents who had received oral hygiene instruction at their latest dental visit, respondents who perceived that their teeth were good, those who were not denture wearers, and respondents who reported more than 20 teeth present. All these relationships were statistically highly significant. Exceptionally, no statistically significant difference was found between men and women in 1985 and between residents of Copenhagen and other parts of the country in 1990. No difference in regular dental visits was found between respondents who had gum bleeding and those who did not.

The demand data for each survey and age group are presented in Table 2 in accordance with a 'modified' standard cohort table method (a standard cohort table assumes equidistance between the points in time for which there are data and the intervals used to delineate the birth cohorts, but here, only 10-year cohorts were available with quintennial surveys, so one 10-year age cohort must skip one survey to be refound 10 years later, 10 years older). The table illustrates three distinct patterns. First, column comparisons (also called cohort or intercohort effects) showed consistent decreases within each of the pooled surveys. When they were compared with the overall increase in the total demand from 58.8% in 1975 to 75.7% in 1990, these data suggested a strong pattern of change resulting from cohort succession. That is, as new cohorts entered the population and older cohorts left the population, the overall demand increased around 5 percentage points from

Table 2. 'Modified' standard cohort table illustrating the percentage of respondents in 10-year age groups who reported regular dental visits at least once a year for the last 5 years in 1975, 1980, 1985, and 1990. The number in parentheses denotes cohort number in 1975 and 1980 reinvestigated 10 years later, in 1985 and 1990, respectively. Reading of the table is exemplified by emphasizing cohort 1 in 1975–85 and cohort 0 in 1980–90. Cohort (0) serves as the reference group in the logistic regression analysis

Age (years)	Percentage of regular dental users							
	1975		1980		1985		1990	
		(Cohort)		(Cohort)		(Cohort)		(Cohort)
15–24	90.2	(1)	90.5	(1)	92.6	(5)	90.1	(5)
25–34	74.8	(2)	87.4	(2)	89.3	(1)	87.7	(1)
35–44	65.5	(0)	77.3	(0)	84.5	(2)	89.3	(2)
45–54	52.2	(3)	57.4	(3)	61.0	(0)	82.6	(0)
55–64	41.5	(4)	44.1	(4)	51.4	(3)	68.4	(3)
65+	13.9	(5)	20.3	(5)	26.8	(4)	38.3	(4)
Total	58.8		64.5		69.5		75.7	

1975 to 1980 and from 1980 to 1985 and 7 percentage points from 1985 to 1990.

The second pattern involves row comparisons (also called period effects). It was observed that, except for the two youngest age groups, consistent increases were found in all age groups across the four surveys. Although a period effect could be suggested, for instance as a result of increased access to dentists with increasing numbers available or improvements in the dental care program, the strong interrelation between period and the consistent cohort effects would indicate that the period effects could be artefacts of the cohort effects.

The third pattern is provided by the diagonal comparisons (also called age or intracohort effects). This study, in effect, comprised two intertwined age effects, one from 1975 to 1985 and one from 1980 to 1990. In addition to their biologic age, the age groups have been denoted with a cohort number under which they may be found 10 years later (as an example, two such cohorts are indicated with a different borderline around cells in the table). The age effects were less straightforward. The youngest cohort (1) decreased slightly from a high of around 90% to 88–89% 10 years later. The next cohorts (2) showed increased demand in both decades. The 35- to 44-year-old cohorts (0) differed in the two quasi-longitudinal assessments, as the first showed a decrease (65.5% to 61%) and the second an increase (77.3% to 82.6%) Cohort 3 demonstrated a very minor decrease in the first decade and a considerable increase (57.4% to 68.4%) in the second decade. The oldest cohort (4), which showed very little period changes from 1975 to 1980, had a considerable decrease in the first decade but less so in the second decade (41.5% to 26.8% versus 44.1% to 38.3%). Overall, the diagonal comparisons did not demonstrate clear age effects.

Finally, in Table 3, logistic regression models were built on the basis of the predisposing, enabling, and need variables, and analysis was carried out for each survey population to establish the relative importance of the variables for the variation in demand for dental care. The reference categories for the analyses (the 0-coded groups) were those given in Table 1. To retain the cohort pattern as used in Table 2, the log models for the 1985 and 1990 populations were modified so that the reference age group in those two models were the 45- to 54-year-olds—that is, corresponding to the 35- to 44-year-olds in 1975 and 1980. Table 3 illustrates that all models were highly statistically significant and with high R^2 values. Hit rates ranged between 78% and 88%, sensitivity of the models between 84% and 97%, and specificity between 61% and 71%. Their outcomes, however, were not quite identical. The ratio of the odds (OR) of not having a regular dental care pattern in the 1-coded category of the predictor variables to that in the 0-coded category is represented by the OR in the first column of the table. Thus, a respondent aged 65 years or more in 1975 was 6.88 times more likely not to have a regular dental behavior than a respondent aged 34–45 years. Conversely, the fractional odds for the 15- to 24- and 25- to 34-year-olds or for gender express a decreased probability of not having a regular dental care pattern when moving from the 0-coded category (the 35- to 44-year-olds or the men) to the 1-coded category. This translated to a higher probability for the age groups less than 35–44 years old when compared with the 35- to 44-year-olds to have regular dental care habits, and to a higher probability for women to have regular dental care habits than men. The result of each variable in the model can be considered a net effect of that variable with the joint effects of the other variables being controlled (all-other-conditions-being-equal situation). The standardized regression coefficient, B, may be considered to express the relative weight of that variable in the final model. Since, owing to a methodologic flaw, certain salient variables were not measured in 1975, the 1980 and 1990 models served to demonstrate the first and second decade outcome.

In 1980, the final model indicated that there was an increased probability of having a regular dental care pattern if respondents were younger, were women, were professionals, were aware of oral hygiene instructions, perceived their dental conditions as good, and did not experience gum bleeding. The model variables could explain 47% of the variation in demand. In 1990 the final model indicated that there was an increased probability of having a regular dental care pattern if respondents were women, had high household income, were aware of oral hygiene instructions, perceived their dental conditions as good and did not experience gum bleeding, and reported more than 20 teeth present. The variables could explain around 40% of the variation in demand. From 1980 to 1990 the significant predictors for regular dental care shifted from being predominantly predisposing (age, gender, occupation, education) and need (perceived condition and bleeding) variables to predominantly enabling (income, hygiene instruction) and need (perceived condition and bleeding and number of teeth) variables.

Discussion

The background for this 15-year analysis of demand is a previous analysis of utilization covering the same period of time. Dramatic changes were found in the types of dental services provided to Danish adults, and sharp price increases for adult dental care were noted (18). Conventional economic theory would indicate that, although the health sector is not a perfect market, increased prices for the consumers—that is, for the patients, could be expected to lead to a reduced demand for dental care or a reduced utilization of dental care. Thus, previous studies have found that demand for dental visits is negatively related to out-of-pocket expenses for dental care (16, 31–33). In this study the only indication that economic status has gained more

Table 3. Odd ratios (OR), beta values (B), and Wald statistics of final logistic regression models for demand for regular dental care of adult Danes, 1975–90. Only the significant variables remaining in the final models are presented

	1975			1980			1985			1990		
Variables	OR	B	Wald	OR	B	Wald	OR	B	Wald	OR	B	Wald
Predisposing												
Age (years)			91.46***			17.28**		NS	NS		NS	NS
15–24	0.16	−1.80	33.67***	0.36	−1.03	7.33**						
25–34	0.68	−0.39	2.65	0.61	−0.5	2.71						
35–44	†											
45–54	1.51	0.41	2.86	1.36	0.3	1.01						
55–64	1.97	0.67	6.82**	1.35	0.3	0.82						
65+	6.88	1.91	27.92***	1.87	0.62	2.24						
Gender	0.69	0.16	5.84*	0.38	−0.96	23.41***	0.66	−0.42	4.69	0.26	−1.35	36.26***
Occupation			35.52***			14.32**		NS	NS		NS	NS
Professional	†											
Self-employed	2.26	0.82	13.14***	1.38	0.32	1.11						
Students, etc.	0.00	−5.48	0.29	2.33	0.85	2.77						
Skilled workers	1.58	0.46	3.66*	0.97	−0.04	0.01***						
Unskilled workers	3.90	1.36	29.93***	2.54	0.93	8.84**						
Pensioners	2.09	0.73	6.52**	1.96	0.67	3.75*						
Education	‡	‡	‡	1.79	0.58	6.04**	1.67	0.51	5.67**		NS	NS
Enabling												
Income	‡	‡	‡		NS	NS	0.99	−0.002	3.00	0.99	−0.002	9.72**
Residence	2.09	0.71	14.08***		NS	NS		NS	NS		NS	NS
School dental		NS	NS		NS	NS		NS	NS		NS	NS
Hygiene instruction	2.05	1.87	59.91***	1.02	0.02	3.63*	5.4	1.69	34.04***	1.02	0.02	11.63***
Need												
Perceived condition	‡	‡	‡	1.02	0.02	53.48***	1.02	0.02	28.42***	1.01	0.01	6.61**
Perceived bleeding	‡	‡	‡	1.02	0.02	26.4***	1	0.01	5.82**	1.01	0.01	11.29***
Denture wearer	1.13	0.12	3.66		NS	NS	3.72	1.31	27.08***		NS	NS
No. of teeth	1.22	0.20	5.87*	1.14	0.13	3.12	1.18	0.17	3.84*	1.95	0.67	4.82*
Constant		−3.07	89.47***		−1.92	48.78***		−3.25	69.57***		−1.07	19.00
	Chi-square = 508.5; df = 15; $p < 0.001$ $R^2 = 33.02\%$			Chi-square = 671.9; df = 16; $p < 0.001$ $R^2 = 47.10\%$			Chi-square = 626.5; df = 8; $p < 0.001$ $R^2 = 45.33\%$			Chi-square = 443.2; df = 6; $p < 0.001$ $R^2 = 39.82\%$		

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.
† Reference group.
‡ Data unavailable in 1975 dataset.

importance in the population with regard to dental demand comes from the shift in significant predictor variables in the logistic regression models (Table 3). Whereas household income did not previously attain a significant role, the 1990 model indicates an increased probability for regular dental care with increasing income. This shift comes about during the period with increased dental care costs. The present analysis indicates that the increase in utilization which exceeded what could be expected from the population increase during the period (18) may be explained by the continuous increase in demand from the adult population. Thus, in addition to the small increase in the population covered by the National Health Insurance and in spite of increases in the average dental care costs, most age groups demanded more dental care.

The analysis indicates that cohort succession may be the main explanation of the changes in demand. This implies that the usual reports of decreasing demand with increasing age from single cross-sectional studies may be misleading. The demand is not a function of the aging process per se but may be related to the background and previous dental experience of the changing cohorts. Interestingly, this corresponds to a 10-year analysis of demand for dental care among elderly Americans (26). A further examination of a few of the bivariate relationships in Table 1 may clarify this. Thus, in 1975, 37% of the population reported participation in school dental care, whereas 70% reported this feature in 1990. This is in correspondence with other studies (7), and although school dental care does not remain as a significant variable in the regression models due to obvious collinearity with variables such as age or number of teeth, the influence of this early exposure to preventive dentistry has previously been found to be correlated to continued regular dental care (3, 8).

The identification of the effects of cohort succession suggests that if the trends observed in this study continue through the next 15 years, then the overall demand

rates in the adult population could exceed 80%, and most of the increase would be coming from the population older than 55 years, since the younger cohorts already exceed 80%. The assessment coincides with that of Wolinsky & Arnold (26) about elderly Americans. The discussion on the future tasks of the dental profession might give further considerations to this perspective.

The age-period-cohort analysis applied in this study is descriptive. Although an attempt was made to submit the data to regression analysis (22, 26), the outcome was so uncertain that the attempt was aborted. This experience seems to be in concordance with the prediction of Kupper et al. (22) that the statistical analysis of APC data is plagued by many unresolved issues and potential sources of errors. The main reason is that the effects of age, period and cohort are pairwise confounded with each other: age and cohort effects in the cross-sectional data in each column; age and period effects in each cohort diagonal; and cohort and period effects in each row. Thus, a strictly statistical solution to the age-cohort-period problem is at present not possible (20, 25).

The trends in demand for dental care illustrated in this study seem to be in concordance with other Western societies as well. Thus, studies in the USA (34, 35), the UK (36), Norway (37), and Sweden (38) all indicate that demand for dental care has increased during the 1970s through the 1990s. With regard to why this is happening, it seems logical that if the oral conditions of children continue to improve, then succeeding cohorts of young adults should become older adults and, finally, elderly, with increasingly improved oral health conditions, especially when it comes to periodontal health. Although the direct cause–effect relationship in adults between dental care and oral health has been questioned (39), at least there is an opportunity to retain the improved oral health situation. Perhaps, the demand for better lifestyles (40) combined with the cohort succession phenomenon will determine the future demand for dental care.

In conclusion, continued increases in demand for dental care may have considerable consequences for the dental care delivery system, both in terms of volume, the character of the services, and the tasks of dental personnel. As expressed by Barmes (40) and in line with series of studies: 'We need careful national monitoring of the trends and consequent planning—needs change so fast and so persistently that no plan, however excellent, can be relied upon for more than a few years. Five-year updating is, in my opinion, essential.'

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