

Changing oral health status of 6- and 12-year-old schoolchildren in Portugal

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Aims To assess the actual oral health status of Portuguese schoolchildren aged 6 and 12 years according to gender and urbanisation, to highlight the trend over time in dental caries prevalence of children, to assess the dental care habits and the provision of preventive services to children, and to analyse the effect of dental care habits on caries experience. **Basic research design** Clinical examinations of oral health status were carried out in 1999 according to WHO criteria and included dental caries, enamel lesions, oral hygiene status (OHI-S) and Community Periodontal Index (CPI). Structured questionnaires for interviewing children on dental care habits and participation in preventive programmes at school were used. The study comprised 799 6 year olds and 800 12 year olds. **Results** In 1999, the prevalence proportion rates of dental caries were 46.9% in 6 year olds and 52.9% in 12 year olds. Dental caries experience was 2.1 dmf-t and 1.5 DMF-T, respectively. Significant reductions in caries prevalence rates took place over time; in 1984 the mean dmf-t of 6 year olds was 5.2 and for 12 year olds it was 3.7 DMF-T. Enamel opacities were found for 7.2% of children and 2.1% had moderate dental fluorosis. At age 12, 90% of children had poor oral hygiene, i.e. CPI Score 2 (bleeding and calculus). Toothbrushing twice a day was reported for 31% of 6-year-olds and 55.6% of 12-year-olds; 17.8% of children aged 6 had seen a dentist during the past year and this was found to be 58.3% at age 12. Substantial proportions of the children received preventive dental services in school. Multivariate analysis of dental caries experience showed that gender, location, nationality, dental visits and frequency of toothbrushing were significant independent variables. **Conclusions** Further implementation of school based oral health promotion and application of population-directed preventive strategies are needed in Portugal.

Key words: dental care habits, dental caries prevalence, preventive oral care for children, time trends in caries

Introduction

During the past decade evidence has accumulated in several Western industrialised countries of encouraging trends in the prevalence and severity of oral disease. In children, this has been shown by a reduction of dental caries experience and growing numbers of caries free individuals (Beltrán-Aguilar *et al.*, 1999; Burt, 1994; Marthaler *et al.*, 1996; World Health Organization, 2000a). The reasons for this development are complex but may involve a more sensible approach to sugar consumption, improved oral hygiene practices, extensive use of fluoridated toothpaste, topical application of fluorides and fluoride rinsing (Bratthall *et al.*, 1996). In several countries school-based preventive oral care and oral health education programmes have been established in addition to the implementation of mass campaigns for promotion of oral health (Petersen, 1992; Petersen and Torres, 1999; Wang *et al.*, 1998). The decline in dental caries experience also has been ascribed to changes in diagnostic criteria and preventive and restorative efforts by dental health services (Chen *et al.*, 1997). Finally, the possible role played by broad socio-economic factors were highlighted in macro-ecological studies of caries reductions

and the limited impact made by dental services has been indicated (Nadanovsky and Sheiham, 1995).

In Portugal, oral health services are provided by private dental practitioners. Patients pay 100% of the fees or may be reimbursed by their private insurance scheme if dental care is included in the package of benefits. School-linked preventive oral care programmes for children were introduced during the late 1980s. Children are encouraged through health education to adopt regular oral hygiene habits and to pay regular visits to the dentist. Moreover, the children are offered preventive services such as fluoride supplements and fissure sealing.

Two national surveys have been carried out in order to monitor the oral health status of Portuguese children (Almeida 1997; Almeida *et al.*, 1990a; Almeida *et al.*, 1990b; Almeida *et al.*, 1991). The oral epidemiological surveys included information on dental caries, enamel hypoplasia and dental fluorosis, periodontal health status and malocclusion. In 1984, 17% of 6-year-olds were caries free and the mean DMF-T was 3.7 at the age of 12 (Almeida *et al.*, 1990b). Correspondingly, in 1990 the proportion of 6-year-olds being free of dental caries was 24% while the figure of 3.2 DMF-T was observed for

children aged 12 (Almeida, 1997). Meanwhile, no systematic studies have been conducted in Portugal, which provide information on the oral health behaviour situation of schoolchildren and which may assist the planning and evaluation of school oral health programmes.

The objectives of the present study were 1) to assess the actual oral health status of Portuguese children aged 6 and 12 years according to gender and urbanisation, 2) to highlight the trend over time in dental caries prevalence of children, 3) to assess the oral hygiene practices, dental visiting habits and the provision of preventive services to schoolchildren in Portugal, and 4) to analyse the effect of dental care habits on caries experience among the children.

Study population and methods

In 1998, the population of Portugal was 9,474,070 people of which 17% was less than 15 years old. Life expectancy at birth is 71.2 years for males and 78.2 years for females. The GNP per capita is 9079 EURO and 8.2% of GNP is spent on health care. The population per dentist ratio is 2,520, however, access to dental care is low in rural areas since more private dental practitioners are located in urban centres. The level of fluoride in drinking water varies from 0.02 ppm to 0.5 ppm (Pinto *et al.*, 1999).

The present survey was carried out in 1999 as a cross-sectional survey. The World Health Organization (WHO) pathfinder principle (World Health Organization, 1997) was applied for sampling of children and 16 focal points throughout the country were identified in order to obtain national samples of 6-year-olds and 12-year-olds. Six clusters of schools were chosen in the metropolitan areas of Lisbon and Oporto; two clusters were selected in other urban seaside areas (West coast and Algarve), three clusters of urban inland areas (North, West coast, South) and five clusters were identified for sampling of rural children (North, Centre inland, West coast, South, Algarve). The study covered both public and private schools and the schools selected were the same as for the previous surveys conducted in 1984 (Almeida *et al.*, 1991; Almeida *et al.*, 1990a; Almeida *et al.*, 1990b) and in 1990 (Almeida, 1997). All schools involved provided complete lists of children in classrooms and children of ages 6 and 12 years were then sampled at random. At each age level, a sample of 50 children for each cluster were chosen for the 16 focal points and all children present in the classrooms were included in the investigation. The final study population then comprised 799 children of age 6 and 800 children of age 12 (boys: 49%, girls: 51%). The data were obtained in agreement with Portuguese ethical regulations and consent was given by the parents.

Data were collected in classrooms by means of clinical examinations and questionnaires. The examinations were carried out according to WHO criteria (World Health Organization, 1997) under artificial light using dental mirrors and the WHO CPI periodontal probe. The following conditions were registered: dental caries, Community Periodontal Index (score 0: healthy; score 1: gingival bleeding; score 2: calculus), enamel opacities/hypoplasia, and dental fluorosis. The CPI index was recorded in 12-year-olds only. In addition, the oral hygiene status was

recorded by means of the Simplified Oral Hygiene Index (OHI-S) as recommended by Greene and Vermillion (1964). The two clinical examiners (CMA, SJ) were calibrated prior to the study in order to control reliability; one examiner (CMA) was calibrated in connection with previous investigations in 1983 and 1990. During the survey duplicate examinations of approximately 10% of the children were performed in order to assess intra- and inter-examiner variability in the use of the diagnostic criteria. The Kappa statistics (World Health Organization, 1993) on intra- and inter-examiner consistency in the diagnosis of caries were 0.93 and 0.92 respectively.

Gender, location and ethnic background were recorded as part of the clinical examination. Moreover, before the clinical examinations took place the children participated in an interview whereby information was gathered about toothbrushing habits, dental visiting habits, participation in fluoride mouthrinsing and use of fluoride supplements. A simplified highly structured questionnaire was used for this purpose and the questionnaire was pretested for control of reliability and validity.

Processing and analysis of data were carried out by means of the Statistical Package for the Social Sciences (SPSS - PC Version 10.0). The prevalence of dental disease was expressed by the prevalence proportion rate. Frequency distributions and means of dmf-t/DMF-T were calculated for the univariate and bivariate analyses. The mean OHI-S was computed and, based on the empirical distributions, the scores were classified into four levels as described by Lang (1998). The CPI data were analysed according to WHO recommendations whereby participants were categorised by maximum CPI score and the mean number of sextants with certain gingival conditions was computed. Frequency distributions were used to describe data on enamel opacities, hypoplasia and dental fluorosis. Finally, the bivariate analyses of the sociological variables were performed by frequency distributions. The Student's t-test or ANOVA were applied for the statistical evaluation of differences in means whereas proportions were compared by use of the Chi-square test. The multivariate analysis comprised multiple linear regression (Salas-Wadge, 1994); socio-behavioural variables were inserted for the analysis of dependent variables dmf-t and DMF-T, and the regression coefficients were evaluated by t-tests.

Results

Dental caries

The prevalence proportion rate of dental caries in the primary teeth was 46.9% at age 6 and 52.9% of 12-year-olds had caries of their permanent teeth. In 6-year-olds the mean dmf-t was 2.1 and 1.5 DMF-T was observed for children aged 12 (Table 1). Skewed distributions of caries experience were found (Table 2). The d/D-component of the caries index was dominant for both age groups. As shown in Table 1, the mean caries experience in deciduous teeth of 6-year-old children was significantly higher in periurban and rural areas as compared to children living in urban centres ($p < 0.001$). For permanent teeth of 12-year-olds, the caries figure was significantly higher in periurban areas as compared to urban and rural areas ($p < 0.001$). The level of dental caries was higher in

Table 1. The mean caries experience of Portuguese 6-year-olds (dmf-t) and 12-year-olds (DMF-T) according to urbanisation (Standard Error of Mean given in brackets)

	Urban	Periurban	Rural	Total
6 years (n = 399)	(n = 150)	(n = 250)	(n = 799)	
d-t	1.7	3.2	2.4	1.9
m-t	0.04	0.1	0.1	0.1
f-t	0.2	0.1	0.1	0.1
dmf-t	1.9	3.4	2.6	2.1
	(0.1)	(0.3)	(0.2)	(0.1)
12 years (n = 400)	(n = 150)	(n = 250)	(n = 800)	
D-T	0.8	2.1	1.0	0.9
M-T	0.05	0.1	0.1	0.1
F-T	0.6	0.4	0.5	0.6
DMF-T	1.5	2.5	1.6	1.5
	(0.1)	(0.1)	(0.1)	(0.1)

Table 2. Distribution (Pct) of Portuguese children aged 6 (n = 799) and 12 years (n = 800) according to absolute value of dental caries experience.

	0	1-2	3-4	5-6	7-8	9-10	11-12	13+
6 years (dmf-t)	53.1	17.4	10.8	6.7	5.9	2.7	1.8	1.7
12 years (DMF-T)	47.1	28.8	16.4	5.3	1.6	0.3	0.1	0.6

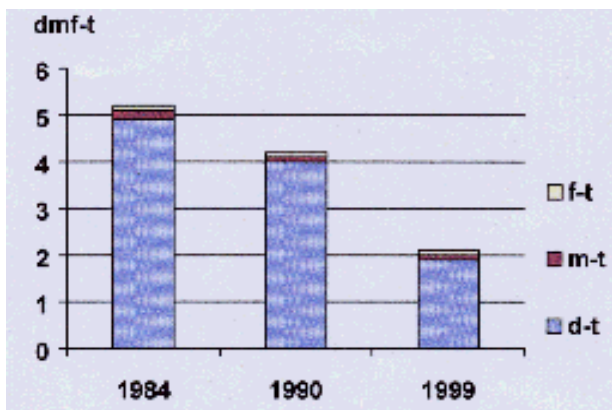


Figure 1. Mean dental caries experience (dmf-t) of 6-year-old Portuguese children by year of study.

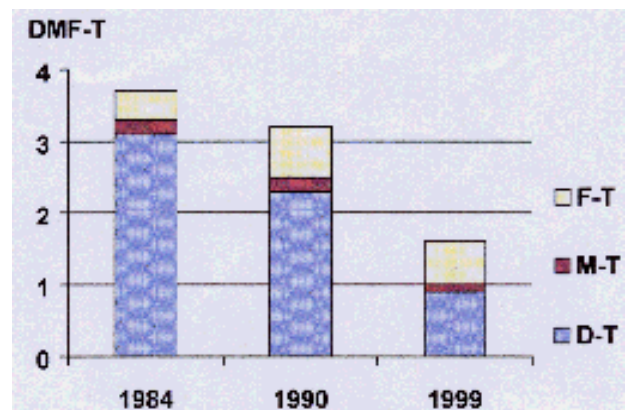


Figure 2. Mean dental caries experience (DMF-T) of 12-year-old Portuguese children by year of study.

children attending public schools than for children in private schools. For example, among 6-year-olds, 2.5 dmf-t was found for children in public schools against 0.7 dmf-t for children of private schools ($p < 0.001$).

Figures 1 and 2 show the mean caries experiences among children as compared to the findings of the corresponding national surveys in 1984 and 1991. At age 6, the caries levels declined significantly ($p < 0.001$) from 5.2 dmf-t in 1984 and 4.2 dmf-t in 1990. Parallel reductions in the prevalence proportion rates were observed from 83.0% in 1984 to 75.8% in 1990. Among 12-year-olds, the caries experience decreased significantly ($p < 0.001$) from 3.7 DMF-T in 1984 and 3.2 DMF-T in 1990; the prevalence proportion rates of caries were 85.5% in 1984 and 78.3% in 1990.

Enamel lesions

The clinical examinations revealed that demarcated enamel opacities were found for 7.3% of children aged 6 years and 7.1% at age 12. Hypoplasia was less frequent, i.e.

0.3% in 6-year-olds and 0.9% of 12-year-olds. The prevalence rates of dental fluorosis were recorded as follows. At age 6, 11.6% had very mild fluorosis, 6.9% mild and 1.8% had moderate fluorosis. At age 12, 21.1% of the children had very mild fluorosis, 11.0% mild, and 2.5% had moderate fluorosis. No major variations in frequency of enamel lesions were observed according to location and gender.

Gingival conditions

Table 3 indicates that the majority of children had CPI maximum score 2 (i.e. gingival bleeding and calculus). Three out of four children had fair oral hygiene status as measured by the Oral Hygiene Index (Table 4). Minor differences in CPI scores and oral hygiene were found by gender and location.

Dental health care

About one third of children aged 6 years claimed to brush twice a day (Table 5); brushing was performed by

Table 3. The percentages of Portuguese children of age 12 (n = 800) with CPI maximum scores and the mean number of sextants with CPI-scores.

	CPI max %	Mean no. sextants
Score 0 (healthy)	4.4	2.4
Score 1 (bleeding)	5.6	0.9
Score 2 (bleeding and calculus)	90.0	2.7

Table 4. The distribution (Pct) of Portuguese children by level of Oral Hygiene Index.

OHI	(Scores)	6 years (n = 793)	12 years (n = 799)
Very good	(Score 0–0.2)	7.6	5.3
Good	(Score 0.3–0.6)	16.5	18.4
Fair	(Score 0.7–1.8)	72.6	74.5
Poor	(Score 1.9–3.0)	3.3	1.9

Table 5. The percentages of Portuguese children with certain dental care habits according to age and urbanisation.

	Age	Urban	Periurban	Rural	Total
Toothbrushing twice a day	6 years (n = 799)	33.0	34.0	26.8	31.0
	12 years (n = 799)	61.1***	34.0	43.4	55.6
Annual visits to the dentist	6 years (n = 799)	18.9*	16.0	15.2	17.8
	12 years (n = 799)	63.1***	36.0	47.8	58.3

* $p < 0.05$ *** $p < 0.001$

Table 6. Percentages of Portuguese children who receive preventive dental services on a regular basis.

	6 years (n = 799)	12 years (n = 799)
Having at least one tooth with fissure sealing	1.4	16.8
Participating in fluoride mouthrinsing (once a week/every fortnight)	50.2	33.9
Receiving fluoride tablets regularly	24.4	20.4

Table 7. Multivariate dummy-regression analyses of caries experience (dmf-t/DMF-T) of children in Portugal (n = 1598).

Independent variable	Category	dmf-t	DMF-T
Age	12 years	-0.31***	0.25***
	6 years	-	-
Gender	Boys	0.20	-0.15*
	Girls	-	-
Location	Rural	0.28***	0.12**
	Urban	-	-
Ethnic group/nationality	Non-Portuguese	0.50*	0.07
	Portuguese	-	-
Dental visits	Annual	0.32***	0.06
	Seldom/no visits	-	-
Frequency of toothbrushing	Twice a day	-0.24***	-0.15***
	Irregular/seldom	-	-
Fissure sealing	Yes	0.03	-0.03
	No	-	-
Fluoride mouthrinsing programme	Yes	0.02	-0.04
	No	-	-
Fluoride tablet programme	Yes	0.02	-0.04
	No	-	-
R ²		0.16	0.21

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

half the 12-year-olds and the practice was relatively more frequent in urban areas. Also, 12-year-old girls (63.4%) more often than boys (47.0%) claimed to brush twice a day ($p < 0.001$).

Nearly 20% of 6-year-olds and 60% of children aged 12 had annual dental visits. However, 58.4% of 6-year-olds and 13.3% of 12-year-olds had never seen a dentist.

Dental visiting habits were significantly more frequent in urban areas than in periurban and rural areas. At age 12, annual dental visits were recorded significantly more often for girls (F: 62.2%; M: 54.1%, $p < 0.05$) and attendees of private schools (private: 85%; public: 63%, $p < 0.01$).

Table 6 shows that just over 1% of 6 year olds compared with 16.8% of 12-year-olds had received fissure

sealants; half the 6-year-olds and one third of 12-year-olds took part in fluoride mouthrinsing programme. At age 6, fluoride mouthrinsing was significantly more frequent in rural areas (93.6%) than in urban areas (30.5%) ($p < 0.001$) and the pattern was the same for 12-year-olds (rural: 50.6%; urban: 26.4%, $p < 0.001$).

Multivariate analysis

The results from regression analysis of dental caries experience (dmf-t/DMF-T) are summarised in Table 7. The independent variables with statistical significant effects on dental caries were age, gender, location, ethnic group, dental visits and toothbrushing habits. For both dentitions, the caries levels were relatively high for rural children and lower for children who performed toothbrushing at least twice a day compared with children who seldom or irregularly brushed.

Discussion

In Portugal, the health care system has been in transition over the past decade. The primary health service is based on private health care providers and a large proportion of funding is private. Thus, health care is mainly financed in the form of direct payments by the patient or to a lesser extent through public or private insurance schemes. The publicly funded oral health care service (National Health Service) is very limited and not comprehensive and there are only a few National Health Service dentists. Private dental practitioners frequently contract with one or more private insurance schemes; each scheme defines its own list of eligible services, and fees are determined within a maximum and a minimum amount set by the National Dental Association. Over the past 15 years preventive oral health care services have been included in the schemes in order to improve oral health of children. In addition, preventive programmes have been implemented in primary schools throughout the country. Oral hygienists are working from community health centres by use of mobile dental units and schoolchildren are then offered preventive care such as fissure sealing, oral hygiene instruction and education. The public health services are responsible for health promotion and disease prevention at community level and for evaluation of the impact of health care programmes. In contrast to general health, no systematic oral health surveillance systems have been established which may assist the evaluation of oral health programmes for schoolchildren.

Thus, the present study intended to assess the changing oral disease pattern of children in light of the implementation of preventive oral programmes in schools. Various focal points were chosen for the study in order to provide data at national level, particularly with respect to urban and rural areas of the country. Due to the sampling design and the high rates of participation the results of the present survey are considered having national relevance and the sample size in each age group was sufficiently large for calculation of precise statistical parameters. The same sites and schools were chosen for collection of clinical data at each year of study and the information therefore may provide for valid time-series analysis. The clinical data were collected according to the standardized criteria of the WHO (World Health Organi-

zation, 1997) and the recommended level of inter-examiner consistency in recording of dental caries was achieved ((World Health Organization, 1993). The reliability of the interview data was controlled by use of highly structured questions and potential information bias may either relate to recall bias or the possibility that participants would report acceptable rather than factual behaviour.

In a European perspective, the actual level of dental caries in Portuguese children seems to be relatively low (Marthaler *et al.*, 1996; World Health Organization, 2000a) and now similar to what is observed recently for countries with advanced public oral health care programmes for children (Pitts *et al.*, 1998; Wang *et al.*, 1998). For example, for 12-year-olds the United Kingdom has reported the mean caries experience at 1.1 DMF-T (Pitts *et al.*, 1998) and the corresponding figure for Denmark is 1.0 DMF-T (National Board of Health, 2002). It is worth noting that for Portuguese children aged 12 years the 1999 level of dental caries is lower than the WHO European goal for the year 2000 (Petersen *et al.*, 1994; World Health Organization 1991) (i.e. no more than 2 DMF-T). Also, the goal of at least 50% of 6-year-old children being free of dental caries was accomplished for Portugal (Petersen *et al.*, 1994). Meanwhile, the caries figures revealed by the present survey seem somewhat lower than those observed in another recent national study but this may possibly be due to different criteria of recording dental caries. Nevertheless, the caries level outlined by the present investigation is consistent with the findings of similar studies of schoolchildren carried out recently in Spain.

For both age groups examined the high d/D-components indicate the need for dental care and that the prevalence of dental caries is not yet under control. This was particularly found for periurban children of both ages. The caries index of deciduous teeth was higher for children living in rural than urban areas and this may partly be explained by differences in dental care habits, social norms and dental attitudes. In addition, the amount of dental caries was somewhat higher for non-Portuguese children while gender had minor effect on the caries experience index. In addition, the need for oral hygiene instruction of children was demonstrated by the survey since the vast majority of children had gingival bleeding and calculus and the oral hygiene score was fair for three out of four children. The poor oral hygiene conditions reflects the irregular toothbrushing habits of children and the study also indicates that toothbrushing is less frequent in Portuguese schoolchildren compared with the situation in several other West European countries (World Health Organization, 2000b).

According to this study there has been a decline in the prevalence of dental caries amongst Portuguese children over the past 15 years. Several reasons for this decline in dental caries experience and the growing proportions of caries free children may be considered. First, the oral hygiene practices of children improved markedly over time. In 1984, 43% of children aged 12 reported toothbrushing on a daily basis (Almeida *et al.*, 1991; Almeida *et al.*, 1990a; Almeida *et al.*, 1990b) against the 84% of children observed in the 1999 survey. Second, an increase in the consumption of fluoride toothpaste parallels the changing oral hygiene habits and currently

most of the toothpaste available on the market in Portugal is fluoridated. Third, significant proportions of the children are now offered preventive oral care services; half of the 12-year-olds and one third of 6-year-olds took part in school-linked fluoride mouthrinsing programmes and one fifth to one fourth of the children had fluoride tablets. However, the present multivariate analysis suggests that such programme activities apparently have some limited impact on the prevalence of caries at the population level.

In conclusion, care needs to be taken that a direct causal relationship exists between the decline in dental

caries and the implementation of preventive programmes but the present oral health situation analysis indicates that some improvement as to the control of oral disease in children has occurred. It is worth noting that while the level of dental fluorosis was low the prevalence of enamel opacities was relatively high. In parallel to the decline in dental caries experience skewed distributions of dental caries are now observed for Portuguese children. The current oral health profile would imply further emphasis be given on effective implementation of the school-based oral health promotion and population directed preventive programmes in Portugal.

References

- Almeida, C.M. (1997): As doenças da cavidade oral nos jovens portugueses: estudo epidemiológico. *Arquivos do Instituto Nacional de Saúde* **23**, 5–178.
- Almeida, C.M., Emílio, M.C., Möller, I., Marthaler, T. (1990a): 1º inquérito nacional explorador de prevalência das doenças e necessidades de tratamento na cavidade oral. I parte. *Revista Portuguesa de Estomatologia e Cirurgia Maxilofacial* **31**, 137–149.
- Almeida, C.M., Emílio, M.C., Möller, I., Marthaler, T. (1990b): 1º inquérito nacional explorador de prevalência das doenças e necessidades de tratamento na cavidade oral. II parte. *Revista Portuguesa de Estomatologia e Cirurgia Maxilofacial* **31**, 215–230.
- Almeida, C.M., Emílio, M.C., Möller, I., Marthaler, T. (1991): 1º inquérito nacional explorador de prevalência das doenças e necessidades de tratamento na cavidade oral. III parte. *Revista Portuguesa de Estomatologia e Cirurgia Maxilofacial* **32**, 9–22.
- Beltrán-Aguilar, E.D., Estupinan-Day, S., Baez, R. (1999): Analysis of prevalence and trends of dental caries in the Americas between the 1970s and 1990s. *International Dental Journal* **49**, 322–329.
- Brathall, D., Hänsel-Petersson, G., Sundberg, H. (1996): Reasons for the caries decline: what do the experts believe? *European Journal of Oral Science* **104**, 416–422.
- Burt, B. (1994): Trends in caries prevalence in North American children. *International Dental Journal* **44**, 403–413.
- Chen, M., Andersen, R.M., Barmes, D.E., Leclercq, M-H., Lyttle, C.S. (1997): *Comparing oral health systems. A second international collaborative study*. Geneva: World Health Organization.
- Greene, J.C., Vermillion, J.R. (1964): The simplified oral hygiene index. *Journal of the American Dental Association* **68**, 7–13.
- Lang, N.P. (1998): Commonly used indices to assess oral hygiene and gingival and periodontal health and diseases. In: *Proceedings of the European Workshop on Mechanical Plaque Control*, ed. Lang, N.P., et al. pp50–71. Chicago: Quintessence.
- Marthaler, T.M., O'Mullane, D., Vrbic, V. (1996): The prevalence of dental caries in Europe 1990–95. *Caries Research* **30**, 237–255.
- Nadanovsky, P., Sheiham, A. (1995): Relative contribution of dental services to changes in caries levels of 12-year-old children in 18 industrialized countries in the 1970s and the early 1980s. *Community Dentistry Oral Epidemiology* **23**, 331–339.
- National Board of Health (2002): *Oral health statistics on Danish children and adolescents*. Copenhagen: National Board of Health.
- Petersen, P.E. (1992): Effectiveness of oral health care – some Danish experiences. *Proceedings of the Finnish Dental Society* **88**, 13–23.
- Petersen, P.E., Christensen, L.B., Möller, I.J., Staehr-Johansen, K. (1994): Continuous improvement of oral health in Europe. *Journal of the Irish Dental Association* **40**, 105–107.
- Petersen, P.E., Torres, A.M. (1999): Preventive oral health care and health promotion provided for children and adolescents by the Municipal Dental Health Service in Denmark. *International Journal of Paediatrics Dentistry* **9**, 81–91.
- Pinto, R., Cristovão, E., Vinhas, T., Castro, M.F. (1999): Teor de fluoretos nas águas de abastecimento da rede pública, nas sedes de concelho de Portugal continental. *Revista Portuguesa de Estomatologia e Cirurgia Maxilofacial* **40**, 125–142.
- Pitts, N.B., Evans, D.J., Nugent, Z.J. (1998): The dental caries experience of 12-year-old children in the United Kingdom. Surveys coordinated by the British Association for the Study of Community Dentistry in 1996/97. *Community Dental Health* **15**, 49–54.
- Salas-Wadge, M.H. (1994): Use of linear regression analysis on dental survey data. *Community Dental Health* **11**, 197–201.
- Wang, N.J., Källestaal, C., Petersen, P.E., et al. (1998): Caries preventive services for children and adolescents in Denmark, Iceland, Norway and Sweden: strategies and resource allocation. *Community Dentistry Oral Epidemiology* **26**, 263–271.
- World Health Organization (1991): *Health for all targets. The health policy for Europe (updated edition 1991)*. *European Health for All Series*, No. 4. Copenhagen: WHO Regional Office for Europe.
- World Health Organization (1993): *Calibration of examiners for oral health epidemiological investigations*. Geneva: WHO.
- World Health Organization (1997): *Oral Health Surveys – Basic Methods*. Geneva: WHO.
- World Health Organization (2000a): *Global Oral Health Data Bank*. Geneva: WHO.
- World Health Organization (2000b): *Health and health behavior among young people*. Copenhagen: WHO Regional Office for Europe.