

Caries prevalence in 12-year-old Cypriot children

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Objective: To determine caries prevalence and caries experience in 12-year-old children living in the Republic of Cyprus and to evaluate whether different variables were associated with caries experience. **Methods:** According to the WHO recommendation, schools were randomly selected by taking into account the distribution between rural and urban regions, so that 10% of Cypriot children attending the sixth grade could be examined. In the school year 2003/2004 the children were examined in schools by one person with the aid of artificial light but without taking radiographs or fibre-optic transillumination. DMFT, presence of fissure sealants and black stain were recorded. **Results:** In total 951 children were examined. Caries prevalence was 32.6% (95% CI 29.62–35.6). The mean DMFT was 0.65 (sd 1.17) and the SiC was 1.95. Fissure sealants were found in 14.3% of the children. No association between frequency of tooth brushing, presence of fissure sealants or presence of black stain and caries experience was observed. Children living in rural areas had significantly higher mean DMFT values than children living in urban areas. **Conclusion:** A further caries decline may be attained by promoting a more extensive use of preventive measures like application of fluoride varnish or fissure sealants.

Key words: caries prevalence, 12-year-olds, fissure sealants, Significant Caries Index, Cypriot children

Introduction

Caries started a marked decrease for many industrialised countries about four decades ago (Marthaler, 2004) but neither in that paper nor in the report on the 1995 ORCA Symposium on caries prevalence in Europe, was Cyprus mentioned (Marthaler *et al.*, 1996). In the Republic of Cyprus studies of child and adolescent dental health were conducted in 1979, 1981, 1990 and 1992. The results of these surveys were published by the Cypriot Ministry of Health reporting a mean DMFT of 2.70 for 12-year-olds in 1981 and 2.16 in 1992 (Dental Services of the Republic of Cyprus, 1992) and the latter figure cited in an international comparative table (Nithila *et al.*, 1998). A June 2011 search of the literature from 1992 onwards (i.e. PubMed, Medline, Google Scholar) found no other papers published on caries prevalence in Cypriot children.

In 2000, the provinces under the jurisdiction of the Republic of Cyprus (Larnaca, Lefkosia, Lemesos, Pafos) had about 750,000 inhabitants of whom 21.5% were under 15 (OECD Health Data, 2004; Statistical Service of the Republic of Cyprus, 2005). Between 1982 and 2002 several socioeconomic factors improved in the Republic (Table 1). The Republic has one university, so far without medical or dental faculty. As a result, physicians and dentists who work in the Republic have to study abroad, most commonly in Greece, the UK, the USA, Hungary, Romania or the Czech Republic.

The dental care for the Cypriot population is provided mainly by dentists who work in private practice and to a small extent by dentists working in the Ministry of Health. Between 1992 and 2002 the number of the active dentists working in the Republic of Cyprus almost doubled, so that in 2001 a dentist served an average of

1092 inhabitants (Table 1). Patients usually pay the full cost of dental care and treatment. Reimbursement of such expenses takes place only if a patient has chosen to contract for this with a private insurance company. All low-income earners, government employees, school children and people with special health or social problems (special needs) are entitled to free treatment by the dentists of the public service. Since 1991, all 11- and 12-year-old children who were examined by a school dentist are eligible to be treated privately by a dentist of their choice with the costs borne by the Ministry of Health.

No water fluoridation is performed in the Republic of Cyprus and in general, the fluoride concentration in drinking water is 0.1 to 0.2 mg/L. Fluoridated salt is not available but fluoridated toothpastes have been sold for many years and their market share is estimated at over 90%. Between 1982 and 2002, the average annual sugar consumption per capita increased by 40% (International Sugar Organisation, 2002).

The main purpose of this study was to determine the caries prevalence in 12-year-old children in the Republic of Cyprus on a national and regional level. Further aims were to calculate the Significant Caries Index (SiC) as proposed by Bratthal (2000) and to investigate whether some of the factors known in other countries to reduce caries experience can be confirmed for Cyprus as well.

Material and Methods

The study was conducted during the academic year 2003/2004 (September, October, February and March) as a national cross-sectional study. In the Republic of Cyprus, children usually are enrolled at school by the age of 6 years and must attend primary school at least

Table 1. Socio-economic data for the Republic of Cyprus

| Year | Gross Domestic Product (GDP) in Int\$ | Mean income per capita in Int\$ | Mean life-expectancy men / women in years | Expenses for health system in % of GDP | Annual sugar consumption per capita in kg | Number of inhabitants per dentist |
|------|---------------------------------------|---------------------------------|---|--|---|-----------------------------------|
| 1982 | 2,159,508,648 | 6,300 | 73.0 / 77.3 | * | 29.1 | * |
| 1992 | 6,913,953,329 | 13,820 | 74.6 / 79.1 | * | 38.4 | 1,842 |
| 2002 | 10,558,381,391 | 20,660 | 76.6 / 81.3 | 6.1 | 41.4 | 1,092 |

* no figure available

Sources: International Sugar Organisation, 2002; WHO, 2011; World Bank, 2010.

Table 2. Caries prevalence, treatment need and care index (with 95% confidence intervals) in 12-year-olds from the four provinces of the Republic of Cyprus

| | All children <i>n</i> =951 | Boys <i>n</i> =473 | Girls <i>n</i> =478 | Children from Lefkosia <i>n</i> =326 | Children from Lemesos <i>n</i> =362 | Children from Larnaca <i>n</i> =145 | Children from Paphos <i>n</i> =118 |
|--|-------------------------------|-----------------------|------------------------|---|--|--|---------------------------------------|
| Caries prevalence | 32.6% (29.6-35.6) | 33.6% (29.3-37.9) | 31.6% (27.4 -35.8) | 26.1% (21.3-30.9) | 35.6% (30.7-40.5) | 33.8% (26.1-41.5) | 39.8% (30.9-48.6) |
| Proportion of children with DT>0 | 13.4% (11.2 -15.6) | 14.4% (11.2 -17.6) | 12.3% (9.4 -15.2) | 12.9% (9.6 -16.5) | 16.0% (12.2 -19.8) | 4.8% (1.3 -8.3) | 16.9% (10.1 -23.7) |
| Care Index* | 64.6% | 62.7% | 66.7% | 57.1% | 60.0% | 68.0% | 52.0% |
| Proportion of children with at least one fissure sealant | 14.3% (12.1 -16.5) | 12.3% (9.3 -15.3) | 16.3% (13.0 -19.6) | 15.0% (11.1 -18.9) | 16.0% (12.2 -19.8) | 15.2% (9.4 -21.0) | 5.9% (1.6-10.2) |

* Care Index = MFT/DMFT x 100

for 6 school years. Thus, the majority of children attending the sixth grade are 12 years old. The number of schoolchildren attending the sixth grade was 9500. According to the recommendations of the WHO (1997) for caries epidemiological studies, 10% of the children in an age group have to be examined in order to have reliable data. In all provinces, schools were randomly selected taking into account rural and urban areas so that in each province 12% of the children attending the sixth grade could be examined. As about 20% of the children from the sample could not be examined for various reasons (absence, lack of parental consent, failure to return the consent form), additional children were selected to ensure that the WHO recommendation to examine 10% of the age group of interest could be met. Prior to the examinations, written approvals from the Ministry of Education, local education authorities, school heads and parents were obtained.

The dental examinations took place in schools by using dental mirrors, explorers and artificial light. Neither radiographs nor fibre-optic transillumination were used. Examinations were performed by one person (DP) trained and calibrated by a dentist with extensive experience in oral epidemiology (AS). Kappa value for the intra-examiner reliability was 0.98 and for the inter-examiner reliability 0.89. Following WHO criteria (1997) the DMFT index was recorded. The presence of fissure sealants was also noted without taking into account whether or not it was complete. It was also noted whether black stain was present.

After the clinical examination the children answered a few questions about oral hygiene habits and provision of dental care: Do you have your own toothbrush? How often do you brush your teeth (twice a day, once a day, sometimes, never)? Which toothpaste do you use (packets of different kinds of toothpastes were shown to avoid misunderstanding)? Have you ever visited a dentist? If 'yes' then how often (once, twice, more per year)? and Why have you been to the dentist (control, treatment, pain)? All data were recorded anonymously on a standard log sheet.

Descriptive and analytical statistics were performed with SPSS v10.0 and statistical significance set at $p < 0.05$. The prevalence of caries, the mean DMFT values, the Significant Caries Index (SiC) and the care index percentage (MFT / DMFT x 100) were calculated for both the total sample and subgroups. Mann-Whitney and Chi-Square tests were applied.

Results

A total of 951 children, mean age of 11.6 years, were examined: 49.7% boys and 50.3% girls. In total these children had 23,595 erupted permanent teeth representing 88% of the maximum possible number of permanent teeth without taking into account the third molars. The mean number of permanent teeth per child was 20.9. This number was higher in girls (21.5) than in boys (20.4).

Caries prevalence was 32.6% (95% CI: 29.6–35.6) in the whole sample (Table 2). The mean DMFT was 0.65 (sd 1.17) and the SiC was 1.95 (Table 3). Permanent

Table 3. Mean DMFT, DT, MT, FT and SiC values for 12-year-olds from the four provinces of the Republic of Cyprus

| | <i>All</i> | <i>Boys</i> | <i>Girls</i> | <i>Children from Lefkosia</i> | <i>Children from Lemesos</i> | <i>Children from Larnaca</i> | <i>Children from Pafos</i> |
|----------------|--------------|--------------|--------------|-------------------------------|------------------------------|------------------------------|----------------------------|
| | <i>n=951</i> | <i>n=473</i> | <i>n=478</i> | <i>n=326</i> | <i>n=362</i> | <i>n=145</i> | <i>n=118</i> |
| DMF-T | 0.65 | 0.67 | 0.63 | 0.49 | 0.70 | 0.77 | 0.89 |
| D-T | 0.22 | 0.25 | 0.21 | 0.21 | 0.27 | 0.10 | 0.28 |
| M-T | 0.007 | 0.008 | 0.006 | 0 | 0.01 | 0 | 0 |
| F-T | 0.42 | 0.42 | 0.42 | 0.27 | 0.41 | 0.68 | 0.52 |
| Maximum DMF-T | 8 | 8 | 8 | 8 | 8 | 7 | 7 |
| SiC | 1.95 | 1.93 | 1.97 | 1.74 | 1.95 | 2.29 | 2.00 |
| D-T where DT>0 | 1.70 | 1.71 | 1.69 | 1.67 | 1.71 | 2.00 | 1.65 |

teeth had almost never been extracted because of carious defects (mean MT 0.007). The mean DMFT of the whole sample was almost exclusively determined by the caries experience of the first molars: the value for incisors and canines was 0.04, premolars 0.05, first molars 0.55 and second molars 0.01.

The proportion of children needing dental treatment (DT>0) was only 13.4% (95% CI: 11.2-15.5). About one third of the teeth with caries experience (DT>0) needed dental treatment (Table 3).

Little difference was seen by gender with regard to caries prevalence, caries experience and dental treatment need (Table 2 and 3). In contrast to this, distinct regional differences were observed. Caries prevalence and caries experience were lowest in the province of Lefkosia but the lowest proportion of children with need of dental treatment due to caries was found in the province of Larnaca (Tables 2 and 3).

At least one fissure sealant was found in 14.3% of the children examined (Table 2). The mean number of fissure sealed teeth was 0.4 for the whole sample and 2.9 among the children who had at least one fissure sealed tooth.

Furthermore, some factors possibly associated with caries experience were analysed (Table 4). Children with fissure sealants or black stain did not have a lower mean DMFT than children without. DMFT values did not vary with change in frequency of tooth brushing. Children living in urban areas had a lower DMFT than those living in rural areas.

Discussion

This study is the first to present systematically many parameters associated with caries prevalence and caries experience in 12-year-old children of the Republic of Cyprus. For this caries epidemiological study the WHO recommendation to examine 10% of the children out of the age group was met in all provinces of the Republic and the sample was large, nearly 1,000 children. The mean age of the children being 11.6 years meets the criterion for calling them '12-year-olds'. Comparisons with other studies of this age group should take into account the different definitions of 12-year-olds: their mean age may vary between 11.5 and 12.5 years. Unfortunately, in several publications neither a definition of the age group under investigation nor the mean age is presented. Thus, a certain part of the differences in caries prevalence and

Table 4. Association of various variables with caries experience of 12-year-olds from Cyprus expressed as D3+4MFT and D3+4MFS.

| | <i>n</i> | <i>DMFT (sd)</i> | <i>DMFS (sd)</i> |
|---------------------|----------|------------------|------------------|
| All | 951 | 0.65 (1.17) | 0.88 (1.71) |
| Gender | | | |
| Male | 473 | 0.67 (1.18) | 0.93 (1.82) |
| Female | 378 | 0.63 (1.17) | 0.83 (1.60) |
| | | p>0.05 | p>0.05 |
| Fissure Sealants | | | |
| with | 136 | 0.59 (1.03) | 0.79 (1.37) |
| without | 815 | 0.66 (1.20) | 0.90 (1.76) |
| | | p>0.05 | p>0.05 |
| Visits to a Dentist | | | |
| never | 63 | 0.35 (0.86) | 0.40 (1.01) |
| once a year | 396 | 0.72 (1.29) | 1.02 (2.03) |
| twice a year | 299 | 0.68 (1.17) | 0.89 (1.55) |
| more | 193 | 0.55 (0.99) | 0.72 (1.32) |
| | | p>0.05 | p<0.05 |
| Tooth Brushing | | | |
| sometimes | 119 | 0.74 (1.34) | 1.05 (1.94) |
| once a day | 344 | 0.70 (1.21) | 0.92 (1.63) |
| twice a day | 390 | 0.58 (1.10) | 0.79 (1.92) |
| more | 98 | 0.63 (1.12) | 0.86 (1.62) |
| | | p>0.05 | p>0.05 |
| Black Stain | | | |
| yes | 57 | 0.49 (1.00) | 0.63 (1.42) |
| no | 894 | 0.66 (1.18) | 0.89 (1.72) |
| | | p>0.05 | p>0.05 |
| Residential Area | | | |
| urban | 862 | 0.62 (1.13) | 0.83 (1.62) |
| rural | 89 | 0.98 (1.49) | 1.38 (2.38) |
| | | p<0.05 | p<0.05 |

p values by Mann-Whitney Test

caries experience between studies on 12-year-olds may be due to age differences of the study populations.

Obviously, there are only two Cypriot studies available to compare our results with. These surveys encompassed several age groups, including 12-year-olds in 1981 and 1992, and followed WHO recommendations though no mean ages were reported making comparisons uncertain. In 1992, the mean DMFT was 2.16 (Dental Service of the Republic of Cyprus, 1992) and in 2004, 0.65 indicating a

caries decline of about 70% within 14 years. A comparable steep caries decline was reported in Germany between 1993 and 2004 (Schulte *et al.*, 2006). It should be noted that even in 1992 the mean DMFT for the 12-year-old Cypriots was below the global WHO goal for the year 2000 (WHO 1984).

Furthermore, another change was observed. In 1992, the mean FT counted for 45.8% of the mean DMFT (Dental Service of the Republic of Cyprus, 1992), while in 2004 this figure was 64.6%, indicating that dental care had improved over the 12 years. Probable explanations are: the improving economic situation allowed more Cypriots to pay more for regular dental care and dental treatments; free access to dental care for children from low income families was introduced; and, the increase in the number of dentists improved access to dental care. These assumptions are supported by the fact that 90% of the children under investigation reported visiting a dentist at least once a year and that only 13.4% needed dental treatment.

Comparison of the data from our survey with those from other national studies conducted among 12-year-olds in some European countries reveals that around 2004 in the Republic of Cyprus caries prevalence and mean caries experience were as low as in Germany and England, if not lower (Table 5). The Cypriot data for 12-year-olds should also be compared with those from neighbouring countries: much higher caries experience reported as the mean DMFT values were 3.4 in Lebanon, 2.7 in Turkey, 2.3 in Syria and 1.18 in Egypt (WHO, 2010).

According to numerous studies, caries experience correlates inversely with socioeconomic status (Klemme *et al.*, 2004; Reisine and Litt, 1993). This observation may explain why children from the province of Lefkosia, which is the capital of the Republic of Cyprus, had a lower caries experience than children from the other Cypriot provinces (Table 2). In this province the proportion of inhabitants with high socioeconomic status is greater, due to location there of most of the hospitals, authorities and the country's only university. Children from the urban areas had significantly lower DMFT values than children living in the rural (mountainous) regions (Table 4). The same observation had been made in Cyprus in 1992 (Dental Services of the Republic of Cyprus) and is also reported in other countries together with the association with lower socioeconomic status in urban regions (Cahen *et al.*, 1993; da Almeida *et al.*, 2003).

It is difficult to explain why caries experience in the Republic of Cyprus was as low as in many western European countries. Fissure sealants have contributed in countries like Germany, England or Slovenia to a decrease in caries experience (Pieper and Schulte, 2004; Pitts *et al.*, 2002; Vrbic, 2000) but not in the Republic of Cyprus as these had been applied only in 14% of children and these did not have lower DMFT than children without fissure sealants (Table 4). With regard to fluorides, the main source available for the Cypriot population is fluoridated toothpaste. Although officers of the Cypriot Ministry of Health reported that in the last 20 years some caries-preventive programmes (i.e. distribution of fluoride tablets for sucking, rinsing with fluoride-containing solutions) had been carried out in selected schools which were considered to have many children with a high caries risk, no official figures about the effectiveness of these programmes are available. So it is probable that these programmes have contributed to the caries decline observed but the extent remains unknown. The idea that Cypriots do not consume much sugar had to be rejected because consumption of sugar increased distinctly in this period and has reached now the same high level as in Germany. With regard to diet, it is noteworthy to mention, that recently an epidemiological study was published showing that a high consumption of cheese correlates with a low caries experience (Ohlund *et al.*, 2007). Unfortunately this information was not available when we conducted our survey and thus we did not ask children about their consumption of cheese traditionally a large proportion of Cypriots' diets. It is recommended that future caries epidemiological studies in Cyprus include this variable.

The economic situation has strongly improved in the Republic of Cyprus during the last 3 decades with parallel improvements in health. With regard to dentistry it can be assumed that people were increasingly able to buy fluoride-containing toothpastes and renew toothbrushes regularly. In countries with a mainly low income population this is reported to be a serious problem especially for families (Emerich and Adomowicz-Klepalska, 2010). Although caries prevalence among 12-year-olds from the Republic of Cyprus can be regarded as low, a further reduction could be attained by promoting a more extensive use of preventive measures such as the application of fluoride varnish or fissure sealants. These measures have proven to be very effective in other countries (Ahovuo-Saloranta *et al.*, 2004; Momeni *et al.*, 2007; Pieper and Schulte, 2004).

Table 5. Caries prevalence, mean DMFT and SiC values in 12-year-olds from national studies conducted in selected European countries

| Country | Year of study | Source | Caries Prevalence | Mean DMFT | SiC |
|------------------------|---------------|---------------------------------|-------------------|-----------|-------------|
| England | 2000/2001 | Pitts <i>et al.</i> , 2002 | 38% | 0.89 | Unavailable |
| Germany | 2004 | Schulte <i>et al.</i> , 2006 | 39% | 0.98 | 2.70 |
| Italy | 2004 | Campus <i>et al.</i> , 2007 | 43% | 1.09 | 2.99 |
| Portugal | 1999 | Da Almeida <i>et al.</i> , 2003 | 53% | 1.50 | Unavailable |
| Cyprus (present study) | 2004 | | 33% | 0.65 | 1.95 |

References

- Ahovuo-Saloranta, A., Hirii, A., Nordblad, A., Worthington, H. and Mäkälä, M. (2004): Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents. *Cochrane database of systemic reviews*: 3: CD 001830.
- Bratthall, D. (2000): Introducing the Significant Caries Index together with a proposal for a new global oral health goal for 12-year-olds. *International Dental Journal* **50**, 378-384.
- Cahen, P.M., Obry-Musset, A.M., Grange, D. and Frank, R.M. (1993): Caries prevalence in 6- to 15-year-old French Children based on the 1987 and 1991 national surveys. *Journal of Dental Research* **72**, 1581-1587.
- Campus, G., Solinas, G., Cagetti, M.G., Senna, A., Minelli, L., Majori, S., Montagna, M.T., Reali, D., Castiglia, P. and Strohmer, L. (2007): National Pathfinder Survey of 12-year-old children's oral health in Italy. *Caries Research* **41**, 512-517.
- Da Almeida, C.M., Petersen, P.E., André, S.J., Toscano, A. (2003): Changing oral health status of 6- and 12-year-old children in Portugal. *Community Dental Health* **20**, 211-216.
- Dental Services of the Republic of Cyprus (1992): *Pancyprrian epidemiological study for oral hygiene*. Lefkosia, Republic of Cyprus: Ministry of Health.
- Emerich, K. and Adamowicz-Klepalska, B. (2010): Trends in dental caries experience among children and adolescents in northern Poland between 1995 and 2003. *Community Dental Health* **27**, 218-221.
- International Sugar Organisation (2002): *Sugar Year Book 2002*. London: International Sugar Organisation.
- Klemme, B., Tramini, P., Niekusch, U., Roszbach, R. and Schulte, A.G. (2004): Relationship between caries prevalence and fissure sealants among 12-year German children at three educational strata. *Sozial- und Präventivmedizin* **49**, 344-351.
- Marthaler, T.M., O'Mullane, D. and Vrbic, V. (1996): The prevalence of dental caries in Europe 1990-1995. *Caries Research* **30**, 237-255.
- Marthaler, T.M. (2004): Changes in Dental Caries 1953-2003. *Caries Research* **38**, 173-181.
- Momeni, A., Hartmann, T., Born, C., Heinzel-Gutenbrenner, M. and Pieper, K. (2007): Association of caries experience in adolescents with different preventive measures. *International Journal of Public Health* **52**, 393-401.
- Nithila, A., Bourgeois, D., Barmes, D.E. and Murtomaa, H. (1998): WHO Global Oral Data Bank, 1986-96: an overview of oral health surveys at 12 years of age. *Bulletin of the World Health Organization* **76**, 237-244.
- OECD (2004): Health Data 2004. [oecd.org/dataoecd/3/62/31938359.pdf](http://dataoecd/3/62/31938359.pdf)
- Ohlund, I., Holgerson, P.L., Backman, B., Lind, T., Hernell, O. and Johansson, I. (2007): Diet intake and caries prevalence in four-year-old children living in a low-prevalence country. *Caries Research* **41**, 26-33.
- Pieper, K. and Schulte, A. (2004): The decline in dental caries among 12-year-old children in Germany between 1994 and 2000. *Community Dental Health* **21**, 199-206.
- Pitts, N.B., Boyles, J., Nugent, Z.J. and Pine, C.M. (2002): The dental caries experience of 12-year-old children in England and Wales. Surveys co-ordinated by the British Association for the Study of Community Dentistry in 2001/2002. *Community Dental Health* **19**, 46-53.
- Reisine, S. and Litt, M. (1993): Social and psychological theories and their use for dental practise. *International Dental Journal* **43**, 279-287.
- Schulte, A.G., Momeni, A. and Pieper, K. (2006): Caries prevalence in 12-year-old children from Germany. Results of the 2004 national survey. *Community Dental Health* **23**, 197-202.
- Statistical Services of the Republic of Cyprus (2005): Demographic report 2004. www.cystat.gov.cy/mof/cystat/statistics.nsf/populationcondition_21_main_archive_en?OpenForm&yr=2005
- Vrbic, V. (2000): Reasons for the caries decline in Slovenia. *Community Dentistry and Oral Epidemiology* **28**, 126-132.
- World Bank (2010): Countries and Economies: Cyprus. <http://data.worldbank.org/country/cyprus>
- World Health Organization (WHO) (1984): Oral health global indicator for 2000. Geneva: WHO.
- World Health Organization (WHO) (1997): Oral health surveys. 4th ed. Geneva: WHO.
- World Health Organization (WHO) (2008): Core health indicators. http://apps.who.int/whosis/database/core/core_select_process.cfm
- World Health Organization (WHO) (2010): Country oral health profiles. <http://mah.se/CAPP/Country-Oral-Health-Profiles/According-to-Alphabetical/>
- World Health Organization (WHO) (2011): Global health expenditure database. <http://apps.who.int/nha/database/DataExplorer.aspx?d=1>