Situational Analysis of Dental Caries and Existing Oral Health Care of Children and Adolescents in Hubei Province, People's Republic of China: Implications for Change

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Purpose: 1) To evaluate trends in dental caries of children and adolescents of Hubei Province and Wuhan Municipality over the last two decades. 2) To conduct a situational analysis of existing oral health care and to recommend changes to improve this care for children.

Materials and Methods: An analysis was performed on data from national oral health surveys carried out in China at the provincial level, and data on 12-year-old children of Wuhan Municipality. A review of the literature was conducted on available and utilised oral health care facilities by children.

Results: In 1983, the mean decayed, missing and filled teeth (DMFT) of 12-year-olds in Hubei Province was 1.0, and in 1995 it was 0.6. The studies in Wuhan Municipality in 1993–1995 among 12-year-olds reported DMFT values ranging from 0.7–1.5, however different methods of caries assessment were performed in the various studies making comparisons difficult. The caries prevalence and the mean dmft score of 5-year-old children in 1995 in Hubei Province were 69% and 3.6, respectively. The percentage of untreated caries for all age groups in Hubei Province was very high.

Conclusions: Analysis of epidemiological information over the last two decades does not provide any conclusive evidence supporting either an increasing or decreasing trend of dental caries in the child and adolescent population of Hubei Province and Wuhan Municipality. There is, however, a clear need to prevent the incidence of dental caries from increasing and to provide care to address the treatment needs of pre-school and school-age children. The promotion of twice-daily tooth brushing with fluoride toothpaste at maternal and child health care centres, and the establishment of daily tooth brushing with pea-size amounts of fluoride toothpaste in the pre-school and primary school setting are recommended preventive strategies. Establishment of school-based oral health promotion should be accompanied with the provision of Atraumatic Restorative Treatment (ART) sealants and ART restorations which can be provided by dental nurses at dramatically lower costs than the traditional high-tech approach.

Key words: epidemiology, Hubei Province, oral health care, oral health status, Wuhan Municipality

Oral Health Prev Dent 2008; 6: 13-21. *Submitted for publication: 10.04.06; accepted for publication: 01.05.07.*

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Due to its high global prevalence, dental caries amongst children has been described as a 'pandemic' disease (Edelstein, 2006). It is argued that the term 'pandemic' is appropriate, not only due to the global distribution of the disease and its severity, but also because the hundreds of millions who are afflicted have little or no access to care. Furthermore, dental caries has a significant impact on general health of children and the social and economic well being of communities (Sheiham, 2006). For most low-income nations the level of severity is low to very low. Howev-

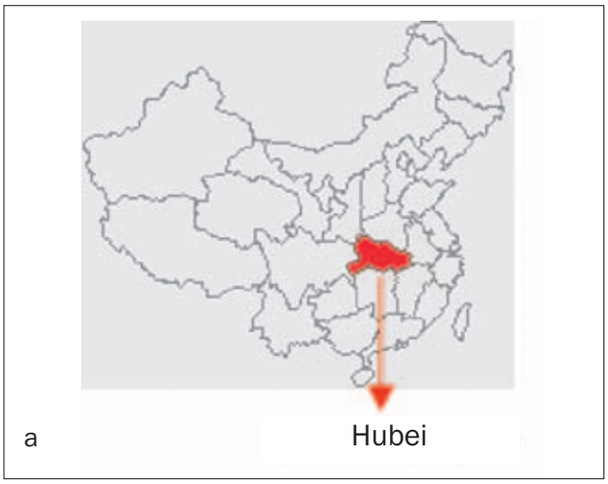

Fig 1a Map of China showing the Hubei Province.

Fig 1b Map of the Hubei Province showing the Wuhan Municipality.

er, as low-income countries transfer economically to the middle-income category, a concomitant shift to a higher severity of dental caries is likely due to dietary changes. China is undergoing accelerated economic and social change and this is exemplified in Hubei Province and Wuhan Municipality located in central China. From 1978 to 2004, the GDP per capita increased from $40 to $1270 in Hubei Province and from $89 to $2600 in Wuhan Municipality.

The hypothesis of this study was that dental caries in children and adolescents of Hubei Province and Wuhan Municipality has been on the increase over the last two decades. It was anticipated that analysis of existing epidemiological data would be able to either confirm or reject this hypothesis. Recommendations were then proposed on how to improve the oral health of children in the context of the present situational analysis of oral health care. The reason to prioritise oral health care for children is that they are at the beginning of their life, and any improvements in care would maximise the chance for the prevention of disease and the establishment of lifelong health habits (Mouradian, 2006).

Geography

Hubei Province, located in central China (Fig 1a) has a population of about 60 million people, of which 56% live in rural communities. Wuhan is the capital city of the province (Fig 1b) and has a population approaching 8 million.

Health care system

Hubei Province has a three-tier system of health care delivery. In rural areas, the first tier is the village medical centre (available in 88% of the villages). The next level is the township health centre, and the highest level is the county hospital. At present, Hubei has more than 530 hospitals at the county level. In urban areas, the first tier is the neighbourhood health station and the factory clinic. The second level is the district hospital and the third level is the municipal hospital. Public oral health care services are rendered in some schools, health centres, factory clinics and in most hospitals. Wuhan has one dental hospital, 45 general hospitals with dental clinics and about 100 private dental clinics offering services that are mainly curatively oriented with little emphasis on prevention.

Maternal and child health care

A maternal and child health (MCH) network has been established in both urban and rural areas. There are 104 MCH hospitals in Hubei Province. Every city, county, village and large company has a MCH centre. In rural MCH centres, care consists of growth monitoring, regular health checkups, immunisation and systematic management of common diseases. In urban areas, other additional programs include ENT (ear, nose and throat) care, mental health, early education and intelligence development. Oral health care programmes are not yet established in MCH clinics.

Dental education and dental personnel

One dental school and the dental departments of three of the medical colleges graduate dentists in Hubei Province. In the last decade, 850 dentists (5 years education) and about 900 middle-level dentists (3 years education) have graduated from these institutes.

Dentists serve in state-owned hospitals in Wuhan or in smaller cities in Hubei Province but very few serve in rural areas. Only a few dentists work in private practice. Since 1999, it has been compulsory for dentists to pass examinations in order to be certified. In 2004, Hubei Province had 3,285 certified dentists and middle-level dentists, which equates to a certified dentist/population ratio of 1:18,000. The number of non-certified dentists is difficult to estimate and may number in the thousands.

There are no dental nurse schools in Hubei Province. However, some medical nurses receive 3 years of medical training and an additional informal short course on dentistry.

Oral health insurance system

Since China's political reform in the 1980's, the government health insurance system has failed. In 1996, the national insurance system was revived and has resulted in an increase in insurance coverage in Hubei Province. Medical insurance usually covers basic dental health care, such as restorations and extractions, but does not cover orthodontics or prosthodontics.

Fluoride in the environment

The concentration of fluoride in drinking water in most areas of Hubei Province is below 0.5 mg F/litre (National Committee for Oral Health [NCOH], 1999), but in some regions such as Bazhou, water fluoride concentrations range from 1.8 to 5.0 mg F/litre (Wang et al, 2004). The prevalence of dental fluorosis of 12-year-old children in Hubei Province in 1995 varied between locations but was on an average 0.9%. However, only very mild and mild Dean's scores were recorded and it is therefore assumed that these forms of dental fluorosis did not pose aesthetic problems (NCOH, 1999). The concentration of fluoride in tap water in Wuhan Municipality is suboptimal (0.22 mg F/litre) for anticaries efficacy (Wang et al, 2004). Salt fluoridation was introduced in Wuhan in 1988 but was subsequently discontinued due to public concerns about toxicity and lack of freedom of choice.

MATERIALS AND METHODS

This study analysed data from two national oral health surveys carried out in China at the provincial level. The first survey in 1983 involved schoolchildren aged 7–17 years old (Ministry of Public Health, 1987). The second survey in 1995, which used World Health Organization (WHO) basic methods and criteria, included the age groups of 5, 12, 15 and 18 years (NCOH, 1999). Four small, less representative studies provide data on 12-year-old school children of Wuhan Municipality (Petersen and Guang, 1994; Peng et al, 1997a; Petersen and Esheng, 1998; Tai et al, 2001).

Information on oral health knowledge, attitude, behaviour and perceived need of children and adolescents were compiled from a review of four studies (Peng et al, 1997b; Petersen et al, 1997; Petersen and Esheng, 1998; Tai et al, 2001).

RESULTS

The caries prevalence and the decayed, missing and filled teeth (dmft) score of the primary dentition of 5-year-old children in 1995 in Hubei Province were 69% and 3.6, respectively. These were somewhat lower than the overall values reported for China (77% and 4.5, respectively; $p < 0.01$) (NCOH, 1999). Fig 2 depicts the mean DMFT score for different age groups. In 1983, the mean DMFT of 12-year olds in Hubei Province was 1.0 and in 1995, it was 0.6 (Ministry of Public Health, 1987; NCOH, 1999). The DMFT values in 1995 of the various age groups in Hubei Province are lower ($p < 0.01$) than the mean national values (NCOH, 1999). The caries experience of rural children and adolescents in Hubei appear to be lower than their counterparts in urban areas. This regional situation corresponds with the national situation. Fig 3 shows that the dmft and DMFT scores (for primary or permanent dentition) of the various age groups consisted mainly of the decayed component. The percentages of untreated caries of all age groups in both Hubei Province and China were very high. The filled component in Hubei is lower ($p < 0.01$) than for the rest of China (Ministry of Public Health, 1987; NCOH, 1999).

The studies of 12-year-old children in Wuhan Municipality between 1993 and 1995 reported DMFT values ranging from 0.7 to 1.5 (Petersen and Guang, 1994; Peng et al, 1997a; Petersen and Esheng, 1998; Tai et al, 2001).

Four per cent of the 12-year-old children in Wuhan and two small cities in Hubei Province claimed to have

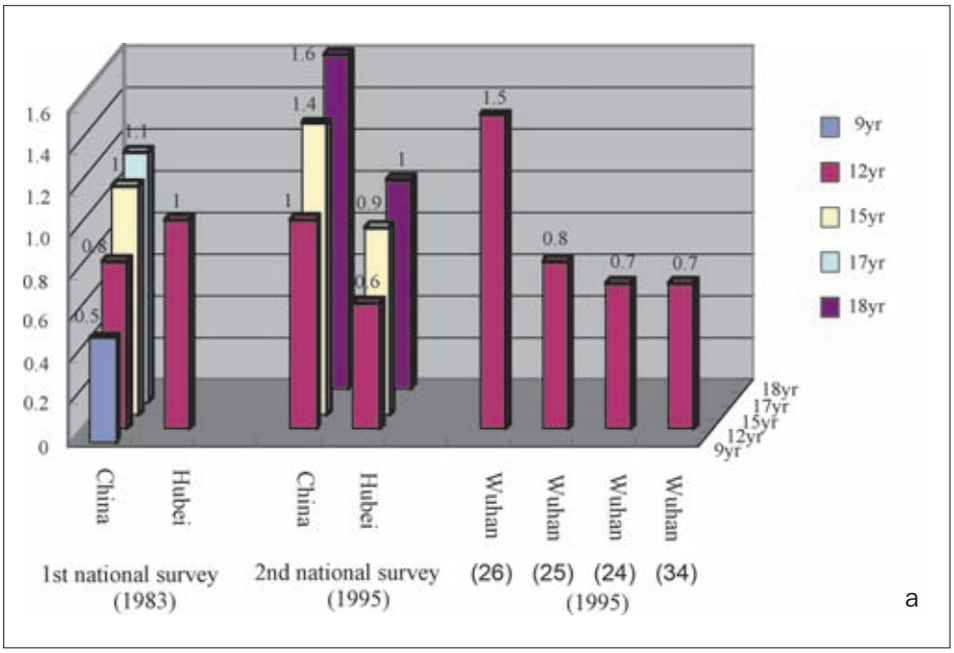

Fig 2 DMFT values of children and adolescents in China. The y-axis represents the DMFT score. Each x-axis represents a specific time cohort. Each z-axis shows cohorts of increasing age.

Fig 2a DMFT values of children and adolescents in China, Hubei Province and Wuhan Municipality, recorded between 1983 and 1995. References for each Wuhan study are listed in parentheses.

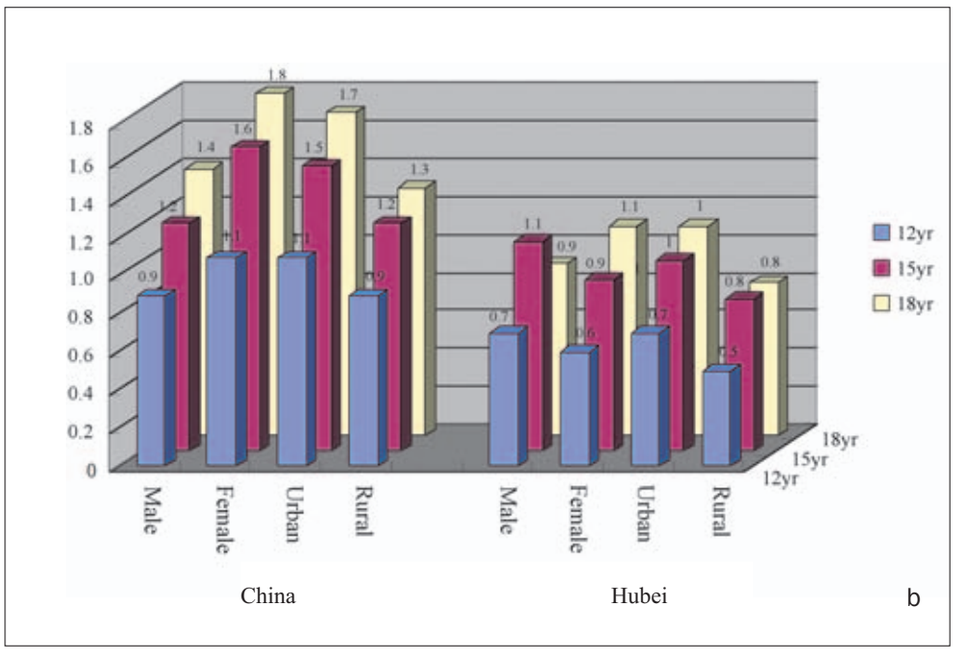

Fig 2b DMFT values of the second national survey of children and adolescents in China and Hubei Province for urban versus rural and for male versus female.

poor oral health, and 16% of the 12-year-old children perceived a need for restorative dental care (Peng et al, 1997a; Petersen et al, 1997). Of the 12-year-old children, 31% reported that pain was the reason for the most recent dental visit (Tai et al, 2001).

Tooth brushing usually starts in children at around 5 years of age (NCOH, 1999). In total, 39% of the 6-year-old children and 16% of the 12-year-old children reported brushing less than once a day, while less than 25% and 40%, respectively, brushed their teeth twice a day (Petersen et al, 1997). Less than 40% of 6- and 12-year-old children reported that they used fluoride toothpaste (Peng et al, 1997b). The price of toothpaste did not seem to play a significant role since

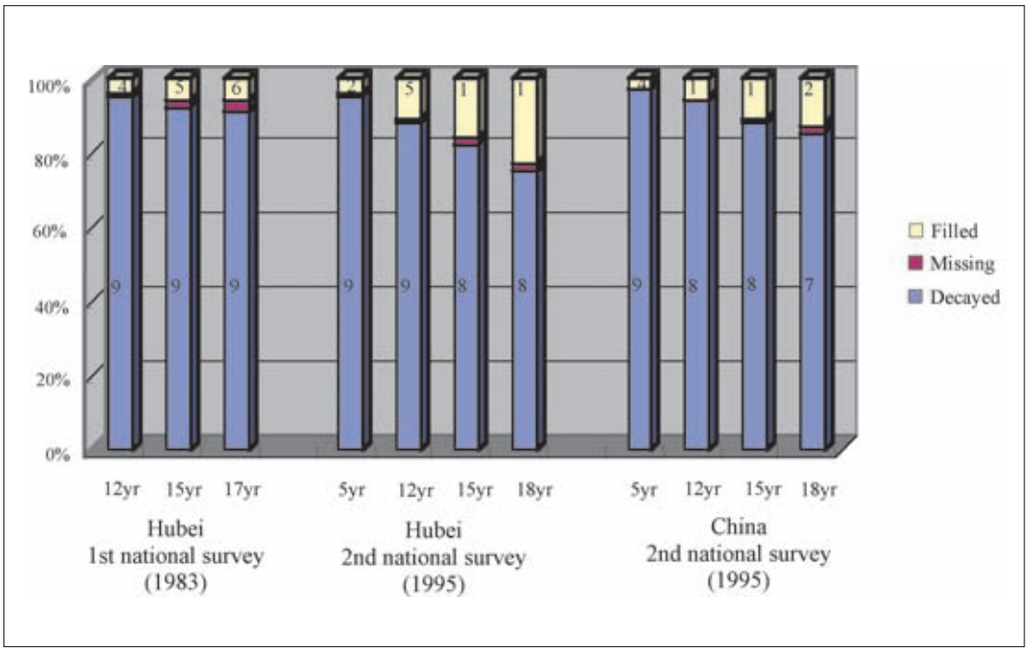

Fig 3 Proportional distribution of the dmft components in 5-year-old children in Hubei Province and China in 1995, and DMFT components of 12-, 15- and, 17- or 18-year-old children of Hubei Province and China in 1983 and 1995.

less than 2% of the population stated that they could not afford to purchase toothpaste (NCOH, 1999). Parents represent the primary source of information on oral health for children, whereas mothers and schoolteachers obtain oral health information mainly through the television (Peng et al, 1997b; Petersen and Esheng, 1998).

Less than 30% of the mothers felt that children younger than 10 years required assistance with tooth brushing (Petersen and Esheng, 1998).

DISCUSSION

The results appear to show that the DMFT scores of 12-year-old children did not change substantially in Hubei Province between 1983 and 1995, thus nullifying the hypothesis for that time interval. This may not be the actual situation. The 1983 survey was performed without using WHO methodology and used a sharp probe which has most likely resulted in an overestimation of caries. Whether dental caries is increasing or decreasing in the 12-year-old population of Wuhan Municipality cannot be concluded since there is no comparative data prior to 1993.

Irrespective of changes in the levels of caries, of greater concern is the high percentage of untreated caries that needs to be addressed. Another survey in Hubei and Wuhan may reveal a trend towards higher incidence and prevalence of dental caries since there has been tremendous economic growth in Hubei in the last decade. However, another survey is not necessary to address the problem of lack of care.

Oral health planning at the district or provincial level is preferred over national planning since such planning meets the socio-economic and political needs of the province (Lalloo et al, 1999). National policies based on national epidemiological data and national means may mask oral health inequalities. This is all the more relevant for China, which has large provincial and municipal populations. It may even be appropriate to plan separately for urban and rural communities in Hubei due to inequitable distribution of wealth and dental manpower. The Health Department of Hubei Province is in charge of public health, including oral health care, and has a certain amount of autonomy to develop and implement oral health strategies.

For low- and middle-income countries undergoing socio-economic transition, prevention is a high priority, especially where restorative care is lacking or where

the perceived need for oral care is low. School-based oral health education is a compulsory component of the school curriculum of primary schools in Hubei Province. However, it is questionable whether the transfer of knowledge through oral health education and campaigns such as 'Love Teeth Day' (LTD) contribute to improvements in the oral health of the children. The effects of the first 6 years of LTD on oral health knowledge and behaviour were evaluated in Wuhan in a pre-/post-intervention cross sectional study (Peng et al, 1997b). The level of knowledge on oral health topics such as 'sweets causing teeth to decay' increased 11% and 'fluoride prevents teeth to decay' increased 15% for the various age groups. A relatively higher proportion of interviewees claimed to brush at least twice a day (mean increase of 11%), used the recommended vertical method of tooth brushing (mean increase 8%), visited the dentist for check-up (mean increase 3%), used fluoride toothpaste (mean increase 33%) and exchanged their toothbrush every 3 months (mean increase 23%). Behavioural changes were more prominent amongst the youth. It is difficult to interpret the findings regarding behavioural change, since the self-reported behavioural changes of the interviewees were probably biased in a positive direction to provide socially acceptable answers. Furthermore, improved changes may be ascribed to other intervening external factors, e.g. increased availability of fluoride toothpaste on the local market, advertising of oral health products and people's increased spending power. Another recent study in Wuhan evaluated the effects of a 6-year school-based oral health education (OHE) programme. No improvements were observed in the dentition status and gingival health of schoolchildren who participated in the programme (Tai et al, 2001).

In 1998, the Hubei Province Committee for Oral Health, in collaboration with the WHO Collaborating Centre for Community Oral Health Programmes and Research (University of Copenhagen), implemented demonstration projects in a number of primary schools in Wuhan City. The school-based OHE programme was based on the concepts of the WHO Health Promoting Schools Project (WHO Collaborating Centre for Community Oral Health Programmes and Research, 1995), which emphasises healthy environments and the involvement of schoolteachers in classroom activities (Petersen et al, 2004). This programme was much more intensive, in terms of teaching activities and the involvement of mothers, than the previous cited study (Tai et al, 2001). Self-reported oral health behaviour amongst the schoolchildren had improved, including activities such as regular tooth brushing, use of fluoride toothpaste, less consumption of cakes and biscuits, and dental visits. Knowledge and attitude, related to the oral health of mothers and teachers, had also improved. However, OHE had only a slight beneficial effect on the gingival health of the schoolchildren, and no beneficial effect was found on caries increment. These findings on OHE corroborate the conclusions reached by a systematic review on oral health education (Kay and Locker, 1996).

The appropriate use of fluorides is the cornerstone for the prevention of dental caries. Approximately 10 years ago, a school-based fluoride-rinsing programme was introduced in primary schools in Wuhan City, but the outcomes have never been evaluated. A school-based preventive programme was introduced in 2003, incorporating the application of fissure sealants and fluoride varnish on approximately 53,000 6–14-year-old schoolchildren in Wuhan. There were 60 dental technicians and nurses designated as the providers of this programmme, who received a short course on the application of these preventive measures. The Wuhan Bureau of Health was responsible for this project, but evaluative data were not available for the present study.

Clinical trials evaluating the effect of 6-monthly professional application of acidulated phosphate fluoride foam (APF) on the primary dentition of pre-school children and on the first permanent molars of primary schoolchildren in Wuhan City reported a 24% reduction in caries increment over a 2-year period (Jiang et al, 2005a; Jiang et al, 2005b). The reduction in caries increment was only found on proximal surfaces, but not on the occlusal surfaces. A randomised controlled trial (RCT) on the effect of twice-a-year professional application of chlorhexidine varnish (EC40) on pits and fissures of first permanent molars of 6–7-year-old schoolchildren in Wuhan City showed a 29% reduction in caries increment over a 2-year period (Zhang et al, 2006). One RTC study evaluated the effect of four-times-a-day chewing on sugar-free chewing gum by 6–7-year-old schoolchildren during the school periods in Wuhan. After 2 years, a 42% reduction in caries increment was observed in the chewing gum intervention group (Peng et al, 2004). Although all the preventive approaches above have shown evidence-based anticaries efficacy, they are only feasible in areas with sufficient dental workforce and/or finance, and are therefore unlikely to be sustainable for the population as a whole.

In light of the apparent opposition to salt fluoridation in Wuhan City and the inability of water fluoridation to reach rural communities, toothpaste is probably the most important delivery system for fluoride (Clarkson and McLoughlin, 2000) and is likely to be

the most acceptable preventive strategy for the whole population of Hubei Province. In many industrialised countries, dental caries has declined dramatically over the last three decades, even when sucrose consumption has remained high. Most experts believe it is due to the widespread and regular twice-a-day tooth brushing with fluoride toothpaste (König, 1990; Bratthall et al, 1994). More recently, the increased availability, affordability and widespread use of fluoride toothpaste was found to be responsible for the decline of dental caries in children of Nepal (Yee et al, 2006). Supervised daily tooth brushing with fluoride toothpaste (1000–1100 ppm F) in a kindergarten in Guangdong Province and in kindergartens in Miyun County, Beijing, resulted in a 31% reduction of caries after 2 years and a 26% reduction in caries after 3 years (Schwarz et al, 1998; Rong et al, 2003).

RECOMMENDATONS

Increasing the availability and usage of affordable and effective fluoride toothpaste

Making available affordable and effective fluoride toothpaste should be a priority. A recent study on fluoride toothpastes in developing countries, including China, estimated that about one third of all tested fluoride toothpastes had insufficient anti-caries efficacy (van Loveren et al, 2005). Therefore, a system of regular and strict quality control on anti-caries efficacy should be established. Proper labelling of fluoride toothpaste is needed in Chinese with regard to its composition of ingredients, and method of use for small children consistent with recommendations specified in the WHO Basic Package of Oral Care (Frencken et al, 2003).

Strengthening school-based oral health promotion

School-based OHE should be integrated in the broader frame of health promotion. Since oral diseases share many risk factors common to other diseases (Sheiham and Watt, 2000), diet, hygiene, smoking, alcohol use, exercise and trauma are issues that should be addressed by a school health team (Table 1). This programme should be supplemented with daily brushing with fluoride toothpaste and supervised by schoolteachers. The success of such programmes is highly dependent of the participation of the community (i.e. parents, teachers, and school and health authorities).

Establishing basic school-based oral health care

Dental caries in school children will continue to occur under a regime of improved preventive care, but at a lower rate. Initial caries, which mainly occur in fissures, can be treated with ART sealants, and early stages of caries cavitation can be treated with ART restorations. Single-surface ART restoration has a 6-year survival rate of 72% (van't Hof et al, 2006). Dental nurses or dental therapists, if properly trained, are able to provide this type of care with high quality (Phantumvanit et al, 1996; Frencken et al, 1998) and at dramatically lower costs than the traditional high-tech approach (Estupiñán-Day et al, 2006).

Establishing MCH-based oral health promotion

The most important target group for the promotion of daily tooth brushing with fluoride toothpaste is preschool children. The rationale for prioritising oral health care for small children is that they are at the beginning of their life, and any success would maximise the chance for prevention of disease and the establishment of lifelong health habits (Mouradian, 2006). The promotion of self-care and prevention at the earliest age possible has a dramatic beneficial effect on caries levels later in life (Verrips et al, 1992). Since tooth brushing usually starts in Hubei children at around 5 years of age (NCOH, 1999) and since 39% of the 6-year-old children reported brushing less than once a day (Petersen et al, 1997), there is a need for improvement. At MCH centres, nurses can inform and show mothers how to care for their own mouths as well as their children's. In kindergartens and day-care centres, caretakers could supervise daily tooth brushing with pea-size amounts of fluoride toothpaste.

The levels of caries in the primary dentition of 5-year-old children in Hubei Province are appallingly high

Table 1 Health- promoting school program

• Safe water, e.g. for cleaning toothbrushes
• Healthy school canteen, e.g. vending machines and nearby tuck shops sell snacks and drinks conducive to health like sugar-free chewing gum instead of sugary snacks
• School premises and sport and playing grounds are safe for exercise and are not a risk for craniofacial trauma
• Emergency protocols are available, e.g. in the case of dental trauma, a fallen-off tooth should be kept in the mouth or in milk, and the child should immediately be referred to a dental clinic
• Tobacco and alcohol free school, which implies that also teachers do not drink alcohol and do not smoke in the school

(NCOH, 1999) and almost all caries is untreated. Painful, untreated caries in young children has severe impacts on their well being, because toothaches can alter eating and sleeping habits and have an impact on growth. Failure to thrive, characterised by poor weight gain in otherwise healthy children, has been associated with toothache (Elice and Fields, 1990). Young children with one pulpally involved tooth were lower in weight than control children (Acs et al, 1992). Subsequent tooth extraction in children with associated poor weight gain led to improvements in weight gain (Acs et al, 1992; 1999) and to significant improvements in the children's eating preferences, quality of food eaten, social behaviour and sleeping habits, as reported by their parents (Acs et al, 2001; Thomas and Primrosch, 2002; Filstrup et al, 2003). Tooth extraction of painful primary teeth can therefore be considered a preventive measure in general health. Nurses and care takers of pre-school children should be trained to recognise toothache in young children so as to inform parents that a visit with their child to the dentist is needed. Non-painful decayed primary teeth may be treated with silver diamine fluoride application to arrest dental caries (Chu et al, 2002; Llodra et al, 2005). This treatment can be provided by dental auxiliaries.

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